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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems]*, Subcommittee SC 5, *Control products and components.*

This second edition cancels and replaces the first edition (ISO 10094-2:2010), which has been technically revised.

The main changes are as follows:

— Addition of definitions for response time, settling time, and shifting time in Clause 3;

— Revision of the procedure for the repeatability test: addition of 15 % and 85 % of the electrical control signal full-scale to tested values (in addition to 50 %) in 7.2.4;

— Addition of two subclauses relating to Sensitivity (7.3.7) and Offset (7.3.8) respectively;

— Revision of the test procedure to determine leakage characteristics to simplify the test practice (10.2).

— Deletion of the no tank test version and test circuit from the test practices in Clause 11 related to dynamic characteristics;

— The former subclause 11.2, frequency characteristics, has been made an informative annex (Annex A).

A list of all parts in the ISO 10094 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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 pressure 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 document specifies the test procedures and a method of presenting 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 document is:

— to facilitate 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.

The tests described in this document are for components with an exhaust port vented to the atmosphere.

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 ISO 6953-3 provides an alternate dynamic test method for flow-rate characteristics using an isothermal tank instead of a flow meter. However, this method measures only the decreasing flow rate part of the hysteresis curve of the forward flow and relief flow characteristics.

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.

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 6358-1, *Pneumatic fluid power — Determination of flow-rate characteristics of components using compressible fluids — 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 10094-1:2021, *Pneumatic fluid power — Electro-pneumatic pressure control valves — Part 1: Main characteristics to include in the supplier's literature*

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 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
response time
time from initial electrical signal change to an observed output pressure equal to 90 % of the total change in pressure

3.2
settling time
time lapse from initial change to the time from which the observed output pressure remains between 95 % and 105 % of its total change in pressure

3.3
shifting time
time from initial electrical signal change to an observed output pressure equal to 10 % of the total change in pressure

4 Symbols and units

Table 1 — Symbols and units

Description	Symbol	Units
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]
Hysteresis	H	% FS
Linearity	L	% FS
Sensitivity	m	Pa/V, Pa/mA or Pa/numerical signal
Offset	O	%
Atmospheric pressure	p_{atm}	Pa
Reference pressure	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
Maximum inlet pressure	$p_{1,max}$	Pa
Maximum regulated pressure	$p_{2,max}$	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	% FS
Resolution	S	% FS
Reference temperature	T_0	K

[a] As described in 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 %.

Table 1 *(continued)*

Description	Symbol	Units
Temperature at the inlet port[a]	T_1	K
Temperature at the outlet port[a]	T_2	K
Electrical control signal	w	V, mA or numerical signal
Pressure difference	Δp	Pa
Maximal difference of hysteresis	$\Delta p_{2,h,max}$	Pa
Maximal difference of the linearity	$\Delta p_{2,l,max}$	Pa

[a] As described in 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 supplies

The tests shall be carried out under nominal electrical 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 constant (within 10 % FS).

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 Figure 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, 7, 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 can 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.

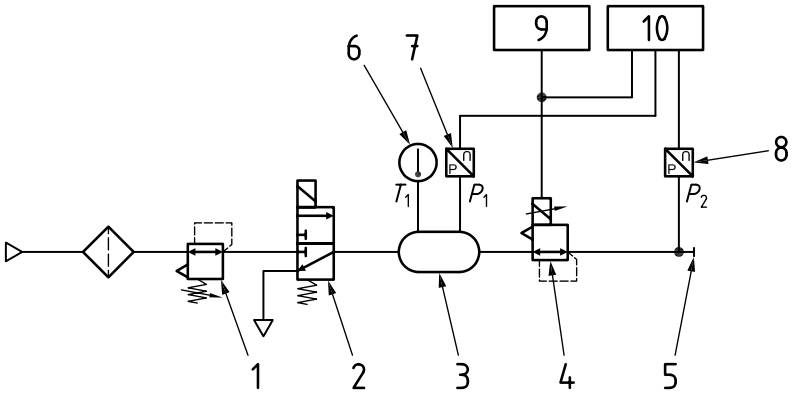
NOTE 2 The symbols used in the circuit diagrams shown in Figures 1, 7, 9 and 10 are in accordance with ISO 1219-1.

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 static characteristics testing. This test is conducted with no forward flow and with the relief port open to atmosphere. For all tests described in 7.2, apply the inlet pressure chosen according to 5.3.2.



Key

1	supply pressure regulator	6	inlet temperature T_1 measuring-element
2	shut off valve	7	inlet pressure p_1 transducer
3	inlet volume or optional pressure measuring tube with transition connector	8	regulated pressure p_2 transducer
4	component under test	9	signal generator
5	plug	10	data recorder

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

7.1.2 Pressure measurement

The inlet pressure sensor is connected to the volume or pressure-measuring tube with transition connector 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 regulated pressure transducer shall be connected as close as possible to the outlet port.

7.2 Test procedures

7.2.1 Control signal/pressure static characteristic 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 minimum electrical control signal (0 %), measure the regulated pressure, p_2 for the following control signal values. This defines response to the lower portion of the 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 for 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 stepped signal between 0 % to 15 %, 15 % to 50 % and 50 % to 85 % of the electrical control signal full-scale, according to Figure 2, 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 15 %, 50 % and 85 % of the electrical control signal full-scale.

At each period indicated by the index j = 1, ..., 20, when the regulated pressure is stabilized for 15 %, 50 % and 85 % of the electrical control signal full-scale (hereinafter referred to as x), note the corresponding regulated pressure, $p_{2,x,j}$