INTERNATIONAL STANDARD

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Pneumatic fluid power — Electro-pneumatic continuous flow control valves —

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

Transmissions pneumatiques — Distributeurs électropneumatiques à commande continue de débit —

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

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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 10041-2 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 5, *Control products and components*.

ISO 10041 consists of the following parts, under the general title *Pneumatic fluid power — Electro-pneumatic continuous flow 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.

Electro-pneumatic continuous flow control valves continuously modulate the pneumatic power of a system in response to a continuous electrical control signal and link the electrical control quantity to the effective section of each variable port of the output stage (flow rate stage). The mass flow rate that crosses each restriction depends on the downstream and upstream pressures and the type of gas.

When control of position or force, including position- or force-tracking of a pneumatic cylinder, is required, electro-pneumatic continuous flow control valves can be used to precisely modulate the mass flow rates entering or exiting each cylinder chamber, resulting in a precise positioning. It is therefore necessary to know some performance characteristics of these electro-pneumatic continuous flow control valves in order to determine their suitability for a particular application.

Pneumatic fluid power — Electro-pneumatic continuous flow control valves —

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

1 Scope

This part of ISO 10041 specifies the test procedures and a method of presenting the results concerning the parameters that define the main characteristics to be included in the supplier's literature of electro-pneumatic continuous flow control valves, in accordance with ISO 10041-1.

This part of ISO 10041 is intended to

— facilitate the comparison of these types of valves by standardizing test methods and the presentation of test results, and

— assist in the proper application of these valves in pneumatic systems.

The specified tests are not production tests to be carried out on each valve manufactured.

NOTE 1 Tests related to electro-pneumatic continuous pressure control valves are specified in ISO 10094-2.

NOTE 2 Tests described in this part of ISO 10041 are performed on valves with exhaust port(s) connected to the atmosphere except for two-port valves.

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 1219-1, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols for conventional use and data-processing applications*

ISO 5598, *Fluid power system 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 10041-1:2010, *Pneumatic fluid power — Electro-pneumatic continuous flow 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 and ISO 10041-1 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
Critical back-pressure ratio[a]	b	—
Sonic conductance	C	$m^3/(s \cdot Pa)$ (ANR)[c]
Subsonic index	m	—
Atmospheric pressure	p_{atm}	Pa
Reference pressure[c]	p_0	Pa
Inlet port stagnation gauge pressure[b]	p_1	Pa
Working port stagnation gauge pressure[b]	p_2, p_4	Pa
Air exhaust port stagnation gauge pressure[b]	p_3, p_5	Pa
Cracking pressure	Δp_c	Pa
Hysteresis	H	%
Maximum hysteresis difference	$\Delta p_{2,h,max}$	Pa
Linearity	L	%
Maximum linearity difference	$\Delta p_{2,l,max}$	Pa
Volume flow rate at standard reference atmosphere	q_V	m^3/s (ANR)[c]
Volume flow rate related to the relief flow rate	$q_{V,r}$	m^3/s (ANR)[c]
Maximum volume flow rate related to the forward flow rate	$q_{V,f,max}$	m^3/s (ANR)[a]
Repeatability	r	%
Reference temperature	T_0	K
Inlet port temperature[a]	T_1	K
Working port temperature[a]	T_2	K
Electrical control signal	w (w_{start}, w_{stop})	V, mA or digital signal
Resolution	S	%

[a] Defined in ISO 6358-1.

[b] See ISO 11727[4].

[c] Reference atmosphere is defined in ISO 8778[2], i.e.: T_0 = 293,15 K, p_0 = 100 kPa (1 bar) and relative humidity of 65 %.

The graphic symbols used in Figures 1 to 4 and in Figures 6 to 8 are in accordance with ISO 1219-1.

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 control valve 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

If possible, testing should be conducted at an inlet pressure of 630 kPa (6,3 bar). If this is not possible, the inlet pressure shall be selected from the values given in ISO 2944.

5.3.3 Verification

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 nominal electrical conditions.

6 Test procedure

6.1 Test conditions

The valve under test shall be installed and operated in accordance with the manufacturer's application instructions.

6.2 Inlet pressure

During the static and dynamic tests specified in Clauses 7 to 11, the inlet pressure shall be maintained constant.

During the dynamic tests specified in Clause 11, a tank buffer as indicated in Figure 8 shall be used in order to reduce fluctuations in the inlet pressure.

6.3 Static tests

During the static tests specified in Clauses 7 to 10, as soon as steady-state conditions are reached, every series of measurements obtained under related specified test conditions shall be recorded. When these measurements are performed in a step-by-step manner, the test conditions shall be modified slowly to prevent instability.

NOTE Figures 1 to 4 and Figures 6 to 8 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.

7 Tests to determine control signal-flow rate characteristics

7.1 Test circuits

7.1.1 Test circuit with working port connected to the atmosphere

7.1.1.1 Figure 1 represents a typical test circuit for measuring the control signal-flow rate characteristics of a three-port valve when the working port is connected to atmosphere. This circuit diagram uses the test circuit specified in ISO 6358-1 for testing under steady-state conditions components that exhaust directly to atmosphere, with the following additional requirements:

— the valve under test shall be located in the circuit so that the inlet port is connected to the upstream transition connector and pressure-measuring tube;

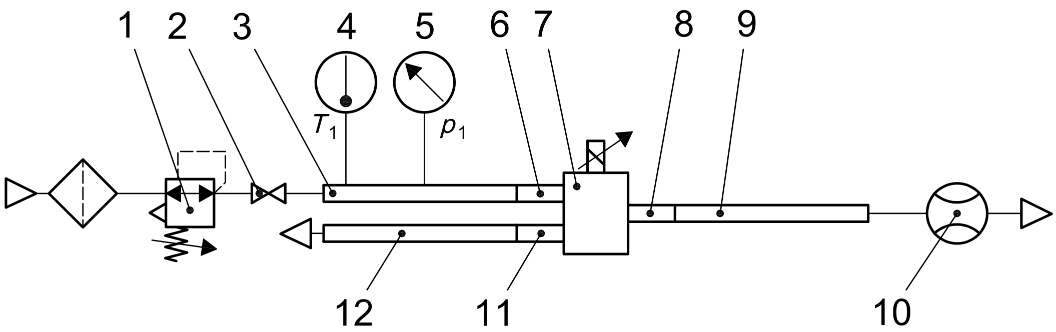
— the flowmeter shall be located downstream of the valve under test, at the working port and not at the inlet port, in order to measure the actual operating flow rate, using downstream transition connector and pressure-measuring tube;

— items 11 and 12 are not required when using component under test for which the exhaust port cannot be connected.

7.1.1.2 The test circuit for five-port control valves is the same as the one shown in Figure 1, with the working port that is not being evaluated connected to atmosphere.

NOTE When possible, in the case of five-port valves, both working ports can be evaluated simultaneously when connected to the atmosphere using two flowmeters located downstream of the valve under test at both working ports.

7.1.1.3 The test circuit for two-port control valves is the same as the one shown in Figure 1, except that the component under test does not have any exhaust port.



Key

1 supply pressure regulator

2 shut-off valve

3, 9, 12 pressure-measuring tubes

4 sensor to measure inlet temperature T_1

5 pressure gauge or transducer to measure inlet pressure p_1

6, 8, 11 transition connectors

7 valve under test

10 flowmeter to measure operating mass flow rate

Figure 1 — Test circuit for determining control signal-flow rate characteristics with the working port that is being evaluated connected to atmosphere

7.1.2 Test circuit to measure relief flow rate and forward flow rate

7.1.2.1 The test circuit to measure relief flow rate and forward flow rate shall be used to measure:

— the control signal-flow rate characteristic when the operating pressure is equal to the inlet pressure,

— the control signal-flow rate characteristic when the working port being evaluated is subjected to an intermediate pressure between the inlet and exhaust pressures,

— pressure-relief flow rate global characteristics,

— pressure-forward flow rate global characteristics.

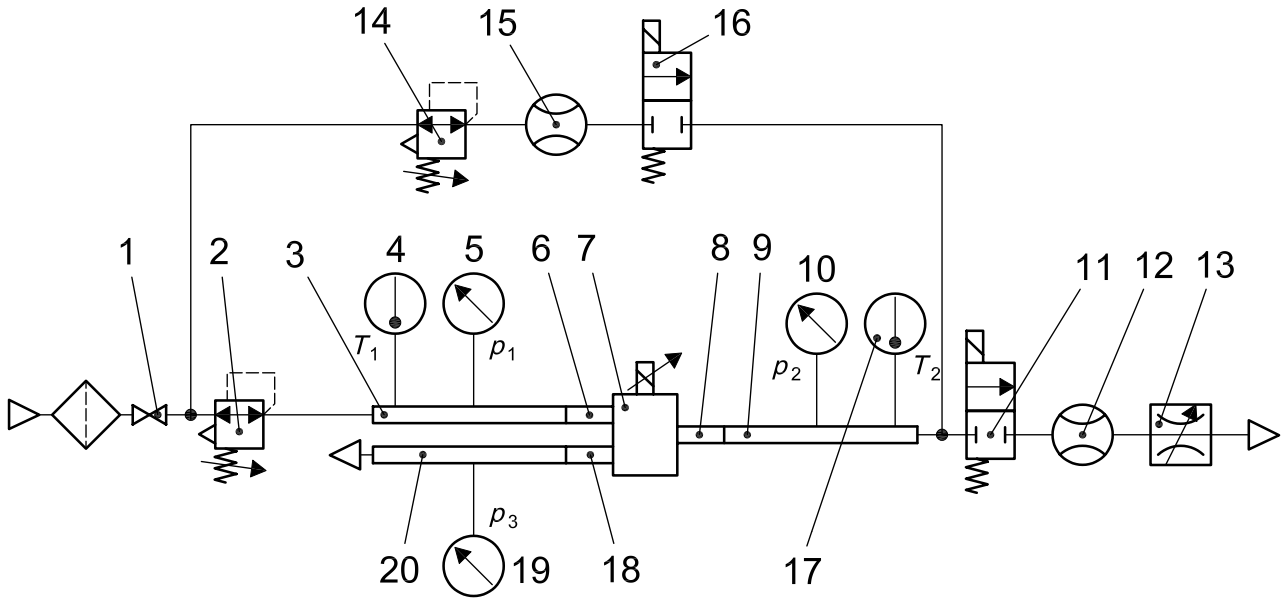
7.1.2.2 Figure 2 represents a typical circuit for testing a three-port flow control valve. This circuit diagram combines:

— the test circuit for in-line test described in ISO 6358-1 for testing under steady-state conditions components with upstream and downstream pressure-measuring tubes (used for forward flow rates measurements), and

— the exhaust-to-atmosphere test circuit specified in ISO 6358-1 for testing under steady state conditions components that exhaust directly to atmosphere (used for relief flow rates measurements).

7.1.2.3 The test circuit for five-port control valves is the same as the one shown in Figure 2, with the working port that is being evaluated connected to the test circuit and the working port that is not being evaluated connected to atmosphere.

7.1.2.4 For testing two-port control valves (no exhaust port), the test circuit shown in Figure 2 is used only to measure forward flow rates.



Key

1	inlet shut-off valve
2	inlet pressure regulator
3, 9, 20	pressure-measuring tubes
4	sensor to measure inlet temperature T_1
5	pressure gauge or transducer to measure inlet pressure p_1
6, 8, 18	transition connectors
7	valve under test
10	pressure gauge or transducer for measuring operating pressure p_2
11, 16	solenoid valves
12	flowmeter to measure forward flow rate
13	flow control valve to regulate forward flow rates
14	operating pressure regulator for relief flow rates
15	flowmeter to measure relief flow rate
17	sensor to measure temperature T_2 for relief flow rates
19	pressure gauge or transducer to measure relief pressure p_3

Figure 2 — Test circuit for measuring relief flow rate and forward flow rate

7.1.3 General requirements

— The component under test shall be located in the test circuit so as to connect all ports to the transition connectors and pressure-measuring tubes. Items 18, 19 and 20 are not required when using component under test for which the exhaust port cannot be connected.

— Transition connectors 6, 8 and 18 and pressure-measuring tubes 3, 9 and 20 shall be in accordance with ISO 6358-1.

— Components 1 to 6 correspond to the upstream part of the test circuit used for forward flow rates measurements. These components shall be used also for relief flow rate measurements as the inlet port of the component under test shall be connected to the supply circuit, following the normal use of the component.

— Components 8 to 13 correspond to the downstream part of the test circuit used for forward flow rates measurements.