INTERNATIONAL STANDARD

ISO 23552-1

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Safety and control devices for gas and/or oil burners and gas and/or oil appliances — Particular requirements —

Part 1: Fuel/air ratio controls, electronic type

Dispositifs de commande et de sécurité pour brûleurs à gaz et/ou à fioul et pour appareils à gaz et/ou à fioul — Exigences particulières —

Partie 1: Dispositifs de régulation du rapport air/combustible de type électronique

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 23552-1 was prepared by Technical Committee ISO/TC 161, *Control and protective devices for gas and oil burners and gas and oil burning appliances*.

ISO 23552 consists of the following parts, under the general title *Safety and control devices for gas and/or oil burners and gas and/or oil appliances — Particular requirements*:

— *Part 1: Fuel/air ratio controls, electronic type*

Additional parts are planned.

Introduction

For electronic fuel/air ratio control systems, there are numerous solutions for specific applications in the market. For this reason, ISO/TC 161 decided to draft an International Standard for type testing for closed-loop fuel/air ratio control systems only.

This part of ISO 23552 does not override requirements of relevant appliance standards. It is the intention that the safety of the appliance not be reduced by any normal or abnormal operation of the ERC described in this part of ISO 23552.

In this part of ISO 23552, there is no classification, either by heat input or by applications.

The accuracy of actual fuel/air ratio is not specified as a fixed value.

This part of ISO 23552 specifies which parameters the manufacturer is required to declare and under what conditions this declaration is considered fulfilled. These parameters relate to the fuel/air ratio control systems rather than the combustion process.

This part of ISO 23552 does not include a standard test rig, however, the purpose of the tests is to verify the manufacturer's declaration under the conditions required in this part of ISO 23552.

This part of ISO 23552 is expected to be used in conjunction with ISO 23550:2004. This part of ISO 23552 refers to clauses and subclauses of ISO 23550:2004 or to variations thereof by the qualifier “addition”, “modification” or “replacement” in the corresponding element.

Safety and control devices for gas and/or oil burners and gas and/or oil appliances — Particular requirements —

Part 1:
Fuel/air ratio controls, electronic type

1 Scope

This part of ISO 23552 specifies safety, construction and performance requirements for electronic fuel/air ratio control systems intended for use with gas or oil burners and gas or oil burning appliances. It also describes the test procedures for evaluating these requirements and specifies information necessary for installation and use.

This part of ISO 23552 is applicable only to closed-loop fuel/air ratio controls (see 3.1) and does not differentiate into classes by heat input.

This part of ISO 23552 applies to electronic fuel/air ratio control systems that can be tested independently or as part of an appliance or as part of a burner.

2 Normative references

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

ISO 23550:2004, *Safety and control devices for gas burners and gas-burning appliances — General requirements*

IEC 60068-2-6:1995, *Environmental testing — Part 2: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*

IEC 60730-1:2007, *Automatic electrical controls for household and similar use — Part 1: General requirements*

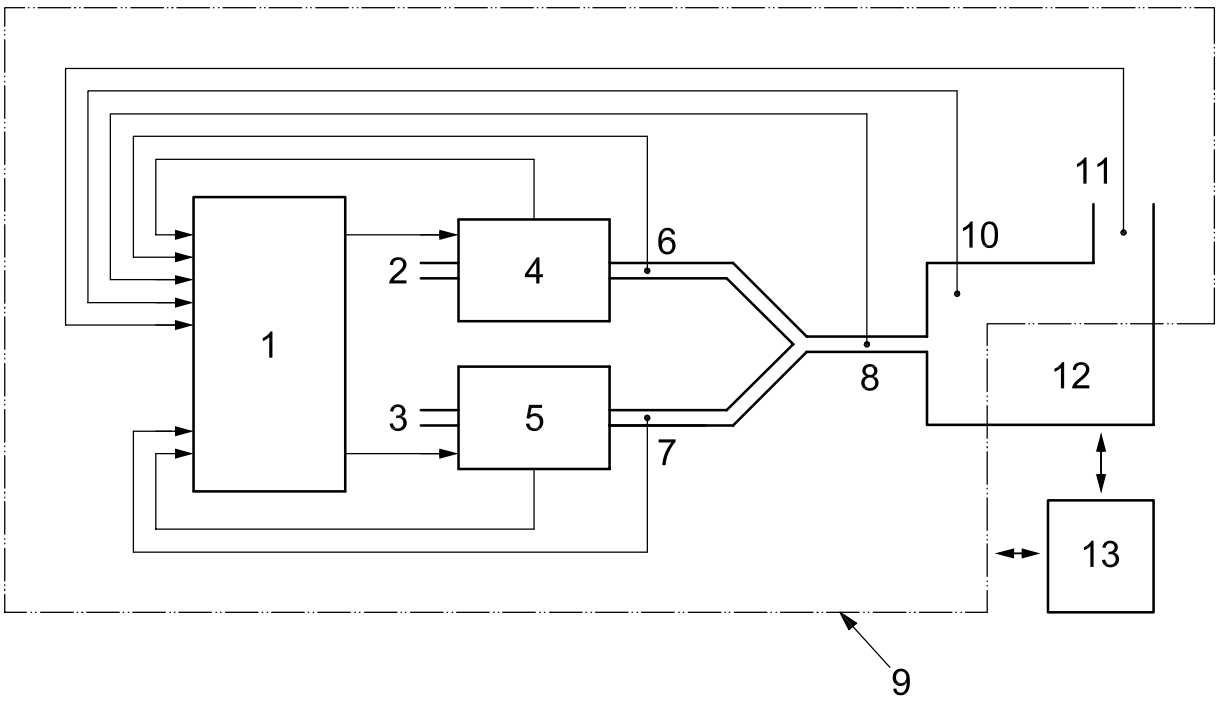
IEC 60730-2-5:2004, *Automatic electrical controls for household and similar use — Part 2-5: Particular requirements for automatic electrical burner control systems*

3 Terms and definitions

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

3.1
electronic fuel/air ratio control
ERC
closed-loop modulating system consisting of the electronic control, actuating elements for the fuel flow and the air flow as a minimum, and allocated feedback signal(s)

NOTE Figure 1 shows an example of different feedback alternatives. For details, see also Table 1.



Key

1 electronic control module
2 air
3 fuel
4 actuator air
5 actuator fuel
6 sensor air
7 sensor fuel
8 sensor fuel/air
9 system boundary of the ERC
10 sensor flame
11 sensor flue gas
12 combustion process
13 burner control system

Figure 1 — Example of an ERC configuration

3.2
electronic control module
electronic main control module incorporating all inputs and outputs for the controlling elements

3.3
actuator
device for controlling the amount of fuel or air

3.4
sensor
device that gives a signal related to a physical property to which it responds

3.5
combustion process
chemical reaction between fuel and air to produce heat

3.6
defined state
state with one of the following characteristics:

a) the system passively assumes a state in which the signal available at the output terminals ensures a safe situation under all circumstances

b) the system actively executes a protective action causing it to shut down followed by a restart or a lock out

c) the system remains in operation, continuing to satisfy all safety-related functional requirements

3.7
fault reaction time
time between the occurrence of a fault and the reaching of a defined state by the ERC

3.8
safety shut-down
de-energization of the main fuel flow means as the result of the action of a limiter, a cut-out or the detection of an internal fault of the system

3.9
lock-out
process in which the system goes into one of the conditions described in 3.9.1 or 3.9.2

3.9.1
non-volatile lock-out
safety shut-down condition of the system, such that a restart can be accomplished only by a manual reset of the system and by no other means

3.9.2
volatile lock-out
safety shut-down condition of the system, such that a restart can be accomplished by either a manual reset of the system or an interruption of the mains power and its subsequent restoration

3.10
abnormal operation
operation of the appliance under the effect of internal failures or under the effect of foreseeable influences outside the specified operational conditions

4 Classification

There is no classification used in this standard.

5 Test conditions

Unless otherwise stated, the ERC shall be tested in the relevant situations such as standby, start-up, normal operation and lock-out.

Unless otherwise stated, the practical assessment shall be carried out under the following conditions:

— ambient temperature: 20 °C ± 5 °C;

— relative humidity: between 40 % and 80 %;

— at rated supply voltage and frequency.

Testing shall always be performed according to a test plan, which shall be included in the test report. The relevant assessment criteria should be part of this test plan.

6 Construction

6.1 General

The ERC shall consist of at least two actuators and either two actuator sensors or a process sensor; see Figure 1 and Table 1, which shall be considered together. It shall have continuous, self-checking modes that can be relevant, e.g. operating mode, stand-by mode, start-up mode and shut down mode. The complete system shall include the peripheral elements, e.g. servo motors, actuators, positional devices, sensors, variable-speed controls for combustion air fans and combustion analysis feedback systems.

Table 1 — Acceptable feedback types

Actuator	Device	Feedback		Output feedback	
		Position [a]	Speed	Flow or ΔP	Pressure
For air	Valve	X	—	X	X
	Fan	—	X [b]	X	X
For fuel	Valve	X	—	X	X
	Pressure regulator	—	—	X	X
—		At least 2 feedbacks (1 gas, 1 air) required [c]			

[a] A feedback signal that is directly related to the mechanical part of the actuator.

[b] If a fan speed signal is used as means to control the air flow, proof of air flow may not rely on fan rotation alone. A possible additional signal can be derived from an independent air-proving device checked at least during start up.

[c] Actuator feedbacks can also be the following from the process:

— ratio of the actual fuel/air mixture;

— ratio signal from the flame;

— signal from the flue gas.

6.2 Construction requirements

ISO 23550:2004; 6.2, shall apply with the addition of the following.

For components constructed of plastic material, aspects of the following apply:

— dimensional stability;

— flow characteristics of the material;

— possible heat shrinkage;

— durability.

They shall be considered with respect to the mechanical, chemical, thermal and environmental conditions of the intended use.

6.3 Materials

ISO 23550:2004; 6.3.1 to 6.3.6, shall apply with the addition of 6.3.7.

6.3.1 Special requirements for electromechanical actuators with position feedback sensors

The actuator feedback sensor shall always represent the actual position of the controlling element. At least the following aspects shall be considered.

— The mechanical connection between the actuator and the actuator feedback sensor shall be of form closure construction and ensure no slippage, e.g. use of form-fitting constructions.

— Torsion of the connection between the sensor and the controlling element shall be minor in relation to the position measured.

If an actuator consists of a separate actuating and controlling element, the non-slippage requirement shall be fulfilled. Screws, pins and other components that are necessary to ensure no slippage shall be secured, e.g. by a locking compound.

6.4 Gas connections

ISO 23550:2004; 6.4, shall apply.

7 Performance

7.1 Performance test

Replace ISO 23550:2004, 7.1, with 7.1.1 to 7.1.3.

7.1.1 At ambient temperature

The timings and sequence actions are measured in the delivered state. The ERC is connected and installed according to the manufacturer's instructions.

The timings and sequence of actions shall conform to 7.6.3 and 7.6.4.

These tests shall be performed under normal conditions (see Clause 5)

— at the manufacturer's declared rated voltage(s) or, if this is a range, at the lowest and highest rated voltages;

— at 85 % of the lowest declared rated voltage;

— at 110 % of the highest declared rated voltage.

7.1.2 At lower temperature

The tests according to 7.1.1 shall be repeated at 0 °C or at the lowest declared ambient temperature when this is lower than 0 °C.

7.1.3 At high temperature

The tests according to 7.1.1 shall be repeated at 60 °C or at the highest declared ambient temperature when this is higher than 60 °C.

NOTE Specific regional requirements are given in Annex C.

7.2 Leak tightness

ISO 23550:2004, 7.2, is not applicable.

7.3 Torsion and bending

ISO 23550:2004, 7.3, is not applicable.

7.4 Rated flow rate

ISO 23550:2004, 7.4, shall apply.

7.5 Durability

ISO 23550:2004, 7.5, shall apply.

7.6 Functional requirements

7.6.1 General

The ERC shall control the fuel-to-air ratio in a manner so as not to cause any hazardous conditions.

It is for this reason that all aspects of an ERC shall be assessed as a complete closed-loop system. The feedback signals of the ERC shall ensure that the predetermined control value has been obtained and is adhered to.

Under conditions that can lead to abnormal operation, the ERC shall maintain a defined state.

If a single potentiometer is used for position feedback in an electromechanical actuator, it shall meet the additional requirements listed in Annex B.

7.6.2 Burner control interface

The ERC shall be interfaced and interlocked with the burner control system in order to ensure that the requirements of the burner control system according to IEC 60730-2-5 and this part of ISO 23552 are fully maintained.

This may be achieved by internal or external interface.

Any interface and interlock between the ERC and burner control shall not degrade the safety of the complete system.

7.6.3 Restart or lock-out after safety shut-down

If a restart follows a safety shut-down, the number and the interval of subsequent restarts shall comply with the requirements of the application standard.

An automatic start-up attempt by a control function shall not override the safety shut-down conditions.

If lock-out follows a safety shut-down, the type of lock-out shall comply with the application standard.

7.6.4 Start-up sequence

The burner control system shall give control commands to the ERC regarding the start-up sequence. A fault condition of the ERC shall result in a defined state.

7.6.5 Pre-set/predefined range

If the ERC operates outside the pre-set/predefined range for longer than as declared by the manufacturer, it shall result in a defined state.

7.6.6 Accuracy requirements

The manufacturer shall declare the typical accuracy for the ERC; see Note 3.

For type testing, the following information shall be supplied:

a) applicable closed-loop (sensor, actuator and electronic control module; see Figure 1) methods as used in the ERC;

b) relevant data of sensors and actuators, which shall be provided as part of the declared typical accuracy of a closed loop; see Tables A.1 and A.2;

c) if more than one closed-loop method is used, the defined accuracy of each closed-loop method; see Table A.3.

At least two (as for component failures) influences under normal operation shall be taken into consideration.

The results of the failure assessment shall be considered as well.

NOTE 1 Due to variations in technology and applications, it is not possible to give minimum quantitative accuracy requirements for all possibilities.

NOTE 2 For calculation of the typical accuracy, the mean square value is recommended.

NOTE 3 The typical accuracy of the system, is $\sqrt{\left(a^2 + b^2 ... + n^2\right)}$ (the root of the sum of the squares), where a, b, ..., n are the accuracies of the individual component, as shown in Annex A.

7.7 Endurance

7.7.1 General

All components of the control shall be able to withstand the tests as detailed in 7.7.2 and 7.7.3. If the control function is an integral part of an apparatus, the long-term performance tests can be combined. The test of 7.7.2 and the test of 7.7.3 shall not be carried out on the same test sample.

In the case of the control not having a clear operating cycle, the long-term performance test shall be carried out for the minimum specified amount of time.

7.7.2 Stress test

7.7.2.1 Thermal stress test

The thermal stress test shall be carried out with the terminals loaded with the loads and power factors as declared by the manufacturer.

The purpose of the test is to expose the electronic components of the control to temperature cycles between limits likely to be reached in normal use owing to fluctuations in ambient temperature, temperature variations in the component itself, power-supply fluctuations and temperature changes, such as from standby to operation and *vice versa*.

The control shall be tested as follows:

a) 14 days at the following electrical and thermal conditions and rate of operation:

   — Electrical conditions: The system is loaded according to the ratings declared by the manufacturer, the voltage is then increased to 110% of maximum declared rated voltage except that for 30 min during each 24 h period of the test the voltage is reduced to 90 % of minimum declared rated voltage. The change of voltage shall not be synchronized with the change of temperature. Each 24 h period shall also include at least one period in the order of 30 s during which the supply voltage is switched off.

   — Thermal conditions: The ambient temperature and/or the mounting surface temperature are varied between the maximum declared ambient temperature or 60 °C, whichever is higher, and the minimum declared ambient temperature or 0 °C, whichever is lower, to cause the temperature of the components of the electronic circuit to be cycled between the resulting extremes. The rate of ambient and/or mounting surface temperature change shall be in the order of 1 K/min and the extremes of temperature maintained for approximately 1 h.

     Care should be taken to avoid the occurrence of condensation during this test.

   — Rate of operation: During the test, the control shall be cycled through all of its normal operational modes (e.g. stand-by, start-up, running) up to a maximum of 6 cycles/min. The number of cycles completed during this test shall be recorded and, if this number is less than 45 000, the remaining cycles shall be executed at the declared rated voltage and at ambient temperature.

b) 2 500 cycles performed, but for a duration of at least 24 h, through all of its normal operational modes (e.g. stand-by, start-up, running) at the maximum declared ambient temperature or 60 °C, whichever is higher, and at 110 % of the maximum declared rated voltage.

c) 2 500 cycles performed, but for a duration of at least 24 h, through all of its normal operational modes (e.g. stand-by, start-up, running) at the minimum declared ambient temperature or 0 °C, whichever is lower, and at 85 % of the minimum declared rated voltage.

d) If a control is provided with a safety-relevant function that on the basis of a sensor or switch is able to initiate a safety action, 5 000 cycles of such safety actions or the number as specified in the specific control standard shall be performed for each safety-relevant function individually at the ambient temperature and nominal rated voltage, by simulating the sensor or switch to initiate such safety action.

   Where possible the testing of the safety relevant functions may be combined.

During the tests a), b), c) and d) as described above, the system shall be operated in such a way that the normal start-up sequence is performed. The time that the system is held in the running position and the time that the control loop is interrupted before the cycle is repeated shall be agreed between the manufacturer and the test authority.

By agreement between the manufacturer and the test authority, any safety-relevant times used during the above tests may be chosen to be as short as practicable so that the thermal stress test is not unnecessarily prolonged.

On completion of the thermal stress test, the test described in 7.1.1 shall be repeated at rated voltage only.

7.7.2.2 Vibration test

When resistance to vibration is declared by the manufacturer, the sinusoidal vibration test shall be carried out as follows in accordance with IEC 60068-2-6:1995, test Fc.

The object of the test is to demonstrate the ability of the control to withstand the long-term effects of vibration at levels declared by the manufacturer.

During the exposures, the control shall be mounted on a rigid fixture by means of the specified fastening arrangement.

The test is performed with the following minimum severity conditions:

— acceleration amplitude: 1,0 *g*, or higher if declared by the manufacturer;

— frequency range: 10 Hz to 150 Hz;

— sweep rate: 1 octave per minute;

— number of sweep cycles: 10;

— number of axes: 3, mutually perpendicular.

A visual inspection shall be carried out after the termination of the exposure. No mechanical damage shall be found and the control shall comply with the construction requirements as specified in the specific control standard. On completion of the vibration test, the test of 7.2 shall be repeated at rated voltage only.

7.7.3 Long-term performance test

The manufacturer shall declare that the control has completed the required duration as specified in the specific control standard or a minimum of 250 000 cycles performed through all of its normal operational modes (e.g. stand-by, start-up, running), with the terminals loaded with the loads and power factors as declared, without failure.

The control shall have been tested under the following conditions.

a) 90 % of the total number of cycles or duration of time shall be performed at the declared rated voltage and at ambient temperature.

b) 5 % of the total number of cycles or duration of time shall be performed at the maximum declared ambient temperature or 60 °C, whichever is higher, and at 110 % of the maximum declared rated voltage.

c) 5 % of the total number of cycles or time duration shall be performed at the minimum declared ambient temperature or 0 °C, whichever is lower, and at 85 % of the minimum declared rated voltage.

On completion of this test, the test sample shall still comply with IEC 60730-1:2007, 13.2.2 to 13.2.4.

7.8 Internal faults

7.8.1 General

The failure modes of components shall be in accordance with IEC 60730-2-5:2004, H.27.1.4.

For those failure modes not covered by IEC 60730-2-5:2004, H.27.1.4, a separate failure mode analysis shall be performed.

The software of an ERC shall be of class C in accordance with IEC 60730-1:2007, H.2.21, H.11.12, H.27.1.3 and H.27.1.4 and IEC 60730-2-5:2004, H.11.12. Information shall be provided only for the safety-related

segments of the software. Information of the non-safety-related sections shall be sufficient to establish that it doesn't influence the safety-related sections.

The assessment shall be done in accordance with IEC 60730-2-5:2004, H.27.1.3.103, for permanent operation.

7.8.2 Information to be supplied by the manufacturer

For the assessment of the ERC, the information supplied by the manufacturer shall be in accordance with Table 2.

Table 2 — List of required information

Requirement	Information	Reference	Method [a]
1	Software sequence documentation [b]	—	X
2	Programme documentation [c]	—	X
3	Fault analysis, including Tables A.1 and A.2	—	X
4	Safety classes and structure [d]	—	D
5	Analytical measures and fault-control techniques employed	—	X
6	Fault-reaction time	—	D
7	Control response(s) in case of detected fault	—	D
8	Circuit diagram, complete with component list with circuit reference electrical ratings, relevant operating stresses and tolerances	—	X
9	Sufficient design details to enable assessment of the safety functions; this shall include the manufacturer design calculations on the effect of tolerance on critical circuit components	—	X
10	Declarations and specifications	7.6.5, 7.6.6	X

[a] "Method X" means that the information is given to the test authority; "method D" means that the information is given to the test house and to the appliance manufacturer (if applicable).

[b] The software sequence shall be documented together with the operating system sequence and shall include a description of the control system strategy, the logic diagram, data flow and timings.

[c] Programming documentation shall be supplied.

[d] Within a control, different safety classes may apply to different functions.

7.8.3 Information

IEC 60730-2-5:2004, H.7, shall apply.

7.8.4 Compliance

IEC 60730-2-5:2004, H.27.1.3.103, shall apply.

8 EMC/Electrical requirements

8.1 Protection against environmental influences

ISO 23550:2004, 8.1, shall apply, except for the following modification:

Replace "control" with "ERC".

8.2 Variations in supply voltage

ISO 23550:2004, 8.2, shall apply with the following addition:

ERC shall meet the requirements of this part of ISO 23552; see 7.1.1.

For test procedure for voltages below 85 %, see IEC 60730-2-5.

8.3 Short-term voltage interruptions or drops

ISO 23550:2004; 8.3, shall apply.

8.4 Variations in supply frequency

ISO 23550:2004; 8.4, shall apply.

8.5 Surge immunity test

ISO 23550:2004; 8.5, shall apply.

8.6 Electrical fast transient/burst

ISO 23550:2004; 8.6, shall apply.

8.7 Immunity to conducted disturbances

ISO 23550:2004; 8.7, shall apply.

8.8 Immunity to radiated fields

ISO 23550:2004, 8.8, shall apply.

8.9 Electrostatic discharge immunity test

ISO 23550:2004; 8.9, shall apply.

8.10 Test for immunity to power frequency magnetic field

ISO 23550:2004, 8.10, shall apply.

8.11 Electrical requirements

8.11.1 General

The electrical equipment shall conform to the relevant requirements of IEC 60730-1:2007, Clauses 4, 8, 9, 10, 11, 12, 13, 14, 16, 18, 19, 20, 21, 22, 24, 25 and 27 and the applicable part 2 of IEC 60730.

For the tests under IEC 60730-1:2007, Clause 12, the equipment under test shall include all parts of the ERC. After being allowed to cool down to the normal ambient temperature, the system shall be re-tested to 7.1.1 and the ERC shall comply with the requirements of ISO 23550:2004, 7.5.6.

It is recognized that for special applications it is permissible to use designs and test methods that differ from those specifically defined in these clauses, but which nevertheless comply with the intent of these clauses.

8.11.2 Class of protection

The class of protection of the complete system with their own enclosure(s) shall be at least IP 40 in accordance with IEC 60529:2001. For systems or parts thereof for use in open air, the protection shall be at least IP 54. For systems or parts thereof without enclosure or an enclosure not meeting these requirements, protection to IP 40 or IP 54 shall be provided by the appliance or by a control cabinet in which it is installed.

8.11.3 Electronics and software

Electronics and software, including those applied in sensor(s) and actuators, shall be in accordance with IEC 60730-1:2007, Annex H, with the exception of H.26.

9 Marking and installation

9.1 Marking

The ERC components shall be marked with the following information in clear and indelible characters:

— manufacturer and/or trade mark;

— type reference;

— date-code or serial number;

NOTE The US and Canada require date codes.

— also the rated voltage(s) or rated voltage range and frequency, if applicable when the ECM has its own enclosure.

The following shall be clearly indicated on the RC:

— value of the replaceable fuse(s) and its characteristics, if applicable on or near each fuse holder;

— marks, e.g. reference numbers, identifying the terminals of the system.

A durability test on the marking shall be carried out according to ISO 23550:2004, 7.5.4.

9.2 Installation and operating instructions

Installation and operating instructions shall be available in any official language of the country in which the system is used.

These instructions shall include the data required for the proper location, mounting, connection, commissioning, operation and maintenance of the system.

These instructions shall, at least, include the following:

a) the supply voltage(s) and frequency;

b) the maximum and minimum ambient temperature;

c) an indication of the degree of protection;

d) clear indications for the connection of different supply voltage circuits (it shall, for instance, be clearly indicated that an isolating transformer that is earthed at one side shall be used if connection is to be made to a supply without an earth-bonded conductor or to a supply with line voltage between the phases);

e) a listing and a diagram of the limits of the programme settings and details of their adjustment range(s) if any; and information on the set points, accuracy, repeatability, etc.;

f) the maximum current rating for each output;

g) the position(s) in which the system can be mounted;

h) the length and type of cable(s) for the connection of external components; see also Clause 8;

i) a typical external wiring diagram;

j) the rated input, in watts, of the system itself, if higher than 25 W;

k) installation, commissioning, servicing and maintenance instructions and details of replacement parts;

l) manufacturer's test schedules and relevant supplementary information;

m) system component specifications including

- type,
- values,
- tolerances,
- ratings,
- operating values,
- component manufacturer/supplier;

n) overall output channel accuracy, by making use of Table A.3;

o) the applications for which the system is intended.

Annex A
(normative)

Manufacturer's declaration for sensors, actuators and repeatability

A.1 Terms and definitions

NOTE For better understanding of the terms used in Tables A.1 and A.2, the following definitions are quoted from other standards.

A.1.1
normal operation
operation within the specifications

NOTE Adapted from ISO 12100-1 and IEC 60079-14:1987, 311.

A.1.2
drift
positive or negative deviation, parallel to the sensor characteristic

NOTE Adapted from ISO 21647 and IEC 60050(604):1987.

A.1.3
amplification
positive or negative rotation of the sensor characteristic with the intersection of the characteristic and the x-axis as point of rotation

NOTE Adapted from ISO 5598.

A.1.4
offset
positive or negative deviation of the intersection of the sensor characteristic and the y-axis

NOTE Adapted from IEC 60546-1 and IEC 61083-1.

A.1.5
resolution
minimum incremental input or output change

NOTE Adapted from IEC 60523 and IEC 60418.

A.1.6
cross sensitivity
influence of other process or ambient factors

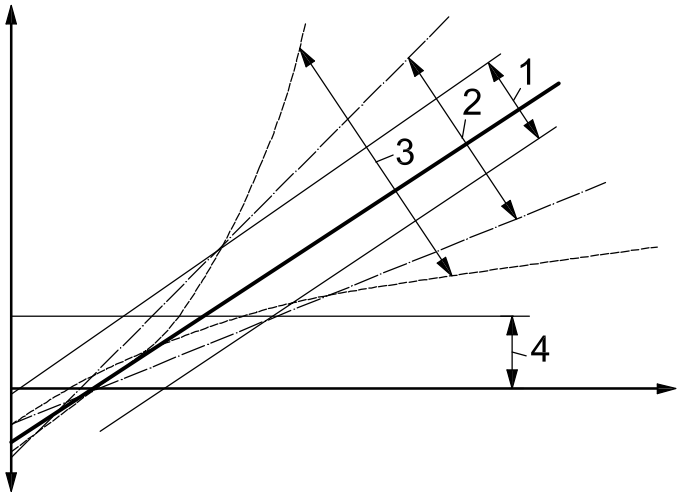
NOTE Adapted from ISO 14956.

A.1.7
linearity
linearity is the worst case deviation of straightness of the actual transfer function from the ideal straight line

NOTE Adapted from IEC 60393-1 and IEC 60747-14-1.

A.1.8
repeatability
ability of a system to provide similar output for repeated operation

NOTE Adapted from IEC 60947-5-7, ISO 9169, ISO 9488 and ISO 9713.



Key

1 drift
2 amplification
3 linearity
4 offset

Figure A.1

Table A.1 — Manufacturer's specification for sensors

Sensor measurement:

Position	Pressure	Flow	Rotation	Flame [a]	Exhaust [a]	Other
Sensor type :						
Sensor technology :						
Sensor range :						

	Normal operation	**Sensor influences, reversible**					**Sensor influences, non-reversible**			
Lower and upper limits	NA				NA		NA	NA	NA	NA
		Humidity	**Barometric pressure**	**Temperature**	**Cross sensitivity**	**Auxiliary power supply**	**Lifetime**	**Lifecycles**	**Temperature**	**End-of-life failure mode**
Accuracy										
- drift										
- amplification										
- linearity										
- offset										
- resolution										
- repeatability										
Response time (t90)										

[a] Process feedback.

Table A.2 — Manufacturer's specification for actuators

Position	Pressure	Flow	Rotation	Others
Actuator type ref				
Actuator technology				
Actuator range				
Potentiometer fixing method				
Mechanical fixing for control valves or dampers				

	Normal	**Abnormal, reversible**			**Abnormal, non-reversible**			
		Humidity	**Temperature**	**Auxiliary power supply**	**Lifetime**	**Lifecycles**	**Temperature**	**End-of-life failure mode**
Actuator accuracy								
- drift								
- amplification								
- linearity								
- offset								
-resolution								
- repeatability								
Response time								

NOTE For closed loop feedback control direct potentiometer fixing is required to measure the final draft shaft or actuator.

Table A.3 — Manufacturer's declaration for typical accuracy

Applicable closed loop method	Typical accuracy ±...%	Measurement
Position		of the actual position
Pressure		of the actual pressure [a]
Flow		of the actual volume [a]
Rotation		of the actual rpm
Flame		of the actual value
Exhaust		by volume oxygen
Other elements		of the actual value

[a] Standard conditions; see ISO 23550:2004, 5.4.

Annex B
(normative)

Special requirements for single position feedback potentiometers in electromechanical actuators

Special requirements for single-position feedback potentiometers in electromechanical actuators

A single potentiometer that is part of a system that incorporates a method for checking the potentiometer integrity on a real-time basis (i.e. faults detected in less than 3 s) is exempt from the requirements in this annex.

The integrity check shall include change of characteristics.

Except as noted above, if a single potentiometer is used for position feedback in an electromechanical actuator, it shall meet the requirements listed below in addition to the requirements of 7.1.

The potentiometer shall be stable for a reasonable period of time at the mechanical, chemical, thermal and environmental conditions of the intended use.

Preferably conductive plastic potentiometers should be used with resistance layer and wiper protected against dust with an enclosure which conforms to at least IEC 60529:2001 IP5X.

The lifetime shall be assessed by a test procedure with a minimum of 2×10^6 cycles at an ambient temperature of 60 °C, with

— $\geqslant 0{,}5 \times 10^6$ full cycles over the whole rotation angle, and

— $\geqslant 1{,}5 \times 10^6$ partial cycles over 10 % of the rotation angle distributed over the whole rotation range.

After the lifetime test there shall not be either an electrical (open or short circuit) or a mechanical damage. The electrical characteristics shall not exceed the values as used for the accuracy calculation.

Annex C
(normative)

Specific regional requirements in Japan

Add the following sentence at the end of 7.1.3.

“The tests according to 7.1.1 shall be repeated at 55 °C. If wider limits are declared by the manufacturer, then these shall be used.”

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