BS ISO 10094-2:2021

BSI Standards Publication

Pneumatic fluid power — Electro-pneumatic pressure control valves

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

Documents
Document Sharing Hub

Full document details: BS ISO 10094-2:2021

National foreword

This British Standard is the UK implementation of ISO 10094-2:2021. It supersedes BS ISO 10094-2:2010, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/18/-/5, Control components.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2021
Published by BSI Standards Limited 2021

ISBN 978 0 580 99892 8

ICS 23.100.50

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2021.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS ISO 10094-2:2021

INTERNATIONAL STANDARD

ISO 10094-2

Second edition
2021-11

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

Reference number
ISO 10094-2:2021(E)

Documents
Document Sharing Hub

© ISO 2021

Full document details: BS ISO 10094-2:2021

COPYRIGHT PROTECTED DOCUMENT

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 10094-2:2021

Contents

Page

Foreword ... **v**
Introduction ... **vi**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms and definitions ... **2**
4 Symbols and units ... **2**
5 Test conditions ... **3**
5.1 Gas supply ... 3
5.2 Temperature ... 3
5.3 Pressures ... 3
5.3.1 General ... 3
5.3.2 Inlet pressure ... 3
5.3.3 Test pressures ... 3
5.3.4 Checking ... 3
5.4 Electrical supplies ... 3
6 Test procedures ... **4**
6.1 Test conditions ... 4
6.2 Inlet pressure ... 4
6.3 Static tests ... 4
7 Control signal/pressure static-characteristics test at null forward or relief flow rate ... **4**
7.1 Test installation ... 4
7.1.1 Test circuit ... 4
7.1.2 Pressure measurement ... 5
7.2 Test procedures ... 5
7.2.1 Control signal/pressure static characteristic test ... 5
7.2.2 Minimum regulated pressure test ... 5
7.2.3 Resolution test ... 6
7.2.4 Repeatability test ... 6
7.3 Calculation of characteristics ... 7
7.3.1 Characteristic curve ... 7
7.3.2 Linearity ... 8
7.3.3 Control signal/pressure hysteresis ... 9
7.3.4 Minimum regulated pressure ... 10
7.3.5 Resolution ... 11
7.3.6 Repeatability ... 11
7.3.7 Sensitivity ... 12
7.3.8 Offset ... 12
8 Flow/pressure static characteristics test ... **12**
8.1 Test circuit for flow rate measurement ... 12
8.2 General requirements ... 13
8.3 Test procedures ... 14
8.3.1 Initial test procedure ... 14
8.3.2 Forward flow rate/pressure characteristics test ... 14
8.3.3 Relief flow rate/pressure characteristics test ... 14
8.3.4 Procedure for other control signal values ... 15
8.4 Calculation of characteristics ... 15
8.4.1 Characteristic curves ... 15
8.4.2 Flow rate/pressure hysteresis ... 15
8.4.3 Maximum forward sonic conductance ... 15
8.4.4 Maximum relief sonic conductance ... 16
9 Pressure regulation characteristics test ... **17**

© ISO 2021 – All rights reserved

AVA Documents
Document Sharing Hub
Full document details: BS ISO 10094-2:2021

9.1 Test circuit ... 17
9.2 Test procedure ... 17

10 Leakage at null forward flow rate or relief flow rate characteristic test ... 17
10.1 Test circuit ... 17
10.2 Test procedure ... 18
10.3 Calculation of characteristic ... 18

11 Dynamic characteristics – Step responses ... 18
11.1 Test Installation ... 18
11.2 Test procedures ... 19
11.3 Calculation of characteristics ... 20
11.3.1 Charge characteristic curves ... 20
11.3.2 Discharge characteristic curves ... 20
11.3.3 Charge characteristics ... 20
11.3.4 Discharge characteristics ... 21

12 Presentation of test results ... 22
12.1 General ... 22
12.2 Control signal/pressure static characteristics ... 22
12.3 Flow rate/pressure characteristics ... 23
12.4 Pressure regulation characteristics ... 23
12.5 Leakage characteristic ... 23
12.6 Dynamic characteristics ... 23

Annex A (informative) **Frequency responses ... 24**

Annex B (informative) **Calculation procedures of gain and phase lag ... 26**

Bibliography ... 30

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 10094-2:2021

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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.

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 10094-2:2021

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.

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 10094-2:2021

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*

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 10094-2:2021

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 %.

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 10094-2:2021

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	$\Delta p_{2,\mathrm{h,max}}$	Pa
Maximal difference of the linearity	$\Delta p_{2,\mathrm{l,max}}$	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, $p_{2,\mathrm{max}}$, plus 200 kPa (2 bar); and

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

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.

© ISO 2021 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 10094-2:2021

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.

© ISO 2021 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 10094-2:2021