



BSI Standards Publication

Gas detectors - Electrical apparatus for the detection of carbon monoxide in domestic premises

Part 1: Test methods and performance requirements

National foreword

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Gas detectors - Electrical apparatus for the detection of carbon monoxide in domestic premises - Part 1: Test methods and performance requirements

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Gaswarngeräte - Elektrische Geräte für die Detektion von Kohlenmonoxid in Wohnhäusern - Teil 1: Prüfverfahren und Anforderungen an das Betriebsverhalten

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European foreword

This document (EN 50291-1:2018) has been prepared by Technical Committee CLC/TC 216 "Gas detectors", the secretariat of which is held by BSI.

The following dates are fixed:

- latest date by which this document has (dop) 2019-02-26
to be implemented at national level by
publication of an identical national
standard or by endorsement
- latest date by which the national (dow) 2021-02-26
standards conflicting with this document
have to be withdrawn

This document supersedes EN 50291-1:2010.

The main technical changes compared to the previous edition EN 50291-1:2010 are:

- End of Life indicator has been made mandatory and must include an audible and visible warning;
- Guidance has been added for assessing battery capacity and expected life;
- Requirements for mains powered alarms with back-up supply have been added;
- The number of potential interference gases has been increased;
- Tests have been added for an optional alarm silence facility;
- Requirements for the audible alarm and associated red visual signal have been clarified; low battery, fault and End-of-life audible and visual warnings are given in an informative annex;
- An informative annex has been added for apparatus displaying low (Warning) CO levels;
- Requirements have been added for apparatus using radio links;
- The sound output alarm requirement has been increased in line with the EN 14604 smoke alarm requirements.

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

1 Scope

This European Standard specifies general requirements for the construction, testing and performance of electrically operated carbon monoxide gas detection apparatus, designed for continuous operation in domestic premises. The objective is to detect defective fossil fuel or solid fuel appliances so that they can be repaired or replaced. The function of the standard is not to monitor low levels of CO for health purposes. (Annex F gives recommendations for units displaying low (warning) CO concentrations). The apparatus may be mains-powered or battery-powered. Such apparatus is intended to warn of an acute level of CO, enabling the occupant to react before being exposed to significant risk.

Additional requirements for apparatus to be used in recreational vehicles and similar premises are specified in EN 50291-2.

NOTE 1 For caravan holiday homes EN 50291-1 applies.

This European Standard specifies two types of apparatus, these are:

- type A – to provide a visual and audible alarm and an executive action in the form of a transmittable output signal that can be used to actuate directly or indirectly a ventilation or other ancillary device;
- type B – to provide a visual and audible alarm only.

NOTE 2 Both type A and type B apparatus can be interconnected.

This European Standard excludes apparatus for:

- the detection of combustible gases, other than carbon monoxide itself (see EN 50194-1);
- the detection of CO in industrial installations (see EN 45544-1, EN 45544-2 and EN 45544-3) or commercial premises;
- CO measurement for smoke and fire detection;
- CO measurement in car parks and tunnels.

NOTE 3 See EN 50545-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 50270, *Electromagnetic compatibility — Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen*

EN 50271:2010, *Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen — Requirements and tests for apparatus using software and/or digital technologies*

EN 50292, *Electrical apparatus for the detection of carbon monoxide in domestic premises, caravans and boats — Guide on the selection, installation, use and maintenance*

EN 60335-1:2012, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1:2010, modified)*

3 Terms and definitions

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

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>

3.1

ambient conditions

normal atmosphere surrounding the apparatus

3.2

clean air

air that has concentrations of less than 3 ppm of carbon monoxide and does not contain interfering and contaminating substances

3.3

domestic premises

any house or building being a place of residence or home of a household, family or person

3.4

fixed installation

apparatus which is intended to have all parts except replaceable batteries permanently installed

3.5

sensor

device, part of the apparatus, the output of which will change in the presence of carbon monoxide

3.6

sensing element

part of the sensor which is sensitive to the gas/vapour to be measured

3.7

volume ratio (V/V)

ratio of the volume of a component to the volume of the gas mixture

3.8

transmittable output signal

signal characterised by a standby and an activation state by which action may be initiated

EXAMPLE Triggering a ventilation device.

3.9

warm-up time

time interval between the time when the apparatus is switched on and the time when the apparatus is fully operational

3.10

alarm set points

fixed settings of the apparatus that determines the volume ratios and durations of exposure at which the apparatus will automatically initiate an alarm and, for type A apparatus a transmittable output signal

3.11

fault warning

visual and audible signal indicating a faulty or failed apparatus

3.12

mains-powered apparatus

apparatus designed to be powered by the normal domestic mains electrical supply, with or without an alternative power source

3.13

battery-powered apparatus

apparatus designed to be powered by batteries only

3.14

continuous operation

apparatus which is continuously powered with continuous or intermittent automatic sensing

3.15

recreational vehicle

recreational vehicles considered by this European Standard include recreational craft, caravans and motor caravans

Note 1 to entry: Other motorised vehicles like trucks are known to have residential accommodation. They are not recreational vehicles but are considered as similar premises in respect of this European Standard.

3.16

caravan holiday home

transportable leisure accommodation vehicle that does not meet requirements for construction and use of road vehicles, that retains means for mobility and that is for temporary or seasonal occupation

[Source: EN 13878:2003]

3.17

apparatus

carbon monoxide detection device, which may also be generically termed "detector", comprising the sensor, remote sensor if applicable, alarm and any other circuit components, power supply and, for type A apparatus, a means of providing an transmittable output signal

3.18

end-of-life

point in time when the apparatus should be replaced

3.19

sealed-for-life

self-contained apparatus where the battery, sensor or any other component cannot be tampered with or replaced

3.20

non-replaceable battery-powered apparatus

apparatus where the battery cannot be tampered with or replaced

3.21

free-field conditions

conditions where there are a minimum number of sound reflecting surfaces or radio frequency reflecting surfaces

3.22

detector

see 3.17

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

- U_E supply voltage at which the low battery warning is given.
 U_R rated battery voltage.
 R_A resistance at which the low battery warning is given with a supply voltage U_R .

5 Design requirements

5.1 General requirements

5.1.1 Unless otherwise stated, the requirements specified are applicable to both type A and type B apparatus.

5.1.2 The apparatus shall reliably detect the presence of carbon monoxide in domestic premises under the stated application conditions, shall produce an alarm, and in the case of type A apparatus, shall be able to initiate executive actions whenever the conditions (in terms of both level and duration) exceed pre-set alarm set points.

5.1.3 Apparatus which includes functionality additional to carbon monoxide detection shall perform according to the requirements of this European Standard and it is recommended that it meets the requirements of the applicable European Standard or equivalent relevant to the additional functionality.

5.1.4 The apparatus, electrical assemblies and components shall comply with the requirements of 5.2 to 5.14 and the performance requirements of Clause 6.

For apparatus utilizing radio links, the requirements of Clause 7 shall be met.

Apparatus shall be designed for continuous operation.

The apparatus shall not be class 0 as defined in EN 60335-1:2012, 3.3.7.

5.1.5 Where the CO sensor is replaceable, the design of the apparatus shall be such that replacement of the sensor does not affect compliance with the requirements of this European Standard.

This condition shall be verified using the information and the documentation given by the manufacturer of the apparatus.

5.1.6 The apparatus shall indicate end-of-life as per 5.5.4.

5.1.7 The apparatus shall be provided with an installation and maintenance instruction booklet or leaflet meeting the requirements of Clause 8.

5.1.8 The apparatus shall be designed so as to discourage unauthorised interference or adjustment.

5.1.9 Except for batteries and replaceable CO sensors, the apparatus shall not have any user replaceable or serviceable components.

5.2 Construction

The apparatus shall comply with the appropriate requirements of EN 60335-1 as listed in Table 1.

When the sensor is replaceable: Mechanical and/or electrical means shall guarantee the replacement of the sensor without errors. In the case of electrical recognition of the incorrect connection or absence of the sensor, the apparatus shall give an automatic signal of a fault. Moreover, it shall either be impossible, or recognized as an error, to connect a sensor not designed for carbon monoxide to a carbon monoxide apparatus.

Table 1 — Construction requirements

Constructional requirement	EN 60335-1:2012 (Sub)clause
Protection against access to live parts	8
Heating	Relevant parts of 11
Leakage current and electric strength at operating temperature	13
Moisture resistance	15.1 and 15.3
Leakage current and electrical strength	16
Overload protection of transformers and associated circuits	17
Abnormal operation	19
Mechanical strength	21
Construction	22
Internal wiring	23
Components	24.1, 24.2 and 24.4
Supply connection and external flexible cords	25.3
Terminals for external conductors	26
Provision for earthing	27
Screws and connections	28
Clearances, creepage distances and solid insulation	29
Resistance to heat and fire	30
Resistance to rusting	31

5.3 Visual indicators

5.3.1 The power supply visual indicator shall be fitted and shall be coloured green. For mains-powered apparatus the visual indicator shall be continuously illuminated. For battery powered apparatus the visual indicator shall flash at least once per minute.

NOTE Annex C provides further information on visual and audible fault indicators.

5.3.2 The visual alarm indicator shall be fitted and shall be coloured red.

5.3.3 The visual fault indicator shall be fitted and shall be yellow.

5.3.4 The visual indicators shall be marked to show their function. Alternatively the function of the visual indicator may be marked somewhere else on the apparatus.

5.3.5 The visual indicators shall be visible when the apparatus is installed in its operating position according to the manufacturer's instructions.

5.4 Alarms

5.4.1 The apparatus shall have an audible alarm, see 6.3.16.

5.4.2 The visual alarm indicator and audible alarm shall operate simultaneously at the set points as listed in Table 2.

5.4.3 An audible alarm shall have a continuous temporal pattern with no silent period greater than 6 s.

5.4.4 The red visual indicators shall flash continuously or in sync with the temporal pattern.

5.4.5 Once activated, the alarm shall remain in operation until the carbon monoxide concentration has reduced to below 50 ppm, unless silenced manually by the user.

Table 2 — Alarm conditions

CO concentration	Without alarm before	With alarm before
30 ppm	120 min	-
50 ppm	60 min	90 min
100 ppm	10 min	40 min
300 ppm	-	3 min

5.5 End-of-life

5.5.1 General

The end-of-life indicator shall be activated at a point that is determined either by prediction or inbuilt testing.

The manufacturer shall determine the minimum length of time, either by prediction or extended stability testing, until the application of test gas C would fail the requirements of Table 5.

5.5.2 Prediction of end-of-life

Where the apparatus utilizes the battery voltage to determine end-of-life, the manufacturer shall supply calculations of worst-case current consumption, worst-case battery capacity, typical duty-cycle, likely temperature excursions and sensor data to ensure that the operating lifetime of the battery does not exceed the lifetime of any other components including the sensor.

Where the apparatus utilizes the battery low voltage to determine end-of-life, the battery shall be tamperproof and it shall not be possible to remove it without the use of a tool.

The manufacturer shall submit to the test house, and retain evidence of, the methodology and any supporting calculations which have been used to predict the end-of-life.

NOTE 1 The end-of-life prediction evidence would normally include data from accelerated and other tests for example showing:

- adequate immunity to interference gases and potential contaminants;
- adequate immunity to leaking due to accretion of moisture under high humidity conditions (electrochemical sensors only);
- adequate immunity to drying out due to loss of electrolyte (electrochemical sensors only);

- adequate stability subsequent to extended temperature cycling tests;
- stability in long term tests in controlled conditions and field trials.

NOTE 2 The example of extended stability testing in Annex A can be used to support lifetime predictions.

5.5.3 Inbuilt testing of end-of-life

The manufacturer shall submit to the test house, and retain evidence of, the methodology and any supporting calculations which demonstrate the operation of the inbuilt testing of the end-of-life detection. This shall be a fully automated process.

The manufacturer shall submit to the test house, and retain evidence of, evidence that the frequency of testing is sufficient to detect the end-of-life, within 30 days of its occurrence.

5.5.4 End of life fault warnings

The end-of-life indication shall utilize either the visual fault warning or a separate end-of-life visual indicator.

NOTE The end-of-life audible indication should be clearly different from the gas alarm indication – see Annex C for an example.

5.6 Fault warnings

5.6.1 The apparatus shall provide an audible and visible fault warning within 10 min of loss of continuity or short circuit to the sensor if the sensor is replaceable or within 1 day if the sensor is non-replaceable.

5.6.2 The audible fault warning shall be clearly identified and different from a gas alarm.

5.6.3 The visual fault warning shall be as per 5.3.3.

5.6.4 The audible low battery warning shall be clearly identified and different from a gas alarm.

5.7 Alarm silence facility (optional)

5.7.1 The provision of a manually operated alarm silence button is optional.

5.7.2 The alarm silence button may be combined with the fault warning silence button (see 5.8) and the test button.

5.7.3 In an alarm condition the operation of the alarm silence button shall silence the audible alarm signal only. The visual alarm signal shall not be suppressed.

5.7.4 The audible alarm signal shall reactivate within 15 min from the time the alarm silence button is operated where the concentration of carbon monoxide surrounding the alarm remains at 50 ppm CO or greater. Continuous operation of the alarm silence facility shall not lead to the apparatus being silenced for more than 15 min without the audible alarm being reactivated.

5.7.5 It shall not be possible to create a silent period unless the apparatus is already in the alarm condition.

5.7.6 It shall not be possible to silence the alarm at concentrations above 300 ppm.

5.7.7 The user manual shall state that any remote silencing feature shall only be used in line of sight of the CO alarm.

5.8 Fault warning silence facility

5.8.1 The provision of a manually operated fault warning silence button is optional.

The alarm silence button may be combined with the fault warning silence button and the test button.

5.8.2 In a fault condition the operation of the fault silence button shall silence the audible fault signal only. The visual fault signal shall not be suppressed.

5.8.3 The audible fault warning shall reactivate within 24 h from the time the fault warning silence button is operated. Continuous operation of the fault warning silence facility shall not lead to the apparatus being silenced for more than 24 h without the audible fault warning being reactivated.

5.8.4 It shall not be possible to create a silent period unless it is already in the fault condition.

5.8.5 The fault warning silence button may be combined with the alarm silence button and the test button.

5.8.6 If the fault warning silence facility is activated, it shall not inhibit the audible alarm signal.

5.8.7 The user manual shall state that any remote silencing feature shall only be used in line of sight of the CO alarm.

5.9 Transmittable output signal (applicable for type A apparatus only)

The type A apparatus shall provide a transmittable output signal at each of the alarm conditions listed in Table 2.

Open-circuit or short-circuit failure of the transmittable output signal shall not prevent the correct operation of the apparatus as a stand-alone alarm.

The transmittable output signal shall be tested in accordance with 6.3.3.

5.10 Software-controlled apparatus

The apparatus shall fulfil the requirements of EN 50271.

5.11 Labelling

5.11.1 All text on the apparatus shall be in accordance with national regulations.

5.11.2 The apparatus shall carry durable label(s) or markings carrying the following information:

- a) the manufacturer's or supplier's name, trademark or other means of identification;
- b) the name of apparatus, model number (if any) and the type of gas to be detected;
- c) the number of this European Standard;
- d) the type of apparatus, A or B;
- e) the serial number or manufacturing date code of the apparatus;
- f) for mains-powered apparatus the electricity supply voltage and frequency and maximum power consumption;
- g) for battery-powered apparatus the type and size of replacement batteries (where replaceable);
- h) indication of the maximum lifetime recommended for the apparatus.

5.11.3 The markings b) and h) shall be clearly visible with the apparatus in a typical installed position.

5.11.4 Where the sensor is replaceable, the apparatus shall carry the next replacement date of the sensor that shall be clearly visible with the apparatus in a typical installed position. This data shall be updated in the apparatus at each revision or replacement of the sensor, with the new date given by the manufacturer. If the updating procedure provides the application of a pre-printed label, this shall be supplied with the new sensor with a warning to replace the previous label attached to the apparatus with the new one: Every sensor shall be provided with a marking which allows traceability of the manufacturing and calibration information of each single sensor (e.g. serial number, manufacturing batch/production date, expected lifetime of the apparatus, etc.).

5.11.5 The markings shall be legible and durable. The durability of the markings shall be checked by establishing that it cannot be removed when rubbed lightly with a piece of cloth soaked in petroleum spirit and then water. When symbols are used, they shall comply with EN 60335-1:2012, 7.6.

5.11.6 The apparatus shall carry a caution, on a label attached to the apparatus (or be marked on the apparatus), giving the following or equivalent information:

CAUTION: READ THE INSTRUCTIONS CAREFULLY
BEFORE OPERATING OR SERVICING.

5.12 Requirements for the use of batteries

5.12.1 Battery low voltage warning

Battery-powered apparatus shall give a visual fault indicator per 5.3.3 and a coincident audible fault warning before a decrease in the performance of the battery prevents correct operation of the apparatus. This shall not inhibit the alarm condition.

For a unit powered by a primary battery the low voltage warning duration shall be at least 30 days.

The battery low voltage warning shall be indicated by:

- a) a visual fault indicator per 5.3.3, and
- b) an audible indicator which sounds at least once per minute coincident with the visual indicator.

The battery low voltage warning audible indication shall be clearly different for the gas alarm indication.

If the apparatus is in an alarm condition, the low battery indications shall be overridden and the alarm shall function as specified in 5.4.2.

If the fault warning silence facility is activated to silence battery low voltage warning it shall not inhibit the audible alarm signal.

5.12.2 Battery capacity

Batteries shall be capable of supplying the quiescent load of the apparatus together with the additional load of routine testing, for a period of 12 months, or longer if specified by the apparatus manufacturer, before the battery low voltage warning is given. At the point when the battery fault warning commences, the batteries shall have sufficient capacity to give an alarm signal as specified in 5.4 for at least 4 min in the event of CO, or in the absence of CO a battery fault warning for at least 30 days. The alarm manufacturer shall provide, to the test house, the discharge curves corresponding to the standby current of the alarm as well as accelerated discharge currents (for example 10X, 100X) for the batteries intended for use. This data and not the battery manufacturer data should be used to estimate the battery capacity.

Guidance on the calculation of the expected battery service life is given in Annex B.

5.12.3 Battery reversal

The battery reversal test shall be applied to apparatus incorporating replaceable batteries if there is any possibility of the apparatus being subjected to reversed polarity of the supply during normal battery replacement.

5.12.4 Battery connections

Where batteries are connected to a circuit board within the apparatus by flexible leads, strain relieving devices shall be fitted adjacent to both battery terminal connectors and the circuit board so that any pull on the leads shall not be transmitted to the battery terminals or circuit board.

5.12.5 Battery removal feature

The removal of any user-replaceable battery used to power or provide back-up power, for the apparatus shall result in a visual warning that the battery has been removed. The visual warning shall not depend upon a power source.

Conformity may be achieved by, but is not restricted to, one of the following examples:

- a) a warning flag that will be exposed with the battery removed and the cover closed;
- b) a hinged cover or battery compartment that cannot be closed when the battery is removed;
- c) a unit that cannot be replaced upon its mounting base/bracket with the battery removed.

5.13 Inter-connectable apparatus

5.13.1 The requirements of this sub-clause and the requirements of Clause 6 shall apply if connecting a number of apparatus to give a general alarm signal. For devices connected via a radio link the requirements of Clause 7 shall apply.

5.13.2 The audible alarm signal shall be emitted by all of the interconnecting apparatus when the alarm condition is activated by one or more of them. If the apparatus are provided with an alarm silence facility, initiation of the alarm silence period of one of the apparatus shall not prevent the audible alarm signal being emitted by that apparatus when the alarm condition is activated by any of the other alarms. The visual alarm indicator, see 5.3.2, shall only be activated on the apparatus that has detected the alarm condition.

5.13.3 The interconnection of the maximum number of apparatus allowed by the manufacturer shall not have a significant effect on the sensitivity of the apparatus nor their ability to meet the battery capacity, (see 6.3.18) or sound output requirements (see 6.3.16).

5.13.4 Open or short-circuits of the interconnecting leads either shall not prevent the apparatus from functioning individually or shall result in an alarm condition or fault warning. This requirement does not apply to mains, or mains/battery supplied apparatus, for which the supply and interconnect wiring should be installed in accordance with the appropriate national regulations.

5.13.5 The apparatus shall be tested in accordance with 6.3.21.

5.14 Back-up power source

5.14.1 General

For apparatus intended for connection to an external power supply, for which an integral backup/standby power facility is provided, the following requirements shall apply:

- a) primary cell battery back-up: the back-up power supply shall be capable of meeting the requirements of 5.12.1;

- b) rechargeable back-up power sources: the back-up power source shall be capable of supplying the quiescent load of the apparatus for a minimum period of 72 h followed by an alarm signal as specified in 6.3.16 for at least 4 min in the event of alarm activation, or in the absence of an alarm condition, a fault warning for at least 24 h. For a mains powered unit with a rechargeable back-up, when the mains is removed, the low voltage warning duration shall be at least 24 h.

In the absence of suitable test procedures to verify the back-up power source, data concerning the apparatus loads and the back-up facility characteristics shall be used to indicate that the above requirements can be met.

5.14.2 Monitoring of back-up power source

The back-up power source shall be monitored by the apparatus for faults. These faults shall include low back-up, open circuit and short circuit failure of the back-up (see 6.3.24).

6 Test and performance requirements

6.1 General requirements for tests

6.1.1 Test samples for type testing

Testing shall be carried as in the schedule outlined in Table 3. A sample selection of specimens shall be numbered individually for the tests defined. Additional specimens shall be provided as required.

Table 3 — Test specimens and suggested test sequence

Test	Clause	Specimen number
Unpowered storage	6.1.5	All
Construction	5.2	3, 4
Drop test	6.3.15	2
Transmittable output signal	6.3.3	5, 6, 7
Alarm Conditions	6.3.4	5, 6, 7
Alarm during warm up time	6.3.5	5, 6, 7
Temperature effect	6.3.7	5, 6, 7
Humidity effect	6.3.8	5, 6, 7
Speed of test gas	6.3.9	5, 6, 7
Supply voltage variations	6.3.10	5, 6, 7
Electromagnetic compatibility	6.3.11	As required
Response to mixtures of carbon monoxide and other gases	6.3.12	5, 6, 7
Effects of other gases	6.3.13	5, 6, 7
Response and recovery to a high CO volume ratio	6.3.6	5, 6, 7
Long term stability	6.3.14	8, 9, 10
Battery fault warning	6.3.17	5, 6, 7
Alarm sound level	6.3.16	1, 3
Battery capacity	6.3.18	As required
Battery reversal	6.3.19	5, 6, 7

Test	Clause	Specimen number
Battery connections	6.3.20	11
Inter-connectable apparatus	6.3.21	5, 6, 7, 12, 13
Back-up power source	6.3.22	12
Stability in high humidity test	6.3.23	14, 15
Stability to low humidity test	6.3.24	16, 17
Apparatus using radio links	7	As required

6.1.2 Preparation of samples

The test sample apparatus submitted for testing shall be deemed representative of the manufacturer's normal production with regard to their construction and calibration.

The sample apparatus shall be prepared and mounted when applicable, in accordance with the manufacturer's instructions without modification.

The entire apparatus shall be subjected to the test conditions.

6.1.3 Use of mask for testing

The use of a mask is allowed for subjecting the apparatus to test gases. The design and operation of the mask used by the testing laboratory (in particular the gas pressure and velocity inside the mask) shall not influence the response of the apparatus or the results obtained. The manufacturer may provide a suitable mask with the apparatus.

6.1.4 Test chamber

The construction of the chamber shall be such as to ensure that the apparatus is exposed to a specific volume ratio of test gas in a reproducible manner.

6.1.5 Unpowered storage

Prior to the commencement of the series of type tests, all apparatuses shall have been subjected once to the following test sequence. The apparatus shall be removed from its packaging and placed in the test chamber.

NOTE It is not the intention to subject the apparatus repeatedly to this prior to each test.

The apparatus shall be exposed to the following conditions sequentially:

- a temperature of $(-20 \pm 2) ^\circ\text{C}$ for 24 h;
- temperature defined in 6.2.6 for 24 h;
- a temperature of $(50 \pm 2) ^\circ\text{C}$ for 24 h;
- temperature defined in 6.2.6 for 24 h.

For b) and d) the humidity shall be as per 6.2.7.

6.2 Normal conditions for tests

6.2.1 General

The test conditions specified in 6.2.2 to 6.2.8 shall be used for all tests unless otherwise specified. Before commencing any test sequence, the apparatus shall be allowed to warm-up for a minimum period of 1 h except for 6.3.5.

Removable parts, such as optional filters, windshields, or diffusion devices supplied or recommended by the manufacturer shall be attached or removed according to which condition gives the most unfavourable result for the test being conducted.

6.2.2 Test gases for alarm testing

The following CO test gas volume ratios, see Table 4, shall be used for alarm testing as described in 6.3.2.

Table 4 — Test gases

Test gas reference	CO volume ratio	Test gas volume ratio
A	30 ppm	27 ppm \pm 3 ppm
B	50 ppm	55 ppm \pm 5 ppm
C	100 ppm	110 ppm \pm 10 ppm
D	300 ppm	330 ppm \pm 30 ppm

6.2.3 Test gases for specified tests

For the long-term stability test, 6.3.14, the mixture of CO in air shall have a volume ratio of 10 ppm \pm 5 ppm.

For the high volume ratio test, 6.3.6, the mixture of CO in air shall have a volume ratio of 5 000 ppm \pm 250 ppm.

6.2.4 Speed of air and test gas

The speed of air or test gas in the test chamber shall be between 0,1 m/s and 0,5 m/s. In the case of a mask, the requirements of 6.1.3 apply.

6.2.5 Power supply

For mains powered apparatus, the electricity supply shall be within \pm 10 % of the nominal value declared by the manufacturer.

6.2.6 Temperature

The tests shall be performed using air and test gases of constant temperature \pm 2 °C within the range 15 °C to 25 °C throughout the duration of each test.

6.2.7 Humidity

The tests shall be performed using air and test gases of constant relative humidity (r.h.) \pm 10 % r.h. within the range 30 % r.h. to 70 % r.h. throughout the duration of each test.

6.2.8 Pressure

The tests shall be performed using air and test gases at ambient pressure \pm 2 kPa within the range of 86 kPa to 108 kPa throughout the duration of the test.

6.3 Test methods and performance requirements

6.3.1 General

6.3.1.1 Prior to testing, the sequence and methods of testing shall be agreed between the manufacturer and the persons undertaking the testing.

6.3.1.2 The apparatus shall comply with all the requirements under the specified test conditions. Unless otherwise stated, each test condition shall be separately varied while the others remain normal as defined in 6.2.

6.3.1.3 When the apparatus is switched on, a warm-up time during which the apparatus is not in an active monitoring mode, is acceptable.

6.3.2 CO gas test

6.3.2.1 Whilst the sequence of tests is recommended it is not mandatory. They shall be carried out in clean air or the test air gas mixture as appropriate.

6.3.2.2 For all testing of alarm conditions, expose the apparatus sequentially to the following test gases as specified in Table 4:

- a) to clean air for 15 min;
- b) to test gas A for 120 min;
- c) to clean air for 15 min;
- d) to test gas B for 90 min or until the alarm activates if less than 90 min;
- e) to clean air for 15 min;
- f) to test gas C for 40 min or until the alarm activates if less than 40 min;
- g) to clean air for 15 min;
- h) to test gas D for 3 min or until the alarm activates if less than 3 min;
- i) to clean air for 15 min.

The exposure build up to the test gas volume ratio shall be less than 10 % of the maximum duration of the test as defined in Table 5, or 1 min, whichever is greater.

The time to alarm shall be measured from the instant that the lower limit of the volume ratio is reached.

Between each gas exposure it is permitted to reset the apparatus.

6.3.2.3 The apparatus shall respond as per Table 5 unless otherwise specified in the test.

Table 5 — Alarm conditions for test gases

Test gas reference	Without alarm before	With alarm before
A	120 min	-
B	60 min	90 min
C	10 min	40 min
D	-	3 min
NOTE It is not expected that the apparatus will alarm with Test gas A beyond 120 min.		

6.3.3 Transmittable output signal

6.3.3.1 Test

For type A apparatus, verify, during every test with the exception of the drop test, see 6.3.15, the state of the transmittable output signal according to the manufacturer's specification.

6.3.3.2 Performance requirement

The apparatus shall provide the transmittable output signal in accordance with the manufacturer's specification.

6.3.4 Alarm conditions

6.3.4.1 Test

Under the environmental conditions specified in 6.2.2 to 6.2.8, test the alarm conditions as described in 6.3.2.2.

6.3.4.2 Performance requirement

When exposed to CO - air mixtures in Table 4, the alarm shall operate according to the conditions in Table 5. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

6.3.5 Alarm during warm-up time

6.3.5.1 Test

Mount the apparatus in clean air for 24 h in an un-energized condition. Introduce the test gas D and immediately switch-on.

6.3.5.2 Performance requirements

The apparatus shall alarm within 15 min of being switched-on.

6.3.6 Response and recovery to a high CO volume ratio

6.3.6.1 Test

Expose the apparatus sequentially to the following test gases in step change sequence:

- to clean air for 15 min;
- to 5 000 ppm CO (high CO volume ratio) as specified in 6.2.3 for 15 min;
- to clean air for 1 h;
- to test gas B for 90 min or until the alarm activates if less than 90 min;
- to clean air for 15 min.

The exposure build up to each test gas volume ratio shall be less than 10 % of the maximum duration of the test as defined in Table 5, or 1 min, whichever is greater.

6.3.6.2 Performance requirement

The apparatus shall not alarm during the initial exposure to clean air.

The apparatus shall alarm within 3 min when exposed to the high CO volume ratio.

After the exposure to the high CO volume ratio, the apparatus shall recover from the alarm state within 15 min, when exposed to clean air.

The apparatus shall alarm according to the conditions stated in Table 5 for test gas B.

After the exposure to test gas B, the apparatus shall recover from the alarm state within 6 min, when exposed to clean air.

6.3.7 Temperature effects

6.3.7.1 Test

Expose the apparatus to a temperature of $(-10 \pm 1) ^\circ\text{C}$ for at least 6 h, followed by the temperature defined in 6.2.6 for at least 6 h and finally to a temperature of $(40 \pm 1) ^\circ\text{C}$ for at least 6 h. The clean air and test gas shall be equalised with the temperature conditions of the apparatus. At the end of each exposure interval and before conditions are changed, subject the apparatus to the test gases as described in 6.3.2.2.

6.3.7.2 Performance requirement

When exposed to CO - air mixtures in Table 4, the alarm shall operate according to the conditions in Table 5. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

6.3.8 Humidity effects

6.3.8.1 Test

Expose the apparatus to a humidity of $(30 \pm 5) \% \text{ r.h.}$ at $(15 \pm 2) ^\circ\text{C}$ for a period of at least 6 h followed by an exposure to $(90 \pm 5) \% \text{ r.h.}$ at $(40 \pm 2) ^\circ\text{C}$ for a period of at least 6 h. The clean air and test gas shall be equalised with the temperature and humidity conditions of the apparatus. At the end of each exposure interval and before conditions are changed, subject the apparatus to the test gases as described in 6.3.2.2.

6.3.8.2 Performance requirement

When exposed to CO - air mixtures in Table 4, the alarm shall operate according to the conditions in Table 5. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

6.3.9 Air velocity test

6.3.9.1 Test

Expose the apparatus to the test gas A at an air velocity of $(1,2 \pm 0,1) \text{ m/s}$ for 2 h in a flow chamber with the apparatus in the normally mounted position.

6.3.9.2 Performance requirement

Throughout the test, the alarm shall not operate.

6.3.10 Supply voltage variations (mains powered apparatus only)

6.3.10.1 Test

Set up the apparatus under normal conditions; see 6.2, at the rated supply voltage U_n and frequency. Subject the apparatus to test gas C in Table 4 at a rated supply voltage of $U_n + 10 \% U_n$. Repeat the test at a supply voltage of $U_n - 15 \% U_n$.

6.3.10.2 Performance requirement

When exposed to test gas C in Table 4, the alarm shall operate according to the conditions in Table 5. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

6.3.11 Electromagnetic compatibility

6.3.11.1 Test

Test the apparatus, including the sensor and any interconnecting wiring for electromagnetic compatibility in accordance with EN 50270.

One sample shall be subjected to each test.

6.3.11.2 Performance requirements

The apparatus shall meet the requirements of EN 50270.

6.3.12 Response to mixtures of carbon monoxide and other gases

6.3.12.1 General

As it is not possible to obtain a stable, ready mixed, test gas mixture as required for this test, Table 6 describes three components which when mixed together in the relative proportions given, will produce a suitable test gas.

Table 6 — Composition of test gas mixture

Component	Test gas volume ratio	Balance gas	Relative proportion in total volume	Calculated volume ratio in the final mixture
1	(60 ± 3) ppm CO, (33 ± 3) ppm H ₂ , (5 500 ± 300) ppm CO ₂	Air	18	54 ppm CO, 30 ppm H ₂ , 4 950 ppm CO ₂
2	(100 ± 10) ppm NO	Nitrogen	1	5 ppm NO
3	(100 ± 10) ppm SO ₂	Air or nitrogen	1	5 ppm SO ₂

Component 1 shall be humidified prior to mixing with components 2 and 3. The overall mixture shall comply with the requirements of 6.2.7.

NOTE NO and SO₂ volume ratios in the resulting test gas might be different from the calculated results because of the reaction between NO, SO₂, O₂, and water vapour.

6.3.12.2 Test

Expose the apparatus sequentially to:

- clean air for 15 min,
- a mixture, the composition of which is described in Table 6, for 90 min or until the alarm activates if less than 90 min, and
- clean air for 15 min.

6.3.12.3 Performance requirement

The apparatus shall not alarm during the initial exposure to clean air.

When exposed to test gas mixture in Table 6, the alarm shall operate according to the conditions in Table 5 for test gas B. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

6.3.13 Effects of other gases

6.3.13.1 Test

The apparatus shall be consecutively exposed to the following gases in air in the specified order under the conditions specified.

The test chamber shall be purged with clean air for a minimum of 1 h between and following exposure to all the interference gases listed below.

Using a syringe or equivalent device add the calculated amount of each substance into the chamber at a rate and in a location such that it is well mixed with the air and does not cause localized high concentrations.

- a) Methane at a volume ratio of (500 ± 50) ppm for 2 h;
- b) ethyl acetate at a volume ratio of (200 ± 20) ppm for 2 h;
- c) hexamethyldisiloxane at a volume ratio of (10 ± 3) ppm for 40 min;
- d) ammonia at a volume ratio of (100 ± 10) ppm for 2 h;
- e) ethanol at a volume ratio of $(2\,000 \pm 200)$ ppm for 30 min;
- f) toluene at a volume ratio of (200 ± 20) ppm for 2 h;
- g) acetone at a volume ratio of (200 ± 20) ppm for 2 h.

The hexamethyldisiloxane test may be carried out with dry gas.

After exposure to all of the gases, the apparatus shall be subjected under normal conditions to test gas C.

6.3.13.2 Performance requirement

The apparatus shall not alarm when exposed to the gases listed in 6.3.13.1.

When exposed to test gas C in Table 4, the alarm shall operate according to the conditions in Table 5. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

6.3.14 Long term stability

6.3.14.1 Test

Mount the apparatus, expose it to a CO test gas mixture as specified in 6.2.3 and energize continuously for a period of 3 months.

At the commencement of the test and every month thereafter the apparatus shall be exposed to the test gases as specified in 6.3.2.

During the test, the ambient conditions shall remain within the overall bands specified in 6.2.6, 6.2.7 and 6.2.8 disregarding tolerances.

6.3.14.2 Performance requirement

The apparatus shall not alarm when exposed to the test gas as specified in 6.2.3.

When exposed to test gases A, B, C and D in Table 4, the alarm shall operate according to the conditions in Table 5. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

An additional extended stability test is recommended to be carried out by the manufacturer to generate statistical data according typical lifetime for the quality management of the product (see Annex A).

6.3.15 Drop test

6.3.15.1 Test

This test is not applicable to apparatus which is only intended to be permanently fixed to a surface.

The apparatus shall be dropped from a height of 1 m in each of three mutually perpendicular attitudes onto a concrete floor. Expose the apparatus to test gas C in Table 4.

6.3.15.2 Performance requirements

When exposed to test gas C in Table 4, the alarm shall operate according to the conditions in Table 5. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

6.3.16 Alarm sound level

6.3.16.1 Object

To demonstrate that the carbon monoxide alarm is capable of providing an adequate sound output.

6.3.16.2 Method of test

At least two samples shall be tested. Units intended additionally for multiple-station interconnection shall be tested in that configuration with the maximum line resistance and maximum number of networked alarms, and the sound output measured on the carbon monoxide alarm subject to an abnormal CO condition or equivalent. Mains powered CO alarms shall be tested when connected to a source of rated voltage and frequency. Battery powered (or equivalent) CO alarms shall be tested with the battery depleted to a point just above or at the battery fault warning level. Mains powered CO alarms incorporating a stand-by power source shall be tested both as mains and battery powered as described above.

NOTE If more than five CO alarms can be interconnected it is permissible to interconnect a minimum of five alarms and simulate the remainder by an equivalent electrical load.

The CO alarm shall be mounted on a mounting board as described in EN 54-3. The sound level shall be measured 3 m from the CO alarm either directly in front of the CO alarm or at an angle specified by the manufacturer within 45° of this.

A sound level meter conforming to EN 61672-1:2013, class 2 or better shall be used.

The A-weighted sound level shall be measured and recorded in dB using the F (Fast) detector indicator characteristic. In the case of fluctuating sound, the maximum value indicated during at least a complete cycle of the sound pattern shall be taken.

The measurement shall be made in a free field condition to minimize the effects of reflected sound energy. The ambient noise level shall be at least 10 dB (A) below the measured level produced by the alarm.

Free field conditions may be simulated by mounting the unit on a wooden board with the centre of the alarm under test at least 1,2 m above the ground (see EN 54-3) and with the microphone located 3 m from the unit and directly in front and conducting the test outdoors on a clear day with a wind velocity of not more than 8 km h⁻¹ and an ambient temperature of 15 °C to 25 °C.

Alternatively an anechoic chamber of not less than 28 m³, with no dimension less than 2 m and with an absorption factor of 0,99 or greater from 100 Hz to 10 kHz for all surfaces, may be used for this measurement.

6.3.16.3 Performance requirements

For battery operated alarms, the sound output shall be at least 85 dB(A) at 3 m after 1 min of alarm operation and at least 82 dB(A) after 4 min of alarm operation.

For mains powered alarms, the sound output shall be at least 85 dB(A) at 3 m after 4 min of alarm operation.

For both battery operated and main powered alarms, the maximum sound output shall not be higher than 110 dB(A) at 3 m after 1 min of alarm operation.

The maximum nominal frequency shall not exceed 3,5 kHz.

6.3.17 Battery fault warning

6.3.17.1 Test

Connect the apparatus to a stabilized power supply set to the rated battery voltage. Decrease the supply voltage from 10 % above the declared low battery voltage in stages of maximum 1 % of declared nominal

voltage U_E at intervals of at least 1 min, until the fault warning is given. Record the supply voltage at which the warning is given as U_E . At the voltage one step below the voltage at which the fault warning is given, expose the apparatus to test gas C in Table 4.

The voltage may be reduced in greater increments, when above 5 % of the fault warning voltage, if declared by the apparatus manufacturer.

Connect the apparatus to a stabilized power supply with a series variable resistor. Set the power supply to the rated battery voltage U_R . Increase the resistance of the series resistor from zero in increments of no more than 1 ohm for apparatus powered with more than 5 V and increments of 0,1 ohm for apparatus powered with 5 V or less, at intervals of at least 1 minute until the fault warning is given. Record the resistance of the series resistor at which the fault warning is given as R_A . With voltage U_R and resistance R_A in series expose the apparatus to test gas C in Table 4.

The resistance may be increased in greater increments, when above 5 % of the fault warning resistance, if declared by the apparatus manufacturer.

6.3.17.2 Performance requirements

When exposed to test gas C in Table 4, the alarm shall operate according to the conditions in Table 5 for the power supply conditions in 6.3.17.1. Recovery from the alarm state shall take place within 6 min when exposed to clean air. The unit shall give a low battery warning as per 5.4.6.

6.3.18 Battery capacity

6.3.18.1 Assessment

Guidance on the calculation of the expected battery service life is given in Annex B.

In the case of third party testing, the manufacturer shall supply details of the capacity of the recommended battery or batteries together with characteristic curves for voltage variation with time at $(20 \pm 20)^\circ\text{C}$ for appropriate values of current drainage.

The current drawn, over the period of 1 hr, by the apparatus in the quiescent and routine testing conditions shall be measured.

This information may be used to check by calculation that the requirements in 6.3.18.2 can be met.

6.3.18.2 Performance requirements

The assessment of 6.3.18.1 shall indicate that the battery or batteries are capable of operating the apparatus for the periods specified in 5.12.2.

The sound level specified in 6.3.16.2 is only required to be met at the start of the low battery voltage warning.

6.3.19 Battery reversal

6.3.19.1 Test

- a) With a new battery fitted, subject the apparatus to test gas C in Table 4;
- b) remove the battery and replace it in the apparatus with reverse polarity for 10 s to 15 s;
- c) remove the battery and replace it in the apparatus with the correct polarity. Subject the apparatus to test gas C in Table 4;
- d) remove the battery and apply a voltage to the apparatus of between U_E and $0,95 U_E$ as determined in 6.3.17.

6.3.19.2 Performance requirements

During stages a) and c) when exposed to test gas C in Table 4, the alarm shall operate according to the conditions in Table 5. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

During stage b) the power supply indicator shall not be activated.

During stage d) the low battery voltage warning shall be given.

6.3.20 Battery connections with flexible leads only

6.3.20.1 Test

Leads shall be subjected to a pull of (20 ± 2) N without jerks for 1 min in any direction allowed by the design.

6.3.20.2 Performance requirements

The strain relieving devices shall be effective in ensuring that strain is not imparted to the battery terminals or circuit board during the test. This shall be checked by visual inspection.

No visible or electrical damage should be evident after the test.

6.3.21 Inter-connectable apparatus

6.3.21.1 Test procedure

6.3.21.1.1 Connect the test apparatus with the maximum number of apparatus allowed in the manufacturer's instructions (see 5.13).

NOTE If more than five apparatus can be interconnected, by hard wiring it is permissible to interconnect a minimum of five apparatus and simulate the remainder by an equivalent electrical load.

In the case of radio link interconnection, at least five apparatus should be used or the maximum number specified by the manufacturer if lower than five.

Trigger one apparatus into the alarm condition using test gas C in Table 4 and check all of the interconnected alarms for an audible alarm signal.

If the apparatus have an alarm silence facility, operate the alarm silence control on the alarming apparatus and, during the alarm silence period, trigger another apparatus into the alarm condition using test gas D in Table 4. Check the interconnected apparatus for an audible alarm signal, including the apparatus in the alarm silence condition.

6.3.21.1.2 With the apparatus interconnected in accordance with 6.3.21.1.1, subject the apparatus to test gas C in Table 4.

6.3.21.1.3 For battery-operated apparatus repeat the test in 6.3.21.1.2 with the interconnecting leads, if fitted, short circuited.

6.3.21.1.4 With apparatus interconnected in accordance with 6.3.21.1.1, repeat the sound output test in 6.3.16 on one of the apparatus. During this test ensure that the other interconnected apparatus are sufficiently screened or distanced so that their audible alarm signals do not influence the measurement.

6.3.21.1.5 Reassess the battery capacity requirements taking into account the load introduced by interconnecting the maximum permitted number of apparatus.

6.3.21.2 Performance requirements

6.3.21.2.1 All the interconnected apparatus shall give an audible alarm signal within 1 min when tested in accordance with 6.3.21.1.1.

6.3.21.2.2 When exposed to test gas C in Table 4, the alarm shall operate according to the conditions in Table 5. Recovery from the alarm state shall take place within 6 min when exposed to clean air.

6.3.21.2.3 The sound output shall be at least 85 dB(A) when measured in accordance with 6.3.16.

6.3.21.2.4 The assessment in 6.3.21.1.5 shall indicate that the battery capacity requirements specified in 5.12.2 can still be met.

6.3.22 Back-up power source

6.3.22.1 Objective

The objective is to demonstrate that the back-up power source is correctly monitored.

6.3.22.2 Test procedure

6.3.22.2.1 Low back-up

The test procedure set out in 6.3.17 shall be used to simulate the depletion of the back-up power source to the point where a low back-up warning is given.

6.3.22.2.2 Open circuit

The back-up power supply shall be disconnected or removed as appropriate and mains power applied to the unit.

6.3.22.2.3 Short-circuit

The back-up power supply shall be disconnected and replaced with a short-circuit between the backup terminals and the mains power applied to the unit.

6.3.22.2.4 Requirements

When tested as described in 6.3.22.2.1, a low back-up signal shall be obtained both with mains power to the unit and without mains power to the unit.

When tested as described in 6.3.22.2.2, the apparatus shall give an audible fault warning.

When tested as described in 6.3.22.2.3, the apparatus shall give an audible fault warning.

6.3.23 Stability in high humidity (non- condensing) test

6.3.23.1 Test

Two apparatus shall be exposed for 168 h to air at $(52 \pm 3) ^\circ\text{C}$ and $(90 \pm 4) \% \text{ r.h.}$ while energised normally.

Care should be taken to avoid condensation.

6.3.23.2 Performance requirements

The two apparatus shall not alarm when exposed to these conditions.

When returned to normal conditions, after at least 6 h but not more than 24 h, the two apparatus shall operate when exposed to test gas C in Table 4. Recovery from the apparatus state shall take place within 6 min when exposed to clean air.

6.3.24 Stability to low humidity test

6.3.24.1 Test

Two apparatus shall be exposed for 168 h to air at $(22 \pm 3) ^\circ\text{C}$ and $(10 \pm 3) \% \text{ r.h.}$ while normally energised.

6.3.24.2 Performance requirements

The two apparatus shall not alarm when exposed to these conditions.

When returned to normal conditions, after at least 6 h but not more than 24 h, the two apparatus shall operate when exposed to test gas C in Table 4. Recovery from the apparatus state shall take place within 6 min when exposed to clean air.

7 Apparatus using radio links

7.1 General

This clause specifies the requirements as regards test methods, and performance criteria for apparatus using radio links to connect to other apparatus.

7.1.1 RF range and reproducibility tests

The operating range of the specimens shall be greater than 100 m in free air or as specified by the manufacturer if longer.

This shall be tested in accordance with 7.2.1.2.

NOTE Field free conditions can be simulated in an RF anechoic chamber. It is acceptable to use the measured transmitter power and the measured receiver sensitivity to calculate the RF link budget and to convert this to the expected RF operating range using the accepted formulas.

7.1.2 Failure of radio link

If the radio transmission is faulty, it shall not impair the functioning of the individual apparatus.

This shall be tested in accordance with 7.2.2.

7.1.3 Identification codes

Radio apparatus shall have a sufficient coding scheme such as to render cross interference unlikely, for example by triggering alarms or receiving alarms from nearby systems.

There shall be a minimum of 65,000 identification codes.

Alternatively the manufacturer shall provide means to the user on site to choose the identification code with a minimum of 256 codes to ensure that a carbon monoxide alarm shall not interfere with other nearby systems.

This shall be tested in accordance with 7.2.3.

7.1.4 Environmental requirements

Equipment using RF links shall fulfil the environmental requirements defined in this standard.

This shall be tested in accordance with 7.2.4.

7.2 Radio link tests

7.2.1 RF Range

For these tests, initially the units are to be powered with batteries in good condition.

7.2.1.1 Transmission power test procedure

The transmission power of each specimen is determined in the most unfavourable transmission direction according to the manufacturer's specification. This may be measured for example in an RF anechoic chamber or under field free conditions. Where the units use different frequencies, it is to be measured at the highest frequency.

The apparatus with the lowest transmission power is identified and marked as "S1". It will subsequently be used for reference measurements so it shall not be used for any of the environmental tests in the other sections of this standard.

NOTE The transmission power test is to be done before the Gas Sensitivity Test. The unit "S1" is not to be tested as per 6.3.2 and it will therefore not be one of the units mentioned in that clause. (i.e. at least one additional sample must be supplied for the RF modules tests).

7.2.1.2 Receiver test

7.2.1.2.1 General

In the frequency band or channel used in 7.2.1.1, the receiver sensitivity of all the specimens (apart from "S1") is tested under field free conditions.

In this test apparatus "S1" is used as the transmitter, orientated such that its most unfavourable transmitting direction faces the receiver. Then each of the other specimens, in turn, is positioned at a distance of 100 m or as specified by the manufacturer if it is greater than 100 m, orientated such that the least sensitive direction of the receiver faces the transmitter. An alarm signal is then transmitted by "S1".

7.2.1.2.2 Requirements

Each of the apparatus tested shall receive the signal from the transmitting apparatus and generate an audible alarm signal within 30 s.

Other receiver equipment shall be similarly tested as per 7.2.1.2.

7.2.2 Failure of radio link tests

7.2.2.1 General

The manufacturer shall provide a means of disabling the radio transmission between two radio linked apparatus.

7.2.2.2 Requirements

The disabling of the radio transmission shall not result in change of state of the apparatus.

Each apparatus shall detect test gas C.

7.2.3 Identification codes verification tests

The manufacturer shall submit documentation describing how the coding operates.

The manufacturer shall demonstrate that either there is a minimum of 65,000 identification codes or the manufacturer shall demonstrate how the changeable 256 coding operates to fulfil the requirement.

7.2.4 Environmental tests

7.2.4.1 Procedure

The apparatus including their radio modules are subjected to the environmental tests in accordance with 6.3.7 and 6.3.8.

During the operational tests the apparatus including their radio modules are monitored.

After conditioning:

- trigger the conditioned carbon monoxide alarm into the alarm condition and check that one interconnected sample goes into alarm within 30 s.
- trigger the unconditioned carbon monoxide alarm into the alarm condition and check that the conditioned one goes into alarm within 30 s.

7.2.4.2 Requirements

Apart from the specific requirements in other parts of this standard the following additional requirements will also apply:

- during the operational environmental tests the apparatus shall not generate nor transmit any alarm or fault warning;
- following the endurance tests no alarm or fault warning shall be generated or transmitted upon commissioning;
- during the test procedure according to 7.2.4.1 each of the ready-to-receive apparatus shall receive the alarm signal from the transmitting apparatus and generate an audible signal within 30 s.
- during the test procedure according to 7.2.4.1 each of the ready to transmit apparatus shall transmit the alarm signal to the receiving apparatus and it shall generate an audible signal within 30 s.

8 User instructions

8.1 All text in the instructions shall be in accordance with national regulations.

8.2 The instructions shall give complete, clear and accurate instructions for the installation, safe and proper operation, and regular checking of the apparatus. The advice should be in compliance with that given in EN 50292.

8.3 The instructions shall include at least the following information:

- a) for mains powered apparatus, the correct operating voltage, frequency, fuse-rating (if any) and method of connection to the mains supply system;
- b) for battery powered apparatus the type and size of replacement batteries, normal operating life, battery replacement instructions, and information on low battery conditions;
- c) guidance on siting and mounting of the apparatus and the warning that the apparatus should be installed by a competent person;
- d) actions to take if the apparatus alarms;
- e) an explanation of all visual and audible indicators, including silencing facilities, see 5.7 and 5.8, where relevant;
- f) a list of commonly occurring materials, vapours or gases, e.g. in cleaning fluids, polishes, paints, cooking operations, etc., which may affect the reliability of the apparatus in the short or long term;
- g) warning of the risk of electric shock or malfunction if the apparatus is tampered with;
- h) instructions on the use of any relevant test procedure supplied with the apparatus;
- i) the expected lifetime of the apparatus;
- j) for type A apparatus, instructions on the use and characteristics of the transmittable output signal;
- k) a note stating the working ranges of both temperature and humidity;
- l) the alarm conditions;

- m) a description of the effects of carbon monoxide on the human body, stating that the apparatus may not prevent the chronic effects of carbon monoxide exposure, and that the apparatus will not fully safeguard individuals at special risk;
- n) warning that installation of the apparatus should not be used as a substitute for proper installation, use and maintenance of fuel burning appliances including appropriate ventilation and exhaust systems;
- o) In the case of apparatus using radio links, the manufacturer shall specify the frequency band or bands used;
- p) the user manual shall state that any remote silencing feature shall only be used in line of sight of the CO alarm.

8.4 Information for carbon monoxide alarms provided with an alarm silence facility shall include a warning that if there is any question as to the cause of an alarm it should be assumed that the alarm is due to dangerous levels of carbon monoxide and the dwelling should be evacuated.

9 Packaging

9.1 All text on the packaging shall be in accordance with national regulations.

9.2 The apparatus packaging shall display:

- a) a warning that the apparatus should be installed by a competent person,
- b) the relevant information regarding storage and transport, and
- c) the expected lifetime of the sensor if it could be affected by storage time and if different to the lifetime of the apparatus.

9.3 The package shall clearly display the following message:

<p>This apparatus is designed to protect individuals from the acute effects of carbon monoxide exposure. It will not fully safeguard individuals with specific medical conditions. If in doubt consult a medical practitioner.</p>
--

Annex A (informative)

Extended stability test – Sample protocol

A.1 General requirements

It is recommended that a sample of at least 30 apparatus, representative of the models being manufactured (particularly regarding the CO sensor), are selected at random. The apparatus can then be subjected to the extended long-term stability test as specified in A.2.

It is recommended that continuous testing over the lifetime period claimed by the manufacturer should be carried out.

NOTE Manufacturers can devise more stringent stability tests at their own discretion.

A.2 Test

The sample apparatus should be numbered and with the date of installation.

The sample apparatus should be energized continuously for the claimed lifetime period.

During the test, the ambient conditions should remain within the overall bands specified in 6.2.6, 6.2.7 and 6.2.8 disregarding tolerances.

At the commencement of the test and every three months (± 7 days) thereafter, expose each apparatus to test gas C in Table 4.

A.3 Performance requirement

At each application of test gas C in Table 4 the apparatus should not alarm within 10 min and should alarm within 40 min.

The lifetime period claimed by the manufacturer should be deemed to have been achieved based on at least a 90 % pass rate.

Annex B (informative)

Calculation of the expected battery service life

B.1 General requirements

The manufacturer should declare the type of battery and its expected service life in normal operation. The service life should be based on the mean current consumption and the capacity of the battery.

The battery manufacturer's data on self-discharge losses and their estimation of the expected life of the battery should be supplied.

The following is an example of how the calculations could be done for a 3 V carbon monoxide alarm using one Lithium Manganese Dioxide cell with a nominal capacity of 1 600 mAh.

B.2 Example

B.2.1 Capacity required for 1 year operation in milli Ampere hours (mAh)

		Value	mAh/year
1.1	Quiescent Current (mean consumption measured)	0,007 mA	61,3
1.2	Button Test for 10 s each week Test Current measured (40 mA)(10 s)(52 w)/(60 s × 60 min)	40 mA	5,7
Total Capacity Required for 1 year operation			67,0 mAh/year

B.2.2 Capacity required for 4 min alarm

Alarm (measured)	Current 40 mA (40 mA)(4 min/60 min)	2,7 mAh
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B.2.3 Capacity required for 30 days low battery beeping

3.1	Quiescent Current (30)(24)(0,007)	0,007 mA	5,0 mAh
3.2	Capacity required to give low battery beeps Sounding the horn (40 mA measured, as it could be different from alarm current) for 10 mS every 45 s (30)(24)(40 mA)(10 × 10 ⁻³)/45		6,4 mAh
Total Capacity for 30 days low battery beeping			11,4 mAh

B.2.4 Carbon Monoxide Alarm Voltage Operating Range

4.1	Low Battery Trip Point (declared by the manufacturer and confirmed by the test laboratory; measurement done with external power supply)	2,5 V
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- 4.2 Minimum Operating Voltage for Low Battery Beeps declared by the manufacturer 2,2 V and confirmed by the test laboratory; measurement done with external power supply)

B.2.5 Battery Data

- 5.1 Capacity available before voltage reaches the low battery trip point of 2,5 V (from suitable graph): 1 500 mAh
The battery voltage shall not fall below the low battery trip point during the one week at 0 °C or the one week at 45 °C).
- 5.2 Capacity available as cell voltage decreases from 2,5 V to 2,2 V: 100 mAh.
- 5.3 The cell manufacturers expected losses over 10 years is 10 % (or 150 mAh) at 20 °C.
At 45°C, continuously (assuming the losses double for every 10°C, increase in temperature and are stable from 20°C to 0°C) the losses could be expected to be 6 % per year. One week at 45 °C and 50 weeks at 20 °C and one week at 0 °C would give an expected loss of 1,096 % per year.
(Calculation of losses $(1 \% \times 51/52 + 6 \% \times 1/52 = 1,096 \%)$; the storage losses at 0 °C are assumed to be the same as the losses at 20 °C).

B.2.6 Expected Service Life

- 6.1 Duration before low battery beeps (allowing for 10 years self-discharge at 1,096 % per year) $(1\ 500 - 164)/67 = 20,0$ years.
The manufacturers stated expected life is over 10 years - so this is acceptable.
- 6.2 Capacity needed from Low Battery Trip Point to Minimum Operating Voltage:
 $2,7\text{ mA} + 11,4\text{ mA} = 14,1\text{ mA}$
Capacity available = 100 mA
 $100\text{ mA} > 14,1\text{ mA}$

The capacity available is sufficient to meet the requirements for alarm signal and low battery beeps from Low Battery Trip Point.

Annex C (informative)

Visual and audible fault indication sequences

It is suggested that the following indication sequences are used for visual and audible fault warnings.

Table C.1 — Visual and audible fault indication sequences

Mode	Audible Sounder	Alarm Red light	Power Green light	Fault Yellow light
Low battery	1 beep/min ^a	None	-	1 flash/min ^a
Fault	2 rapid beeps/min ^a	None	-	2 rapid flashes/min ^a
End-of-life	3 rapid beeps/min ^a	None	-	3 rapid flashes/min ^a
^a Audible beeps and light flashes shall be coincident, or within 100 ms before or after the audible beep.				

Annex D **(informative)**

A–deviations

A- deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN/ CENELEC member. b) **European Standard not under any EU Directive**

This European Standard does not fall under any Directive of the EU.

In the relevant CEN/ CENELEC countries these A- deviations are valid instead of the provisions of the European Standard until they have been removed.

<u>Clause</u>	<u>Deviation</u>
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General	Italy (Italian Law 6/12/1971 n. 1083 and Ministerial Decree 26/04/1995)
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Clause 4, “Concetti di affidabilità” of the Italian standard UNI-CEI 70028:1994” Rivelatori di gas naturale e rivelatori di GPL per uso domestico e similare” is maintained along with all the requirements of the present EN 50291–1.

Annex E (informative)

Test arrangement schematics

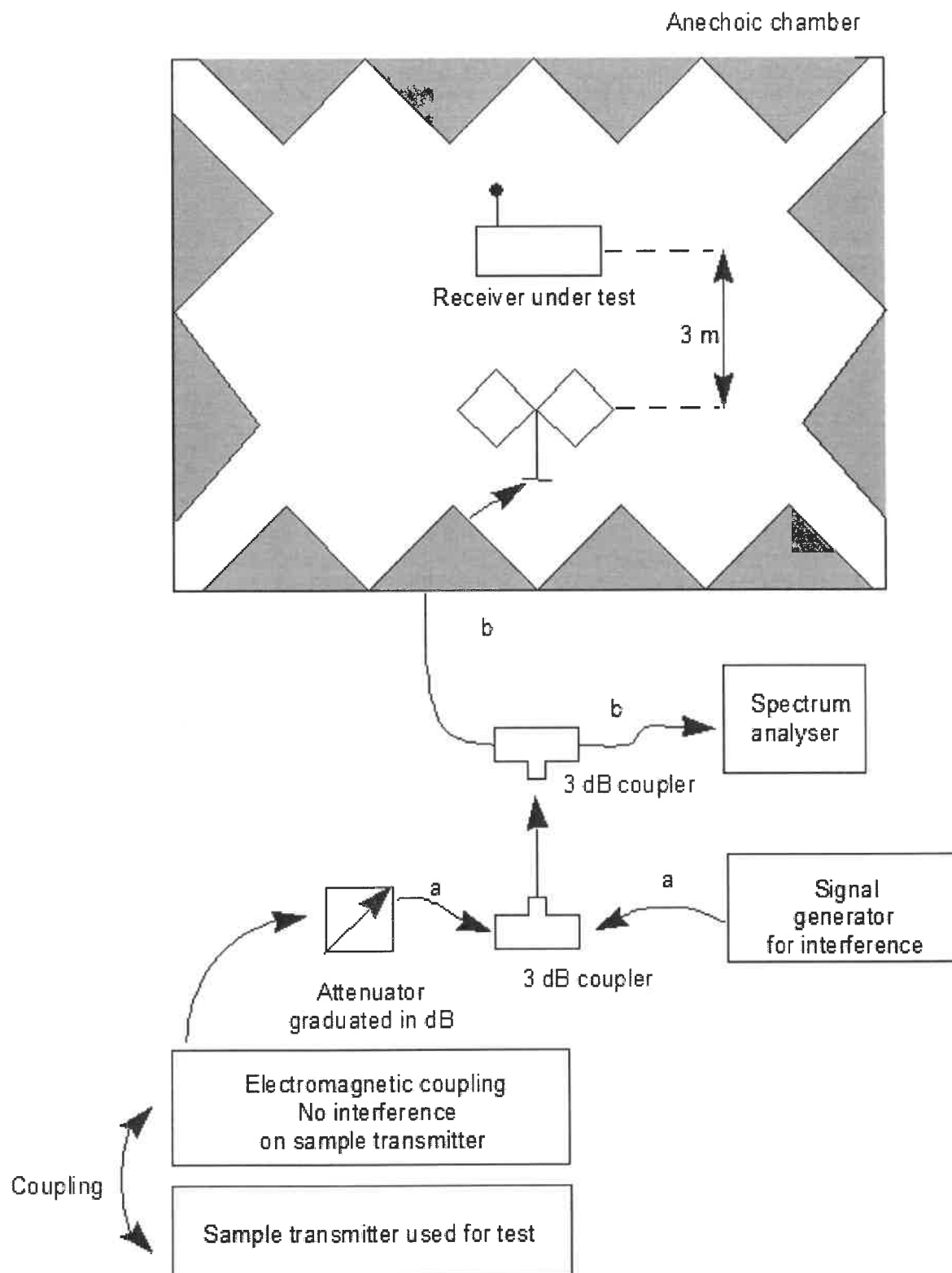


Figure E.1 — Generic test arrangement for receiver

Annex F (informative)

Additional requirements for units displaying low (warning) CO concentrations

F.1 General

Prolonged exposure to “low levels” of CO can impair people’s health. This is particularly true in the case of vulnerable groups such as children, pregnant women, elderly or people with respiratory, heart or other health conditions. Pets can also be more vulnerable.

The research work on the effects of passive smoking and smoking very occasional cigarettes may possibly be used further to confirm this.

This situation has led to the introduction by a number of manufacturers of carbon monoxide alarms with a function that allows low (warning) concentrations to be displayed. These typically have digital displays showing the CO concentration level in ppm CO from 10 ppm CO upwards.

This annex gives recommendations as regards how these should perform.

F.2 Requirements

If a carbon monoxide alarm has such a warning display function it should meet the following requirements:

- a) below 20 ppm CO, the apparatus should give no audible warning;
- b) to alert the user’s attention to prolonged low levels of CO, the unit should give a pre-warning short audible beep (or a few beeps together) every 1 to 5 min, but this audible warning must not be able to be confused with the full alarm sound;
- c) the accuracy of the apparatus should be at least half of the resolution interval displayed;
- d) no audible warning should be given until the CO has been present for the times given in Table F.1 (to prevent nuisance beeps due to momentary non- threatening short durations of CO from sources such as tobacco smoke).

Table F.1 — Audible warnings

CO Level (ppm)	Warnings
20	No audible warning before 30 min
30	No audible warning before 15 min

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