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Pneumatic fluid power — Electro-pneumatic pressure control valves —

Part 2:
Test methods to determine main characteristics to include in the supplier's literature

Transmissions pneumatiques — Appareils électropneumatiques de distribution à commande continue de pression —

Partie 2: Méthodes d'essai pour déterminer les principales caractéristiques à inclure dans la documentation des fournisseurs

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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 10094-2 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 5, *Control products and components*.

ISO 10094 consists of the following parts, under the general title *Pneumatic fluid power — Electro-pneumatic pressure control valves*:

— *Part 1: Main characteristics to include in the supplier's literature*

— *Part 2: Test methods to determine main characteristics to include in the supplier's literature*

Introduction

In pneumatic fluid power systems, power is transmitted and controlled through a gas under pressure within a circuit.

When pressure tracking or pressure regulation is required, electro-pneumatic continuous pressure control valves can be used to track a variable set point with low tracking error or to maintain the pressure of the gas at an approximately constant level.

These control valves continuously modulate the pneumatic power of a system in response to a continuous electrical input signal and link the electrical input value to a proportional pressure value.

It is therefore necessary to know some performance characteristics of these electro-pneumatic continuous pressure control valves in order to determine their suitability.

Pneumatic fluid power — Electro-pneumatic pressure control valves —

Part 2:
Test methods to determine main characteristics to include in the supplier's literature

1 Scope

This part of ISO 10094 specifies the test procedures and a method of presenting the results concerning the parameters which define the main characteristics to be included in the supplier's literature of the electro-pneumatic continuous pressure control valves, conforming to ISO 10094-1.

The purpose of this part of ISO 10094 is

— to facilitate the comparison by standardizing the test methods and the presentation of the test results, and

— to assist in the proper application of these components in compressed air systems.

The specified tests are intended to allow comparison between the different types of continuous pressure control valves; these are not production tests to be carried out on each manufactured product.

NOTE 1 The tests related to non-electrically modulated pneumatic continuous pressure control valves are specified in ISO 6953-2.

NOTE 2 The tests related to electro-pneumatic continuous flow control valves are specified in ISO 10041-2.

NOTE 3 The tests described in this part of ISO 10094 are realised on components with an exhaust port vented to the atmosphere.

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 5598, *Fluid power systems and components — Vocabulary*

ISO 6358-1[1)], *Pneumatic fluid power — Determination of flow-rate characteristics of components — Part 1: General rules and test methods for steady-state flow*

ISO 6953-1, *Pneumatic fluid power — Compressed air pressure regulators and filter-regulators — Part 1: Main characteristics to be included in literature from suppliers and product-marking requirements*

ISO 10094-1:2010, *Pneumatic fluid power — Electro-pneumatic pressure control valves — Part 1: Main characteristics to include in the supplier's literature*

1) To be published.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598, ISO 6953-1 and ISO 10094-1 apply.

4 Symbols and units

For the purposes of this document, the symbols and units listed in Table 1 apply.

Table 1 — Symbols and units

Description	Symbol	SI unit
Maximum sonic conductance at the inlet	$C_{f,max}$	$m^3/(s \cdot Pa)$ (ANR)[b]
Sonic conductance at the exhaust	C_r	$m^3/(s \cdot Pa)$ (ANR)[b]
Atmospheric pressure	p_{atm}	Pa
Reference pressure[b]	p_0	Pa
Total relative pressure at the inlet port[a]	p_1	Pa
Total relative pressure at the outlet port[a]	p_2	Pa
Total relative pressure at the exhaust port[a]	p_3	Pa
Pressure difference	Δp	Pa
Hysteresis	H	%
Maximal difference of hysteresis	$\Delta p_{2,h,max}$	Pa
Linearity	L	%
Maximal difference of the linearity	$\Delta p_{2,l,max}$	Pa
Volume flow rate at standard reference atmosphere	q_V	m^3/s (ANR)[b]
Maximum volume flow rate at the inlet	$q_{V,f,max}$	m^3/s (ANR)[b]
Volume flow rate at the outlet	$q_{V,r}$	m^3/s (ANR)[b]
Repeatability	r	—
Reference temperature	T_0	K
Temperature at the inlet port[a]	T_1	K
Temperature at the outlet port[a]	T_2	K
Electrical control signal for which the regulated pressure increases again	w_{start}	V, mA or numerical signal
Electrical control signal for which the regulated pressure no longer evolves	w_{stop}	V, mA or numerical signal
Resolution	S	%

[a] In accordance with ISO 11727.

[b] The reference atmosphere is defined in ISO 8778, i.e.: T_0 = 293,15 K, p_0 = 100 kPa (1 bar) and a relative humidity of 65 %.

5 Test conditions

5.1 Gas supply

Unless otherwise specified, testing shall be conducted with compressed air. If another gas is used, it shall be noted in the test report.

5.2 Temperature

The ambient, fluid and the component-under-test temperatures shall be maintained at 23 °C ± 10 °C during all the tests.

5.3 Pressures

5.3.1 General

The specified pressures shall be maintained within ±2 %.

5.3.2 Inlet pressure

The inlet pressure used for testing shall be the lower of the following pressures:

— the maximum regulated pressure, $p_{2,max}$, plus 200 kPa (2 bar); and

— the specified maximum inlet pressure, $p_{1,max}$.

5.3.3 Test pressures

The preferential test pressures are chosen as approximately equal to 20 %, 40 %, 60 %, 80 % and 100 % of the maximum of the setting pressure scale.

5.3.4 Checking

It shall be periodically verified that no pressure bleed of measuring instruments is obstructed by solid or liquid particles.

5.4 Electrical supply

The tests shall be carried out under electrical nominal conditions.

6 Test procedures

6.1 Test conditions

The component under test shall be used according to the manufacturer's application instructions.

6.2 Inlet pressure

During every measurement concerning the static or dynamic tests described in Clauses 7 to 11, the inlet pressure, p_1, shall be maintained constant.

In the case of the dynamic tests as described in Clause 11, a tank buffer shall be used in order to reduce the inlet pressure, p_1, fluctuations, as indicated in Figures 9 and 10.

6.3 Static tests

During every measurement series concerning static tests described in Clauses 7, 8, 9 and 10, as soon as the steady conditions are reached, every series of results obtained with related specified test conditions shall be recorded. When these measurements are performed step by step, slowly modify the conditions to prevent instability.

NOTE 1 Figures 1, 6, 8, 9 and 10 represent typical circuits that do not show the electrical supply circuit necessary to operate electrically modulated pneumatic valves and that do not contain all the necessary safety devices for protection against hazards that may be caused by the failure of a component or piping. It is important that those responsible for conducting the tests take into account the necessity to protect personnel and property.

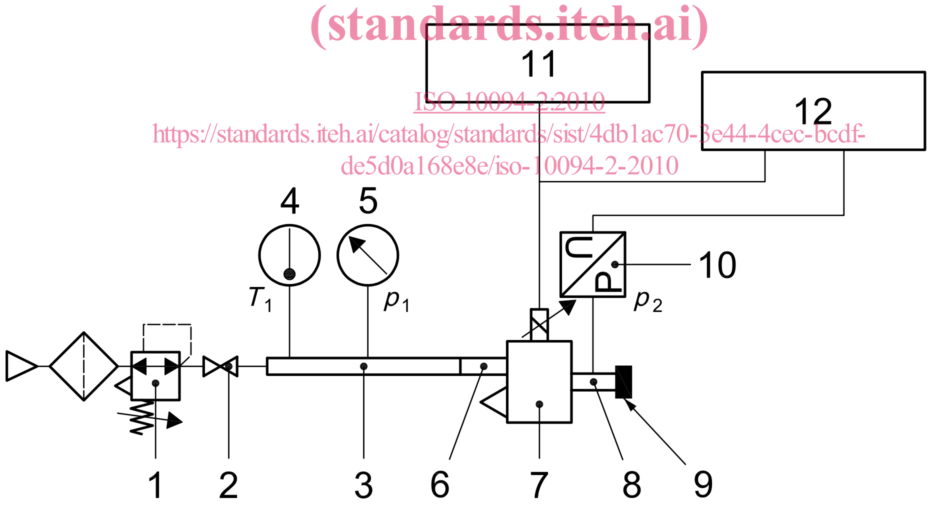
NOTE 2 The graphic symbols used in Figures 1, 6, 8, 9 and 10 are in accordance with ISO 1219-1.

7 Control signal/pressure static-characteristics test at null forward or relief flow rate

7.1 Test installation

7.1.1 Test circuit

Figure 1 represents a typical test circuit for the control signal/pressure characterization at null forward or relief flow rate. For all tests described in 7.2, apply the inlet pressure chosen according to 5.3.2.



Key

1 supply pressure regulator
2 shut-off valve
3 pressure-measuring tube
4 inlet temperature T_1 measuring-element
5 inlet pressure p_1 gauge or transducer
6 upstream transition connector
7 component under test
8 connector with pressure-measuring tap
9 plug
10 regulated pressure p_2 gauge or transducer
11 signal generator
12 X-Y recorder

Figure 1 — Typical test circuit for control signal/pressure characterization

7.1.2 Pressure measurement

The inlet pressure sensor is installed on a pressure-measuring tube in accordance with ISO 6358-1. The regulated pressure sensor is an external measurement sensor, even if the component under test has an internal pressure sensor. The connector 8 which measures the regulated pressure in Figure 1, is plugged to guarantee a null operating flow rate. The length (volume) of this connector shall be as short (small) as possible.

7.2 Test procedures

7.2.1 Control signal/pressure static characteristics test

Using a signal generator to create a triangular signal to explore the control signal full-scale (0 % to 100 %), record the electrical control signal, w, in the X-axis and the regulated pressure, p_2, in the Y-axis of a recorder so as to obtain a hysteresis curve.

The triangular electrical control signal shall evolve with a sufficiently low ramp speed so as to avoid dynamic effects and influence the regulated pressure measurements: 0,5 % of full scale per second is the recommended ramp speed.

7.2.2 Minimum regulated pressure test

Leave the component under test pressurized with the minimum control signal (0 %) at rest for at least 5 min.

From the minimal electrical control signal (0 %), measure the regulated pressure, p_2 for the following control signal values which allow to point out what is happening around this minimal signal:

— 0 %, 0,5 %, 1 % of the control signal full-scale;

— then every 1 % up to 5 % of the control signal full-scale.

Every measurement is made after a rest time of 10 s at each stage. The measurements shall always be made by increasing the control signal.

7.2.3 Resolution test

7.2.3.1 From the minimal electrical control signal (0 %), gradually modify the electrical control signal value by increasing values only, until reaching the value corresponding to 15 % of the regulated pressure full-scale.

7.2.3.2 Note this electrical control signal value w_{stop} and record the pressure evolution as a function of the electrical signal.

7.2.3.3 Maintain this state more than 10 s and gradually re-increase the input signal. Then note the electrical control signal, w_{start}, for which the regulated pressure, p_2, starts re-increasing.

7.2.3.4 Repeat the operations described in 7.2.3.2 and 7.2.3.3 for the electrical control signal values corresponding to 50 % and 85 % of the regulated pressure full-scale. Gradually modify the control signal, by increasing values only, until reaching these values.

7.2.4 Repeatability test

Using a signal generator to create a square signal between 0 % and 50 % of the electrical control signal full-scale, record the regulated pressure, p_2, as a function of time for at least 20 periods.

The frequency of the electrical control signal shall be sufficiently low so as to have a good stabilization of the regulated pressure at 0 % and 50 % of the electrical control signal full-scale.

At each period indicated by the index $j = 1, \ldots , 20$, when the regulated pressure is stabilized for 50 % of the electrical control signal full-scale, note the corresponding regulated pressure, $p_{2\,j}$.

7.3 Calculation of characteristics

7.3.1 Characteristic curve

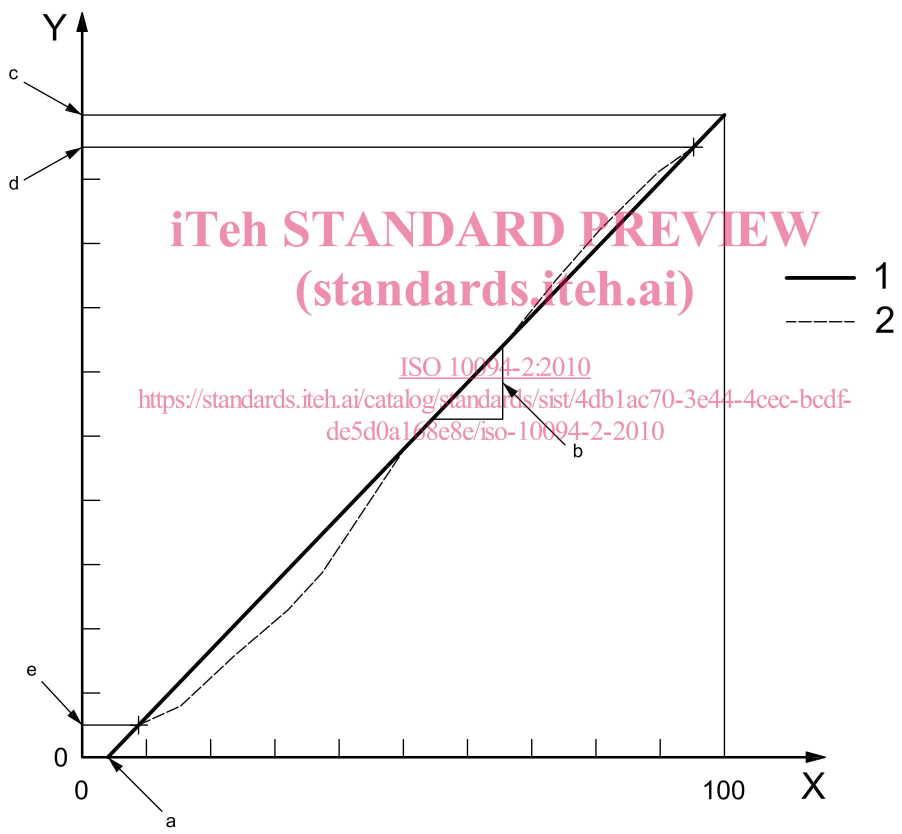
For each value of the control signal, calculate the mean value of the two corresponding pressures measured according to the procedure described in 7.2.1, respectively with an increasing and a decreasing control signal.

Plot the mean pressure curve as a function of the control signal as represented in Figure 2.

The characteristic line is the straight line passing by the mean regulated pressure values of 5 % and 95 % of the regulated pressure full-scale according to Figure 2.

The offset of the straight line shall be determined by the intersection of the straight line with the abscissa axis (regulated pressure, p_2, equal to 0 kPa) as shown in Figure 5.

The slope and the offset of the straight line shall be indicated on the graph, as represented in Figure 2.



Key

X electrical control signal, %

Y regulated pressure p_2, in kPa

1 characteristic line

2 mean pressure curve

[a] Offset.

[b] Slope.

[c] $p_{2,\ max.}$

[d] 95 % of $p_{2,\ max.}$

[e] 5 % of $p_{2,\ max.}$

Figure 2 — Determination of the characteristic curve