Quality features of Smoke Alarm Devices the compliance of which are certified by the EU Certification Mark and their Technical Verification Procedures

Contents

INDICATION: the German version of these Technical Guideline shall be binding.

1 References to Technical Standards and Rules

This guideline contains by means of dated and undated references definitions from other publications (for example European Standards [ES]) which are listed in the following:
For dated references to other publications, the amendments or revisions of these other publications are only part of this guideline if they are implemented into this guideline. For the purpose of this guideline the following cited dated standards will apply even if references are not dated in the further text of the standards.

EN 54-7: 2018	“Fire Detection Systems” – Part 7: Smoke Alarm Device – Point detectors using scattered light, transmitted light or ionization,
EN 14604: 2005/AC:2008	“Smoke Alarm Devices”
IPC-A-610F:2014-07	Acceptance criteria of electronic assemblies
EN 50130-4:2015-04	Alarm systems – Part 4: Electro-magnetic compatibility
EN 50131-5-3: 2017-09	Alarm Systems – Intrusion Alarm and Hold-up Systems Part 5-3 Requirements to transmission devices using radio frequency techniques
EN 61000-4-3:2011-04	„Elektro magnetic compatibility (EMC) - Part 4-3: Testing and measuring procedures – Immunity test against high frequency magnetic fields

The IPC-A-610 "Acceptance criteria for electronic assemblies" standard also applies. In this respect, the following applies:
At least IPC-A-610F:2014-07 applies, alternatively the newer version of IPC-A-610 used and documented by the manufacturer.

2 Terms

For application of this guideline the terms according to EN 14604, EN 54-7 and EN 50131-5-3 will apply and according to Art. 2 of the Regulation (EU) No. 305/2011 (construction product regulation) will apply as well.
Service life of the energy supply independent of mains power supply: Service life of the smoke alarm device.

3 General Remarks

In order to comply with the provisions of this guideline, smoke alarm devices shall comply with the following requirements:

3.1 All functionally relevant individual technical features of all Essential Features of all products defined as harmonized under Regulation (EU) No. 305/2011cited in Annex ZA of EN 14604 must be documented in the test report of the accredited testing body issued for the performance evaluation according to Regulation (EU) No. 305/2011 with information on the respective test result and included in the performance evaluation. The manufacturer of the product to be tested must have included or will include in future in the declaration of performance prepared or to be prepared for the product concerned corresponding information on all individual technical features relevant to the technical equipment of the smoke alarm device.

3.2 It is permitted to use additional modules (for example radio or relay modules) for the smoke alarm device if these additional modules are legally permitted and if using these modules, the smoke alarm device will still comply with all quality features as defined in

this guideline and adverse retroactive effects of the additional modules regarding the quality features will be excluded according to this guideline.

3.3 The general testing and connection conditions according to sections 5.1.1 to 5.1.6 of the EN 14604 will apply. The test plan for the quality tests in accordance with this guideline shall be defined in its relevant points according to that in section 5.1.7 of EN 14604. Upon agreement between the manufacturer and the authorized technical institute, adaption of the test pieces is permitted for example with regard to the software to reduce testing times. Amendments must be documented.

3.4 The applicant makes available at least 20 test objects of the product as tests pieces; the exact number will be defined by the assigned authorized technical institute at its own due discretion. Where justified, the authorized technical institute may require the manufacturer to provide a higher number of test objects or to provide further test objects for necessary additional tests. Regarding their design, calibration and complete functionality, the work pieces submitted for test shall be representative of the normal production of smoke alarm devices of the product or series concerned. For certain tests for example for reasons of adapting testing times it is permitted to amend the software integrated in the test pieces; such amendments must be documented.

3.5 Furthermore, the manufacturer provides:

a.) a technical documentation covering the product.
The documents will contain a concept or several concepts for implementing the requirements according to this guideline. A concept for implementation of this requirement according to this guideline shall include at least the following items:

aa) Description of how the requirement is technically implemented (for example the alarm function). This includes for example the components used and their possibly specific connection. A special set-up may be possibly required as well.

bb) Identification and evaluation according to the probability of occurrence and the impact of the possible causes of failure of the implementation used. A typical cause of failure is e.g. open circuit or short circuit of electrical connections.

cc) Statement of measures taken to appropriately deal with the identified relevant failure causes.

b.) a declaration in which the manufacturer confirms which version of the IPC-A-610 standard he has used and that the production of the series to which the test pieces belong to is carried out in accordance with this version of the IPC-A-610 Class 2 standard. A corresponding proof must be provided in the form of documents such as the quality plan, work and test instructions, etc.

c.) documentation as required in the version of the IPC-A-610 standard applicable in accordance with letter b).

4. Requirements and testing methods

4.1 Basic requirements regarding the functions

4.1.1 Primary function

The product for which the right to use the certification mark is sought or is to be sought must exclusively have the ability to detect fire smoke and, in the event of detection of fire smoke, the ability to alert the persons present in the installation room (primary function) in accordance with the provisions of EN 14604.

4.1.2 Auxiliary functions for the primary function

In addition to the primary function as defined in paragraph 4.1.1, the product shall have other functions only as auxiliary functions to the primary function 'fire smoke detection and warning'. Auxiliary functions support the primary function or monitor the functionality of the product with respect to this primary function. Such permissible auxiliary functions include e.g. transmit, receive and process wireless or wired signals from other smoke alarm devices, transmit wireless or wired signals to other external receivers, for the purpose of controlling the smoke inlets of the detector and for the purpose of controlling its surroundings (up to 50cm radius) for obstacles or an additional heat sensor to minimize false alarms, but always under the condition that the sensor technology used for such auxiliary functions does not provide for any alarm criterion independent of the primary function "fire smoke detection" and therefore does not trigger an alarm itself.

4.1.3 Secondary functions

A smoke alarm device for which the right to use the certification mark is sought or is to be sought may not have any other sensor technology for other fire parameters such as fire gases, heat, flame, etc. besides the primary function "fire smoke detection and alarm" in such a way that it provides for an alarm criterion itself and triggers an alarm (secondary functions).

4.1.4 The requirements listed below apply additionally in superordinate way to all detailed requirements dealt with in this Chapter 4:

- The primary and all auxiliary functions must be guaranteed for 10 years.
- The energy supply of the auxiliary functions/equipment shall be permanently installed and it shall not be possible to remove or replace it by simple means.
- Auxiliary functions and devices shall be non-reactive with respect to the smoke alarm device or its primary functions in accordance with No. 4.1.1 and shall in no way negatively influence the primary function.

4.2 Mains independent energy supply

4.2.1 Requirements

4.2.1.1 Mains independent energy supply for the operating current of the primary functions of the smoke alarm device

For smoke alarm devices exclusively powered with operating current by one or several mains independent power supplies it must be ensured that these mains independent power supplies have an operating life of at least 10 years.

The mains independent power supplies must be permanently installed and it shall not be possible to remove or replace it by simple means.

4.2.1.2 Mains independent power supplies for the operating current of the auxiliary functions of the smoke alarm device

The requirements according to 4.2.1.1 apply accordingly for mains independent power supplies for the operating current of the auxiliary functions of the smoke alarm device independent of the fact whether the power supply of the auxiliary functions is powered by means of a central mains independent power supply for all functions of the product or whether a separate power supply is provided for the power supply of the auxiliary functions. In as far as the auxiliary functions are provided by a separate module and the power supply of this module is not made from a central mains independent power supply for all functions of the whole smoke alarm device, but from a separate mains independent power supply within the module, this mains independent power supply must be permanently installed and it shall not be possible to remove or replace it by simple means.

4.2.1.3 Requirements regarding the service life of the mains independent power supplies for the primary and auxiliary functions of the smoke alarm device.

The manufacturer shall specify the type of the mains independent power supply and its expected operational life. The service life shall be based on the calculated and/or measured average power consumption and on the capacity of the mains independent power supply.

The manufacturer of the smoke alarm device must obtain the following information on the mains independent power supplies from the manufacturer of the mains independent power supplies or from suitable third parties and make it available to the authorized technical institute:

a.) Brand name;
b.) Type;
c.) Discharge profile of the mains independent power supplies at 20° C ambient temperature which allows an estimation of the capacity available for the smoke alarm device. If this information is not made available by the manufacturer of the mains independent power supplies, it may and has to be found out by the manufacturer of the smoke alarm device or it may be calculated by the testing institute.
d.) Self-discharge at 20° ambient temperature;
e.) Calculation of the expected lifetime of the mains independent power supplies including first storage and lifetime of the mains independent power supplies according to the exemplary calculation in Annex E.

If no information is provided regarding self-discharge losses of lithium or alkaline mains independent power supplies, the following values are to be assumed for calculation:

a.) Mains independent power supplies on lithium basis: 1 % per year;
b.) Mains independent power supplies on alkaline basis: 2.5 % per year.

For other mains independent power supply technologies information has to be provided.

4.2.2 Testing method for verification of the manufacturer's information
The verification of the manufacturer specification corresponds to the procedure described in EN 14604:2005 Section 4.15. for mains independent power supplies according to 4.2.1.1, however, at least for a service lifetime of 10 years.

4.3 Drop of supply voltage which results in generation of an interference of the mains independent power supply

4.3.1 Requirement
A drop below the triggering threshold for indication of an interference of the mains independent power supply shall not lead to an alarm signal of the device.

4.3.2. Testing Method
Starting from the voltage (VE) at which an interference indication has been generated (EN 14604 Section 5.16) the supply voltage (V) is reduced in steps of 0.1 V per minute down to a supply voltage value of 0V.

4.4 Protection against penetration of foreign matters

4.4.1 Requirements
The smoke alarm detector shall be designed in such a way that a bullet with a diameter of (1.3 ± 0.05) mm and a bar-shaped access probe with rectangular profile and edge length of (1.0 ± 0.05) mm x (2.0 ± 0.05) mm cannot penetrate into the measuring chamber.

4.4.2 Testing method
The required performance characteristics are theoretically checked by means of the documentation, by visual inspection and/or by a test of the smoke alarm devices introduced for testing.

4.5 Humid Heat, constant (long-term test 21 days)

4.5.1 Requirements
The relation of the response threshold values measured prior and after stress *m*max : *m*min shall not be larger than 1.6.
Operating the facility to make regular tests (EN 14604 Sect. 4.10) shall lead to an activation of the sound emitter.

4.5.2 Testing method
The testing method corresponds to EN 14604 Sect. 5.9, however, with an increased requirement regarding duration; it is 21 days. Additionally, following a climate impact and following a recovery time of at least one hour, activation of the facility to make regular tests (test button) is to be carried out.

4.6 Sulphur dioxide – (SO2-) corrosion (long-term test 21 days)

4.6.1 Requirements
The relation of the response threshold values measured prior and after stress *m*max : *m*min shall not be larger than 1.6.
Operating the facility to make regular tests (EN 14604 Sect. 4.10) shall lead to an activation of the sound emitter.

4.6.2 Testing method
The testing method corresponds to EN 14604 Sect. 5.10, however, with an increased requirement regarding duration; it is 21 days. Furthermore, following a corrosion impact

and following a recovery time of at least one hour, an activation of the facility to make regular tests (test button) is to be carried out.

4.7 Shock (in operation)

4.7.1 Requirements

The relation of the response threshold values, measured prior and after the impact, *m*max : *m*min must not be larger than 1.6.
Operating the facility to make regular tests (test button) (EN 14604 Sect. 4.10) shall lead to an activation of the sound emitter

4.7.2 Testing method

The testing method corresponds to EN 54-7 Sect. 5.13.
Additionally, following a mechanical impact, an activation of the facility to make regular tests (test button) has to be carried out.

Remark: The tests „shock” and “swinging” can be combined. After these two tests, the response threshold is measured according to the procedure defined in EN 14604 Sect. 5.12.

4.8 Electromagnetic Compatibility (EMC), Interference Immunity Tests, radiated electromagnetic fields

4.8.1 Requirements

The relation of the response threshold values, measured prior and after the impact, *m*max : *m*min must not be larger than 1.6.

4.8.2 Testing method

The testing method corresponds to EN 50130-4:2015-04 Sect. 10 “Radiated electromagnetic fields”. However, the field strength in the range 890-960 MHz is increased to 30V/m. The size of the steps of the throughput is 3 MHz.

4.9 Stress under change of temperature

4.9.1 Requirements

The relation of the response threshold values, measured prior and after the impact, *m*max : *m*min must not be larger than 1.6. During stress the test item shall not generate an alarm signal.

4.9.2 Testing method

The test item is stabilized at (25 ± 2)° C and is exposed 10 times to the following temperature cycle:
a) Temperature increase to (65 ± 2) °C in (2 ± 0.5) h;
b) Maintaining the temperature at (65 ± 2) °C up to 8.5 h after starting the cycle;
c) Reduction of temperature to (-10 ± 2) °C in (4 ± 1) h;
d) Maintaining the temperature at (-10 ± 2) °C up to 19.5 h after starting the cycle.
e) Temperature increase to (25 ± 2) °C in (2 ± 0.5) h;
f) Maintaining the temperature at (25 ± 2) °C up to 24 h after starting the cycle.

4.10 Safety relevant Functions

During operation the smoke alarm device shall at any time detect smoke at an early stage and if necessary emit an alarm. For this purpose, the presence of a power supply is indispensable.

4.10.1 Check regarding Function of the Smoke Sensors

4.10.1.1 Requirements

The function of the smoke sensors has to be monitored.

A malfunction preventing recognition of smoke has to be indicated; in this case there may be an appropriate delay of the malfunction from recognition to indication, however, not more than a maximum of 24 hours.

The manufacturer shall provide a documentation according to 3.5a from which the authorized technical institute may take the concept for the function of the smoke sensors.

4.10.1.2 Testing method

Based on the documentation provided by the manufacturer, a technical assessment of the concept is carried out at first with regard to

- Compliance with the requirement according to 4.10.1.1,
- Plausibility of the concept.

If the concept is not plausible, the manufacturer shall remedy possible deficiencies and shall submit the concept again for testing.

After establishing plausibility of the concept, following defined tests will be carried out:

For simulating interference or failure of the smoke sensors, they are put out of operation in coordination with the manufacturer and the authorized technical institute. Within a period of time to be taken from the manufacturer's documentation, however, at the latest 24 hours after the device has been put out of operation, an interference indication has to be indicated.

Remark 1: If necessary, the manufacturer shall provide means to simulate or to carry out the failure of the function of the smoke sensors.

Remark 2: For optimizing the testing procedure, it is permitted to shorten the duration by adjusting the test pieces, for example, the software. Such adjustment is to be carried out in coordination with the manufacturer and the authorized technical institute. The amendments have to be documented.

4.10.2 Check of the Alarm function

4.10.2.1 Requirements

The function of the acoustical signal emitter is to be monitored.

A malfunction leading to a failure of the signal emitter is to be indicated; in this case there may be an appropriate delay of the malfunction from recognition to indication, however, a maximum of 24 hours.

The manufacturer shall provide a documentation according to 3.5a from which the authorized technical institute can take the concept for the alarms.

4.10.2.2 Testing method

Based on the documentation provided by the manufacturer, a technical assessment of the concept is carried out at first with regard to:

- Compliance with the requirement according to 4.10.2.1,
- Plausibility of the concept.

If the concept is not plausible, the manufacturer shall remedy possible deficiencies and submit the concept again for testing.

After establishing plausibility of the concept, following defined tests will be carried out:

For simulating failure of the alarm function, this function is put out of operation (short circuit, interruption) in coordination with the manufacturer and the authorized technical institute. Within a period of time to be taken from the manufacturer's documentation, but at the latest 24 hours after failure of the signal emitter has been recognized, an interference indication has to be indicated if at that point of time failure of the signal emitter still exists.

Remark 1: If necessary, the manufacturer shall provide means to simulate or to carry out failure of the alarm function.

Remark 2: For optimizing the testing procedure, it is permitted to shorten the testing duration by adjusting the test pieces, for example, the software. Such adjustment will be carried out in coordination with the manufacturer and the authorized technical institute. The amendments have to be documented.

4.11 Radio Transmission for radio-linked Smoke Alarm Devices

Following requirements shall ensure a minimum quality for radio transmission between the smoke alarm devices among each other to ensure transmission of alarm messages and other messages. For this purpose, coverage and transmission comprehensibility are of importance.

4.11.1 Coverage

4.11.1.1 Basic Information

This section defines the testing procedure and performance criteria for radio- networked smoke alarm devices.
The coverage is dependent on ambient conditions, transmission power and sensitivity of the receiver. Last named parameters form the system capacity.
The transmission power of the radio transmission is impeded by the so-called „path attenuation" during transmission. This path attenuation is a physical size and is dependent on wave length λ or the frequency used.

4.11.1.2 **Requirements**

The minimum range in the „free field" shall be 200 m.
For this, the system capacity must be larger than the path attenuation.

4.11.1.3 **Testing Methods**

It shall be proven that the required minimum covering range or the covering range stated by the manufacturer for the free field (transmission performance) is achieved or exceeded by the radio transmission characteristics of the smoke alarm device.
To ensure that the transmission performance is sufficient for the field of application as defined in DIN EN 14604:2009-02 the transmission power of the radio transmission equipment must be measured and thereupon be compared with the theoretical free-field attenuation.

4.11.1.3.1 Calculation of the Attenuation in the Free Field

For the attenuation in the free field the following formula applies: $D = 10\log (4 \cdot \pi \cdot r / \lambda)^2$
Explanation:

λ = the wave length [m]; wave length [m] = 300/f [MHz]
r = the distance [m]
D = free field attenuation [dB]

4.11.1.3.2 Measurement of the maximum transmission capacity of the transmitter
The maximum transmission capacity (ERP) is to be measured according to EN300 220-2 by an accredited laboratory. The maximum radiated power (ERP) is to be converted into the effective isotropic radiated power (EIRP) by adding 2.15 dB

4.11.1.3.3 Measurement of the minimum reception sensitivity of the receiver
The minimum reception sensitivity (RS) is to be measured according to EN300 220-2 by an accredited laboratory, namely in the same alignment and antenna polarization which in 5.2.3.2 yielded the maximum ERP. This is to be carried out according to the radiated method. After the minimum level has been found out, the test piece is to be replaced by a replacement antenna to determine the minimum level of the reception sensibility of the receiver.

If no measurement result for the radiated sensitivity is available from a laboratory accredited to ETSI EN 300 220)*, the radiated sensitivity may be measured by the test house by using the method described in **Annex A.**

)* The laboratory must be accredited by an accreditation body. The signers of the Multilateral Mutual Recognition Arrangements of the European Co-operation for Accreditation (EA), the International Accreditation Forum (IAF) and the International Laboratory Accreditation Cooperation (ILAC).

4.11.1.3.4 Correction Factor

The relative transmission power of the test piece is measured in three orthogonal orientations in 5° steps with the test antenna being in vertical polarization. The procedure is repeated with the test antenna in horizontal polarization (i.e. 6 rotations in total).

The average power is calculated from all measured transmitting powers. The powers, converted into watts, are added and divided by the number of measurements. This average value, in watts, is then converted back into decibels (dBm).

The correction factor CdB is the maximum transmission power value minus the average power value (all measurements in 5.2.3).

4.11.1.3.5 Calculation of the Path Attenuation
The path attenuation is calculated from the average transmission power and the average reception sensitivity.

The average transmission power is calculated by subtracting the correction factor CdB from the maximum EIRP value (in 5.2.3.2) and the result is called avEIRP.

The average receiver sensitivity is calculated by adding the correction factor CdB from the minimum RS value (in 5.2.3.3) and the result is called avRS.

The path attenuation is calculated by combining the average transmission power with the average receiver sensitivity as follows:

avEIRP - avRS

The path attenuation D must at least comply with the required radio range as specified. It shall be checked mathematically using the formula or the **table C.1 in Annex C.**

Example for a typical calculation:
ERP 8 dBm
RS -92 dBm (including antenna gain -90 -2 dB)
CdB 6 dB
avEIRP (8+ 2,15 - 6) = 4,15 dBm
avRS (-92 + 6) = -86 dBm

Path attenuation D = avERP - avRS
= 4,15 dBm -(-86 dBm))
= 90,15 dB
For 868 MHz, this results in an RF range of >500 m, which can be considered as a pass.

4.11.1.3.6 Testing Requirement
The determined radio range shall be equal to or greater than the theoretical free field path attenuation for 200 m or a greater range if specified by the manufacturer (refer to Appendix E for this).

4.11.2 Transmission Comprehensibility
The aim of this requirement is to define the capability of the radio reception facility of the smoke alarm device to correctly interpret and carry out radio messages.

4.11.2.1 Requirements
999 messages of 1000 messages sent shall be correctly interpreted.

4.11.2.2 Testing method
The test is to be carried out in a shielded anechoic chamber. The manufacturer shall provide corresponding means to ensure transmission of the necessary number of alarm messages.
The transmission rate of alarm messages shall be determined by the manufacturer and confirmed by the testing institute. There have to be at least 5 alarm messages per minute.
The manufacturer is allowed to modify the reception facility in such a way that it will meet the conditions of this test.
Furthermore, the following will apply:

a) The combination of reception and transmission facility must be configured to the reference level value (refer to Annex D), increased by 6 dB.

b) The number of transmissions must be counted. This arrangement must not influence the output of the transmission facility.
c) The number of the received and decoded messages has to be counted. The arrangement must not influence the input of the reception facility.

4.12 Pollution Compensation

4.12.1 Requirements

The smoke alarm device shall have a tracking facility for the response threshold. The facility of a „drift compensation" for example to compensate the sensor drift because of dirt built-up in the device must not lead to a considerable reduction of the sensor sensitivity with respect to slowly developing fires.

As it is practically impossible to carry out tests with very slow increases of smoke density, an estimation of the detector response behavior with slow increases of smoke density has to be carried out by analyzing the circuit/software and/or by physical tests and simulations.

It is assumed that the smoke alarm device complies with the requirements of this section, if this estimation shows that:

a) for every increase speed of the smoke density R larger than A/4 per hour, here A is the initial uncompensated response value of the device, thus the time in which the test item releases an alarm and the value 1.6 x A/R is not exceeded by more than 100 s, and
b) the compensation range is restricted in such a way that the compensation in this range does not cause the response value of the detector to exceed its initial value by more than the factor 1.6.

A practical and technical assessment must be carried out to verify that the test pieces comply with the requirements of aforementioned items a) and b).

In case alternative technical procedures will be applied, the manufacturer is hold to prove them. For this purpose, the manufacturer has to establish his concept as a basis for the tests. In case the concept is not plausible, the manufacturer is hold to remedy the deficiencies and submit it again for testing. If plausibility has been verified by the test institute, further tests may result from the concept. It is thereupon necessary to summarize and carry out the tests in a test schedule. All tests must have been passed successfully.

4.12.2 Testing method

A practical or technical assessment is carried out to verify that the smoke alarm device meets the requirements of 4.12.1 with regard to items a) and b).

Remark: Further information regarding assessment of these requirements is cited in Annex A of the DIN SPEC 91388.

4.13 Permanent Deactivation after Disassembly

The aim of this requirement is the permanent deactivation of the smoke alarm device after disassembly to exclude alarms and any optical or acoustical messages prior to a possible re-assembly.

4.13.1 Requirements

It must be possible to permanently deactivate the smoke alarm device after disassembly to suppress alarms and any optical or acoustical messages; additionally, smoke measurement can be switched off as well.

The manner how this requirement is met is left to the manufacturer. The manufacturer is hold to document the technical details realized for deactivating the smoke alarm device.

4.13.2 Testing methods

Based on the documentation provided by the manufacturer, a technical assessment is carried out at first with regard to the concept:

- Compliance with the requirement according to No 4.13.1.,
- Plausibility of the concept.

If the concept is not plausible, the manufacturer shall remedy possible deficiencies and submit the concept again for testing.

After establishing plausibility of the concept, the authorized technical institute checks whether all technical details for deactivating the smoke alarm device are available at the test pieces.

4.14 Activation after re-assembly

4.14.1 Requirements

It must be ensured that a disassembled device turns again into operation after reassembly according to the manufacturer's specifications and that a fault state possibly existing during previous disassembly is signaled again and that during re-assembly another possibly existing fault state is duly recognized. Not only successful re-putting into operation but a fault state as well has to be distinctly signaled and indicated, respectively. According to the manufacturer 's specifications a total failure must be recognized.

4.14.2 Testing method

In step 1	the test piece is mounted according to the manufacturer's specifications, it is put into operation and a function test is carried out.
In step 2	the test piece is disassembled and possibly de-activated.
In step 3	the test piece is re-assembled. Successful re-putting into operation according to the manufacturer's specifications must be signaled and indicated in a distinctive way.
In step 4	a permanent interference message is produced exemplarily by manipulation. Thereupon, the test piece is disassembled and if necessary de-activated.
In step 5	the test piece is mounted according to the manufacturer's specifications, put into operation and a function test is carried out. A still existing interference must be indicated immediately.

Remark 1: *The manufacturer must possibly provide for means to evoke a permanent interference message at the test pieces.*

Remark 2: *This test can be carried out by means of special software or changed parameters to reduce the testing time.*

4.15 Communication modules for radio connection to the outside

4.15.1 Requirements

An interference of the communication module for communication to the outside which does not serve for communication of the smoke alarm devices among each other according to 4.11, must neither lead to a negative retroactive effect on the primary function and the auxiliary function of the smoke alarm device as well nor to any signaling at the smoke alarm device which may be perceived by persons present in the room of the installation.
An interference of this communication module may, if at all still possible, only be signaled to the reading point within the scope of remote readout

4.15.2 Testing method

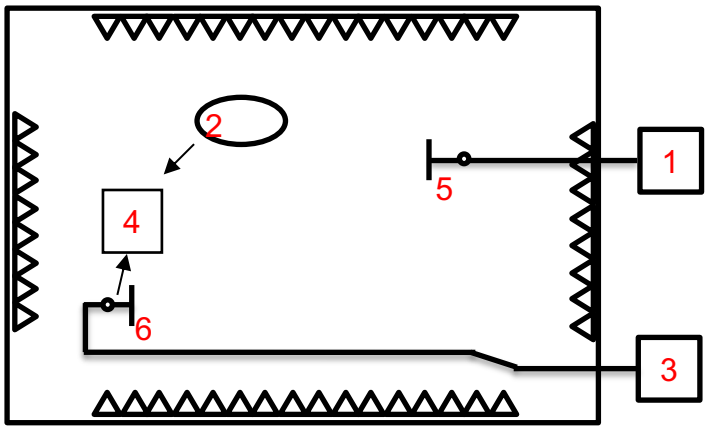
An interference of the communication module is to be generated at least in one way.
When the interference occurs and as long as it persists, the primary and auxiliary functions of the smoke alarm device shall be monitored.
No interferences or other impairments shall occur with respect to these functions.
None of the fault indications present in the test piece and perceptible to persons present, e.g. acoustic and optical indications, shall generate an interference indication (fault message) when the communication module is activated and during the existence of the fault.

Annex A

Testing Construction for Measuring the Transmission Capacity

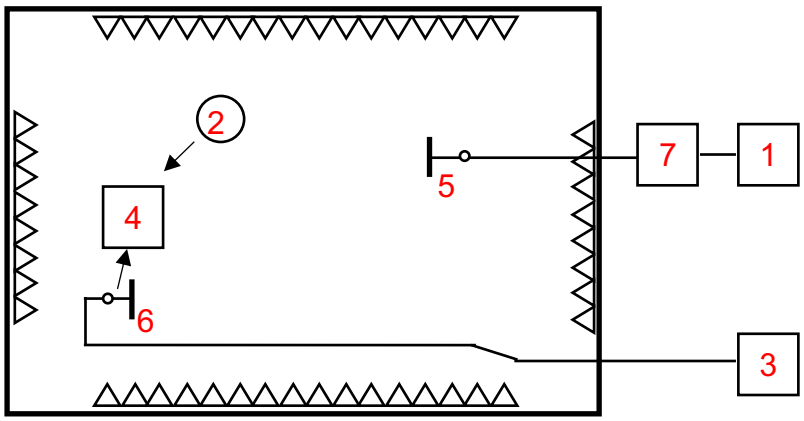
The means for testing must comply with EN61000-4-3.

Testing arrangement for determining the transmission capacity level of the transmitter
Fig. A.1



1 = Spectrum analysator
2 = DUT (transmitter)
3 = Signal generator
4= Measuring station
5= Measuring antenna
6 = Substitution antenna

Testing arrangement for determination of the lowest reception response sensitivity of the receiver
Fig. A.2



1 = Telegram generator
or transmitter in coupler box
2 = DUT (transmitter)
3 = Spectrum analysator
4 = Measuring station
5 = Measuring antenna
6 = Substitution antenna
7 = HF attenuator

Annex B

Graphics of the Angles for the Testing Construction

The following figures show in which directions the transmission capacity has to be measured.

Fig. B1: Test piece in horizontal position on the rotable disk

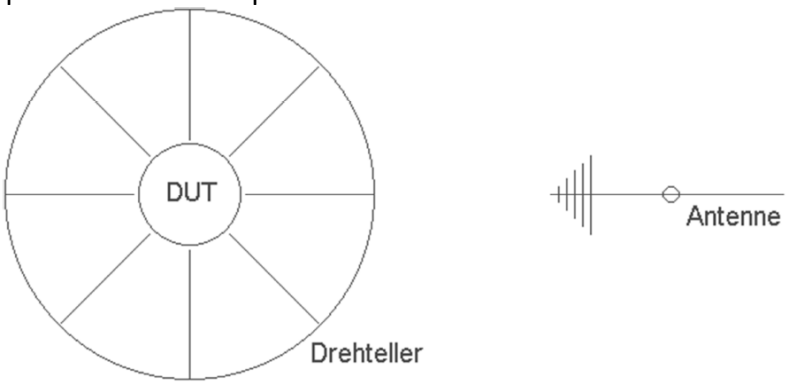


Fig. B.2: Device in vertical position on the rotable disk

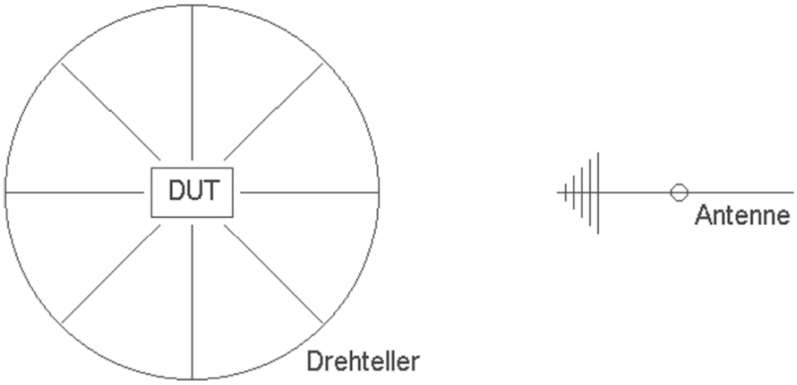
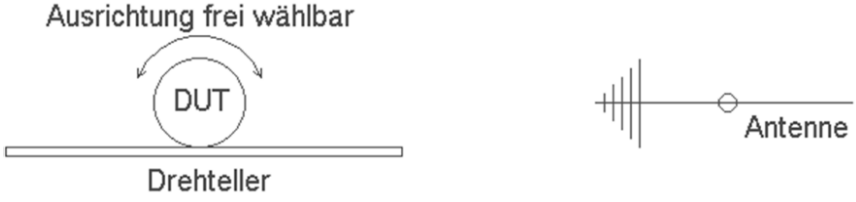


Fig. B.3: Explanation with regard to fig. B2



Annex C

Calculation of Attenuation in the Free Field

For calculation of the attenuation in the free field the following formula applies:

$D = 10\log (4 \cdot \pi \cdot r / \lambda)^2$

Explanation:
λ = wave length [m]; wave length [m] = 300/f [MHz]
r = space [m]
D = free field attenuation [dB].

The following table shows the required minimum transmission capacity in dB in dependency of the frequency (in MHz) and the free field space (in m's).

Table C.1

Frequency [MHz]	Free field space [m]									
	50	100	150	200	250	300	350	400	450	500
13,56	29 dB	35 dB	39 dB	41 dB	43 dB	45 dB	46 dB	47 dB	48 dB	49 dB
27,12	35 dB	41 dB	45 dB	47 dB	49 dB	51 dB	52 dB	53 dB	54 dB	55 dB
40,68	39 dB	45 dB	48 dB	51 dB	53 dB	54 dB	56 dB	57 dB	58 dB	59 dB
434	59 dB	65 dB	69 dB	71 dB	73 dB	75 dB	76 dB	77 dB	78 dB	79 dB
868	65 dB	71 dB	75 dB	77 dB	79 dB	81 dB	82 dB	83 dB	84 dB	85 dB
2450	74 dB	80 dB	84 dB	86 dB	88 dB	90 dB	91 dB	92 dB	93 dB	94 dB

Annex D

Determination of the Reference Level (RL)

For testing the transmission comprehensibility (see 4.11.2.) the devices must be put into a receiving state, which at the moment ensures good reception. The level of this reception status – measured at the spectrum analysator according to Annex A – is called the reference level (RL).

This measurement shall be carried out by using the arrangement as shown in Annex A.

The signal generator for the useful signal is suitably modulated to simulate a signal transmitted or a real transmission facility may be used via an attenuator to adjust the HF-level. In case a real device is used, it should be observed that an appropriate separation is ensured that the receiver does not receive the transmitting device by crosstalk between cables and plug-in connectors when the attenuator is set to the highest value.

The measurement of the reference level shall be carried out under conditions (antenna polarization and alignment of the receiving unit) in which the receiving unit receives the highest signal.

For determination of the reference level (RL) the useful signal level is set to a value at which messages are reliably received and thereupon attenuated in suited steps until less than 80% of the alarm messages are received. Thereupon, the attenuation is to be reduced in smaller steps (for example 1 dB or 0.1 dB) until about 80% to 90% of the alarm messages are received. If this range cannot be achieved for technical reasons of the radio capacity, the figure next to this range is to be used. By no means, it should be less than 80%.

When this point has been reached, the useful signal level is increased by 3 dB and this level represents the reference level (RL).

EXAMPLE When the value observed at the spectrum analyzer is –80 dBm,

the reference level is –80 dBm + 3 dBm = –77 dBm.

Annex E
Non-binding example for calculating the expected service life of the mains independent power supply

For calculation the following constellation examples are listed:

E.1 Single smoke alarm device

Service life of the mains independent power supply required for 10 years of operation		**mAh**
1 year in storage with a consumption of (0,001 mA) · (24 h) · (365 days)	=	8.76
10 years of operation in standby state with an average consumption of (0,007 mA) · (24 h) · (365 days) · (10 years)	=	613.20
Monthly test of 5 seconds duration with a consumption of 40 mA $\frac{(40\ mA)\cdot(5\ s)\cdot(12\ per\ year)\cdot(10\ years)}{(60\ s)\cdot(60\ min)}$	=	6.67
Total value for 10 years of operation (mAh)	=	628.63
Capacity for a 4 minutes alarm with a consumption of 40 mA $\frac{(4\ min)(40\ mA)}{(60\ min)}$	=	2.67
Capacity for 30 days fault warning of the mains independent power supply with quiescent current (0,007 mA) (0,007 mA) · (24 h) · (30 days)	=	5.04
Current of acoustical signal 40 mA for 10 ms every 45 s for 30 days $\frac{(40\ mA)\cdot(10\cdot10\text{-}3\cdot24\ h)\cdot(30\ days)}{(45\ s)}$	=	6.40
Total value for 30 days fault warning of the mains independent power supply fault warning (6.40 + 5.04)	=	11.44

E.2 12 by means of high frequency-interconnected smoke alarm detectors with a single mains independent power supply in every device which powers not only the smoke alarm device but the radio frequency circuitry as well

Service life of mains independent mains power supply required for 10 years of operation **mAh**

The capacity requirements of the smoke alarm device correspond to the requirements of the smoke alarm device as per item E.1 above, however, with the exception that the monthly test consumption is increased by 0.22 mAh. It is pointed out that the testing of the interlinked function to be carried out every six months requires a slightly longer testing duration of the facility of 6 s instead of 5 s. This increases the monthly test requirement from 6.6667 mAh by

$$\frac{(40\ \text{mA})\cdot(1\ \text{s})\cdot(12\ \text{per year})\cdot(10\ \text{years})}{(60\ \text{s})\cdot(60\ \text{min})} = 0.22$$

Operation of the transceiver in standby operation for 10 years with an average consumption of

$$(0{,}005\ \text{mA})\cdot(24\ \text{h})\cdot(365\ \text{d})\cdot(10\ \text{years}) = 438.00$$

Radio frequency messages transmitted by the facility every 6 months with a consumption of 30 mA for 3.5 seconds test messages and 1.0 s for cancel message

$$\frac{(30\ \text{mA})\cdot(3{,}5\ \text{s}+1\ \text{s})\cdot(2\ \text{per year})\cdot(10\ \text{years})}{(60\ \text{s})\cdot(60\ \text{min})} = 0.75$$

Additional capacity required as the acoustical signal is repeatedly emitted while the other 11 units are submitted to a test every 6 months as well

$$\frac{11\cdot(40\ \text{mA})\cdot(6\ \text{s})\cdot(2\ \text{per year})\cdot(10\ \text{years})}{(60\ \text{s})\cdot(60\ \text{min})} = 14.67$$

Additional capacity required due to the radio frequency messages from the other 11 units being tested every 6 months as well (due to mesh configuration)

$$\frac{11\cdot(30\ \text{mA})\cdot(3{,}5\ \text{s}+1\ \text{s})\cdot(2\ \text{per year})\cdot(10\ \text{years})}{(60\ \text{s})\cdot(60\ \text{min})} = 8.25$$

Total value for 10 years interlinked operation of 12 units = 461.67

Generation of radio frequency signals during a 4-minute alarm

$$\frac{(30\ \text{mA})\cdot(10\ \text{s})}{(60\ \text{min})\cdot(60\ \text{min})} = 0.08$$

Generation of radio frequency signals during 30-days-mains independent power supply fault warning for 30 days (total duration of transmissions 12 s)

$$\frac{(30\ \text{mA})\cdot(12\ \text{s})}{(60\ \text{min})\cdot(60\ \text{min})} = 0.1$$

E.3 12 by means of high frequency interconnected smoke alarm devices with 2 mains independent power supplies in each smoke alarm device – one for powering the smoke alarm device and one for powering the radio frequency circuitry.

The required capacities are as calculated in E.1 and E.2, however, including the following changes:

a) The mains independent power supply of the smoke alarm device has to supply all the currents listed in E1. In addition, it has also to supply the current in E2, for the acoustical signal being emitted repeatedly while the other 11 units are tested as well (as the signal emitter of the radio frequency component is supplied by the smoke alarm device ‘s mains independent power supply) when test repetition is triggered via the interconnect.

b) The mains independent power supply of radio frequency module has to supply all currents cited in E2 with the exception of the 4th formula or specification.

E.4 Data of the mains independent power supply

For the purpose of these calculations it is assumed that either one or both of the following product types will be used (nominal capacity 1 600 mA).

a) Capacity available prior to the voltage reaching the low trip point for low capacity of the mains independent power supply for the warning of 2.5 V (from suitable diagram): 1 500 mA;

b) Capacity available when cell voltage of the mains independent power supply decreases from 2.5 V to 2.2 V: 100 mAh;

c) Self-discharge loss is calculated assuming a 1 % loss per year of the remainder of the service life of the mains independent power supply.

   Example:

   Under this assumption the following result is obtained: After a storage of more than 1 year, the capacity consumed by the product per year is subtracted for each year and the loss is calculated on the remaining capacity. For a single smoke alarm device consuming just 63 mAh per year the total self-discharge loss over the 11 year’s period is 140 mAh. For a smoke alarm device with radio frequency circuitry consuming 109 mAh per year the total loss of self-discharge is 120 mAh.

Single smoke alarm device (consumption: 63 mAh/year

Calculations of self-discharge loss of the mains independent power supply (1 % loss of the remaining value per year)

	Remaining capacity mAh	Consumed by device mAh	Self-discharge mAh
0	1 600.00	0	16.00
1	1 584.00	63	15.84
2	1 505.16	63	15.05
3	1 427.11	63	14.27
4	1 349.84	63	13.50
5	1 273.34	63	12.73
6	1 197.61	63	11.98
7	1 122.63	63	11.23
8	1 048.0	63	10.48
9	974.92	63	9.75
10	902.17	63	9.02
Total			139.85

Smoke alarm device with radio frequency connection (consumption: 63 mAh/year)

Calculation of self-discharge loss of the mains independent power supply (1 % loss of the remaining value per year)

	Remaining capacity mAh	Consumed by device mAh	Self-discharge mAh
0	1 600.00	0	16.00
1	1 584.00	109	15.84
2	1 459.16	109	14.59
3	1 335.57	109	13.36
4	1 213.21	109	12.13
5	1 092.08	109	10.92
6	972.60	109	9.72
7	853.44	109	8.53
8	735.90	109	7.36
9	619.54	109	6.20
10	504.35	109	5.04
Total			119.69

E.5 Service life of the mains independent power supply to be expected prior to and during duration of warning when capacity of the mains independent power supply is low.

E.5.1 Single Smoke Alarm Device

a) Service life of the mains independent power supply to be expected

Period of time until battery interference message (taking into account 1 year of storage and 11 years of self-discharge of 1,069 % per year) when using the values according to the afore-mentioned items E.1 and E.4 :

$$\frac{10 \text{ years} \cdot (1\,500 \text{ mAh} - 140 \text{ mAh})}{628.63 \text{ mAh}} = 21.6 \text{ years}$$

Remark: For simplicity's sake self-discharge after expiry of 11 years is neglected.

The lifetime to be expected according to the manufacturer's specification is more than 10 years, thus this value is acceptable.

b) Duration to be expected between interference message of the mains independent power supply and lowest operating voltage

Available total capacity after 4 min alarm using the values cited in items E.1 and E.4:

$$100 \text{ mAh} - 2.67 \text{ mAh} = 97.33 \text{ mAh}$$

From F.1 the value 11,44 mAh for 30 days interference message of mains independent power supply is taken that 97.33 mAh result in the following value:

$$\frac{30 \cdot 97.33 \text{ mAh}}{11.4 \text{ mAh}} = 255 \text{ d}$$

This value exceeds the required 30 days and is thus acceptable.

E.5.2 12 by means of radio frequency inter-connected smoke alarm devices with a single mains independent power supply, which powers not only the smoke alarm devices but the high frequency circuitry as well.

a) Lifetime to be expected

Period of time until interference message of the mains independent power supply is indicated, taking into account 1 year of storage and 11 years of self-discharge of 1.069 % per year when using the values according to the aforementioned items E.2 and E.4:

$$\frac{(10\text{ years})\cdot(1\,500\text{ mAh}-120\text{ mAh})}{628.63\text{ mAh}-0.22\text{ mAh}-461.67\text{ mAh})} = 12.65\text{ years}$$

Lifetime to be expected according the manufacturer's specifications is more than 10 years and is thus acceptable.

b) duration to be expected between interference message of the mains independent power supply and lowest operating voltage

Using E.1, E.2 and E.4. the total capacity available is:

$$100\text{ mAh} - 2.67\text{ mAh} - 0.08\text{ mAh} = 97.25\text{ mAh}$$

From E.1 and E.2 the following values are required:

$$11.44\text{ mAh} \mp 0.1\text{ mAh} = 11.54\text{ mAh}$$

for 30 days interference message of the mains independent power supply.

Thus, 97.25 mAh result in:

$$\frac{(30\text{ d})(97.25\text{ mAh})}{(11.54\text{ mAh})} = 252\text{ d}$$

This value exceeds the required 30 days and is thus acceptable.

E.5.3 12 by means of radio frequency inter-connected smoke alarm devices with two mains independent power supplies in every smoke alarm device – one for powering the smoke alarm device and one for powering the high frequency circuitry

The calculations for the mains independent power supply of the smoke alarm device are similar to those described under E.5.1, however, with the exception that the requirement of the current for high frequency connection is according to E.2.4 which causes the lifetime to be expected is changed as follow:

$$\frac{(10\ \text{years})(1\,500\ \text{mAh} - 120\ \text{mAh})}{(628.63\ \text{mAh} + 14.67\ \text{mAh})} = 21.45\ \text{years}$$

The lifetime to be expected of the mains independent power supply which powers only the high frequency circuitry is calculated by using the capacity mentioned under E.4 less the self-discharge loss and by dividing the required capacity mentioned under E.2 for high frequencies currents only as follows:

$$\frac{(10\ \text{years})(1\,500\ \text{mAh} - 140\ \text{mAh})}{(461.67\ \text{mAh} - 14.67\ \text{mAh})} = 30.43\ \text{years}$$

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