INTERNATIONAL STANDARD

ISO 10770-3

Second edition
2020-04

Hydraulic fluid power — Electrically modulated hydraulic control valves —

Part 3: Test methods for pressure control valves

Transmissions hydrauliques — Distributeurs hydrauliques à modulation électrique —
Partie 3: Méthodes d'essai pour distributeurs de commande de pression

Reference number
ISO 10770-3:2020(E)

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Published in Switzerland

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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).

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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*, Sub-committee SC 8, *Product testing*.

This second edition cancels and replaces the first edition (ISO 10770-3:2007), which has been technically revised.

A list of all parts in the ISO 10770 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

This document describes methods of testing electro-hydraulic pressure relief and pressure reducing valves. These types of electro-hydraulic valves prevent the pressure in a hydraulic system rising above a level defined or set by an electrical input signal.

Relief valves are used to control the pressure in a closed volume by increasing the flow out of the volume if the pressure exceeds the set pressure level. The excess flow is dumped directly to a tank.

Reducing valves are used to control the pressure in a closed volume by restricting the flow into the volume if the pressure exceeds the set pressure level.

The design of the system and the position of the valve within the system dictates which type of valve is appropriate to use.

This document has been prepared with the intention of improving the uniformity of valve testing and hence the consistency of recorded valve performance data so that these data can be used for system design, regardless of the data source.

Hydraulic fluid power — Electrically modulated hydraulic control valves —

Part 3: Test methods for pressure control valves

1 Scope

This document describes test methods for determining the performance characteristics of electrically modulated hydraulic pressure control valves.

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 3448:1992, *Industrial liquid lubricants — ISO viscosity classification*

ISO 4406, *Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*

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

ISO 6743-4, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

ISO 9110-1:1990, *Hydraulic fluid power — Measurement techniques — Part 1: General measurement principles*

ISO 10771-1, *Hydraulic fluid power — Fatigue pressure testing of metal pressure-containing envelopes — Part 1: Test method*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 5598 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 http://www.electropedia.org/

3.1 Terms and definitions

3.1.1
electrically modulated pressure control valve
valve that limits the pressure in a hydraulic system to a level that is continuously variable and proportional to an electrical input signal

3.1.2
electrically modulated relief valve
valve that limits the pressure at the inlet port by dumping excess flow to the tank port

3.1.3
electrically modulated reducing valve
valve that limits the pressure at the outlet port by reducing the flow taken from the inlet port

3.1.4
controlled pressure
pressure difference between inlet and outlet of the relief valve under test or the pressure at the outlet of the reducing valve under test

3.1.5
controlled pressure volume
total volume of fluid in a test rig directly connected to the inlet of the relief valve under test, or the outlet of the reducing valve under test

3.1.6
head loss
minimum pressure drop through a valve

Note 1 to entry: The head loss is plotted as pressure versus flow.

3.1.7
reference pressure
controlled pressure measured at 10 % of rated flow

3.2 Symbols

For the purposes of this document, the symbols given in Table 1 apply:

Table 1 — Symbols

Parameter	Symbol	Unit
Frequency	f	Hz
Input signal	I or U	A or V
Rated signal	I_N or U_N	A or V
Current readout	I_{READ}	A
Pressure gain	$K_P = (\Delta p/\Delta I$ or $\Delta p/\Delta U)$	bar (per input signal unit)
Inductance	L_C	H
Supply pressure	p_P	MPa (bar)
Return pressure	p_T	MPa (bar)
Controlled pressure	p_C	MPa (bar)
Valve pressure drop	$p_V = p_P - p_T$	MPa (bar)
Rated pressure	p_N	MPa (bar)
Output flow	q	l/min
Rated flow	q_N	l/min
Internal leakage	q_I	l/min
Insulation resistance	R_i	Ω
Resistance	R_C	Ω
Time	t	s
Time constant	t_C	s
Dither amplitude	—	% (of max. input signal)
Dither frequency	—	Hz
Hysteresis	—	% (of max. output)
Threshold	—	% (of maximum input)

Table 1 *(continued)*

Parameter	Symbol	Unit
Amplitude (ratio)	—	dB
Phase lag	—	°
Temperature	—	°C

The graphical symbols in this document conform to ISO 1219-1 and IEC 60617-DB.

4 Standard test conditions

Unless otherwise specified, tests shall be carried out using the standard conditions given in Table 2.

Table 2 — Standard test conditions

Parameter	Condition
Ambient temperature	20 °C ± 5 °C
Filtration	Solid contaminant code number shall be stated in accordance with ISO 4406.
Fluid type	Commercially available mineral based hydraulic fluid (i.e. L – HL in accordance with ISO 6743-4 or other fluid with which the valve is able to operate).
Fluid viscosity	32 cSt ± 8 cSt at valve inlet
Viscosity grade	Grade VG32 or VG46 in accordance with ISO 3448:1992.
Supply pressure	Test requirement ±2,5 %
Return pressure	Return pressure shall conform to the manufacturer's recommendations.

5 Test installation

SAFETY PRECAUTION — It is essential that consideration is given to the safety of personnel and equipment during the tests.

A test installation conforming to the requirements of Figure 1, Figure 2 or Figure 3 shall be used for testing all valves. Figures 1 to 3 show the minimum items required to carry out the tests without any safety devices to protect against damage in the event of component failure. For tests using the test circuits shown in Figures 1 to 3, the following apply:

a) Guidance on carrying out the tests is given in Annex A.

b) A separate circuit may be constructed for each type of test. This can improve the accuracy of test results as it eliminates the possibility of leakage through the shut-off valves.

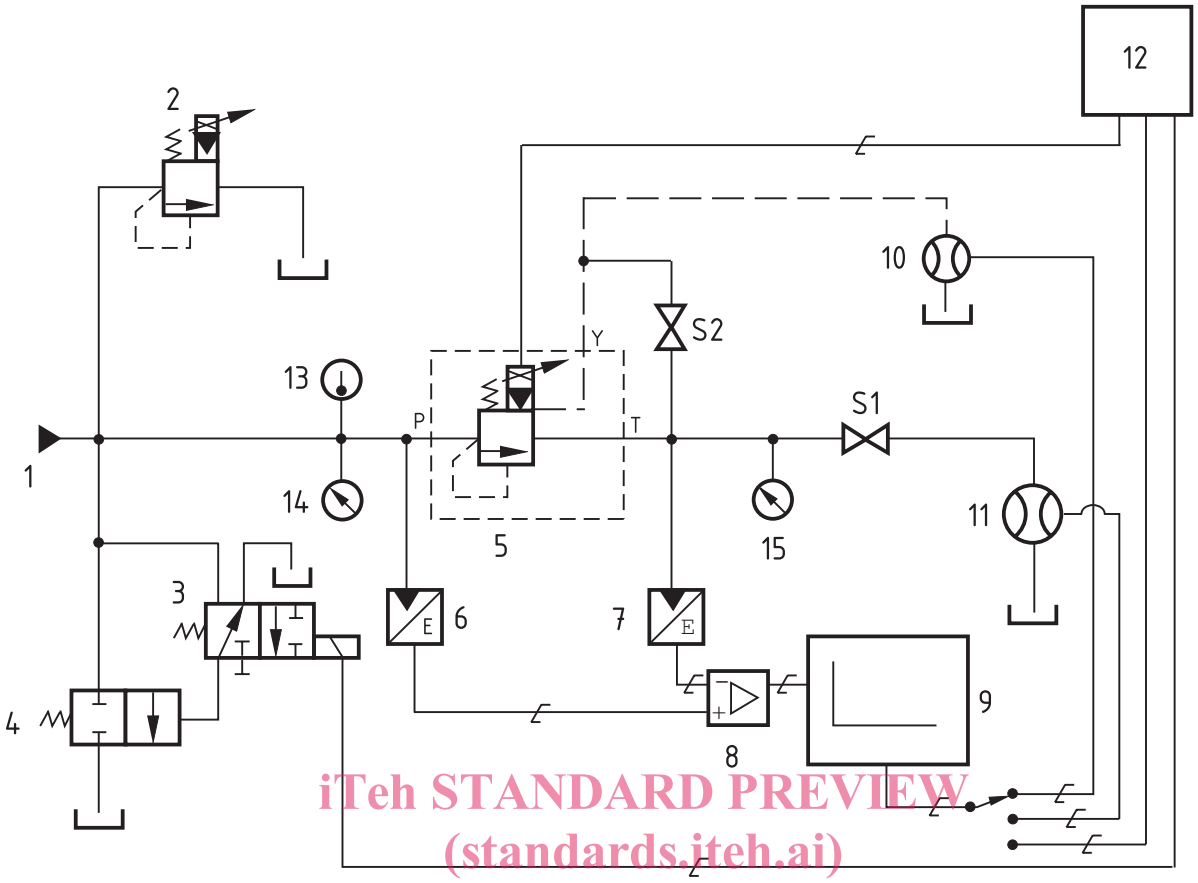
c) Hydraulic performance tests are carried out on a combination of valve and amplifier. Input signals are applied to the amplifier and not directly to the valve. For electrical tests, the signals are applied directly to the valve.

d) If possible, hydraulic tests should be conducted using an amplifier, recommended by the valve manufacturer. If not, the type of amplifier used should be recorded, with the operating details (i.e. pulse width modulation frequency, dither frequency and amplitude).

e) The amplifier supply voltage and magnitude and sign of the voltage applied to the valve during the on and off periods of the pulse-width modulation should be recorded.

f) Electronic test equipment and transducers should have a bandwidth or natural frequency at least ten times greater than the maximum test frequency.

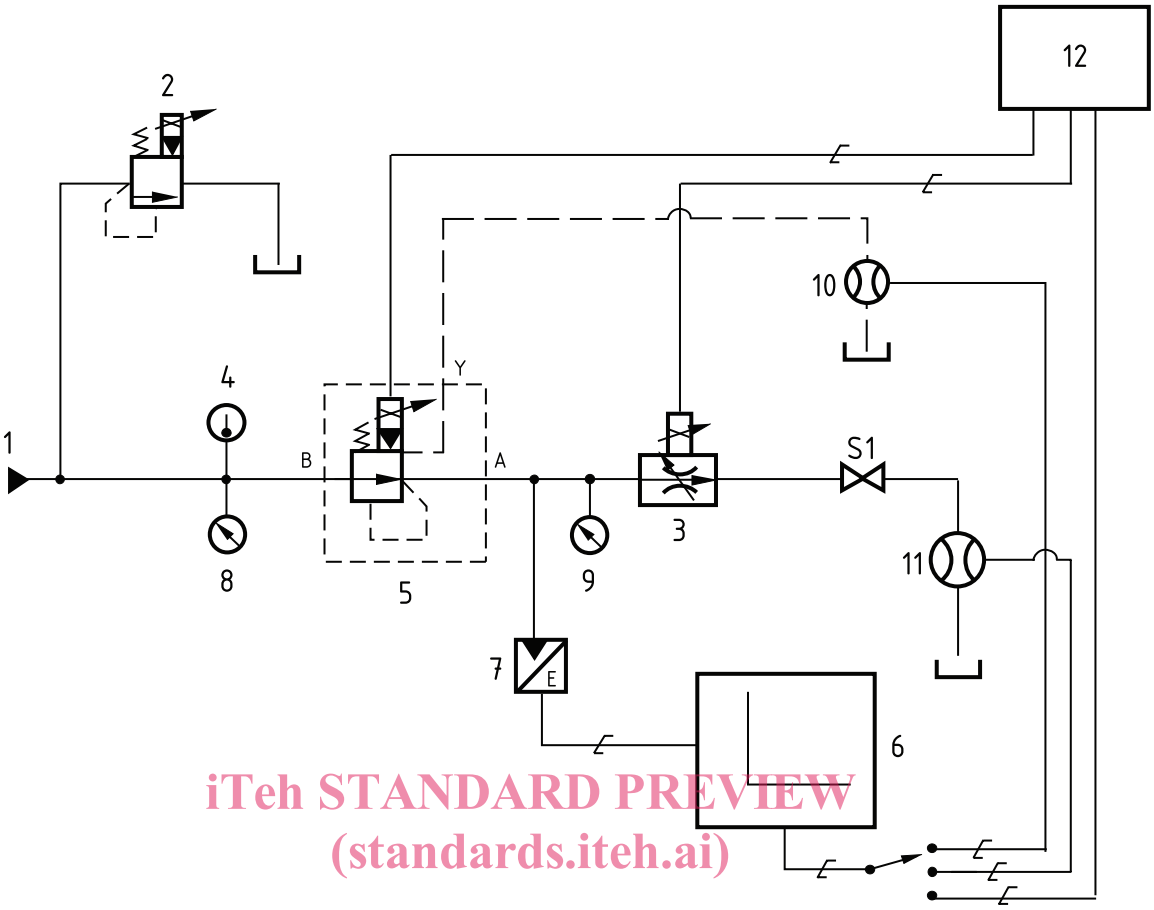
g) Flow transducer 10 shall be selected to have negligible effect on the pressure at port Y.



Key

1	flow source	11	flow transducer
2	system relief valve	12	signal generator
3	pilot valve for unloading valve	13	temperature indicator
4	unloading valve	14	pressure gauge
5	unit under test	15	pressure gauge
6	pressure transducer	S1	shut-off valve
7	pressure transducer	S2	shut-off valve
8	differential amplifier	P	supply port
9	data acquisition	T	return port
10	flow transducer	Y	pilot-drain port

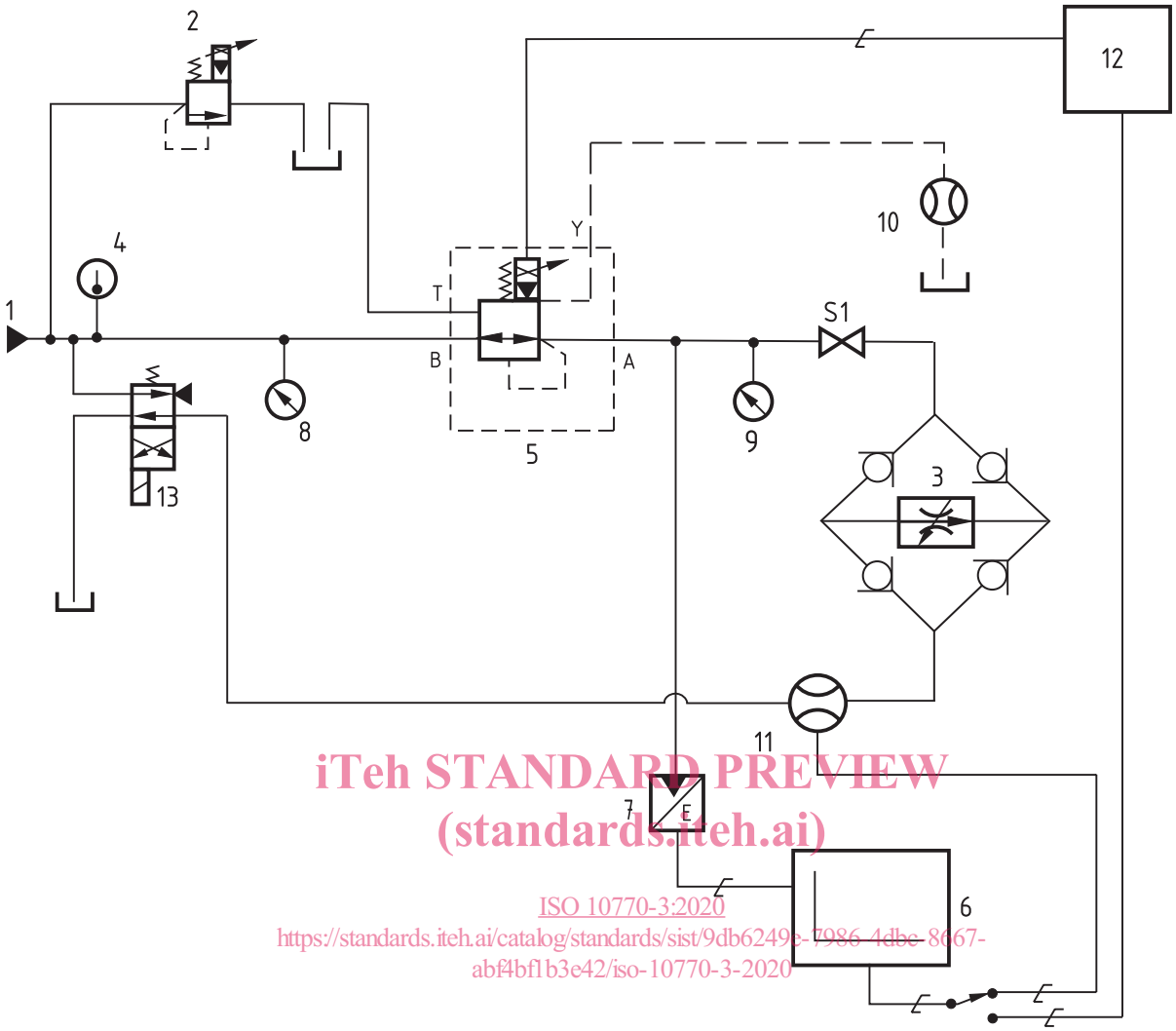
Figure 1 — Relief-valve test circuit



Key

1	flow source	9	pressure gauge
2	system relief valve	10	flow transducer
3	flow control valve	11	flow transducer
4	temperature indicator	12	signal generator
5	unit under test	A	control-pressure port
6	data acquisition	B	inlet-pressure port
7	pressure transducer	S1	shut-off valve
8	pressure gauge	Y	pilot-drain port

Figure 2 — Reducing valve test circuit



Key

1	flow source	10	flow transducer
2	system relief valve	11	flow transducer
3	flow control valve	12	signal generator
4	temperature indicator	13	directional valve
5	unit under test	A	control-pressure port
6	data acquisition	B	inlet-pressure port
7	pressure transducer	S1	shut-off valve
8	pressure gauge	T	return pressure port
9	pressure gauge	Y	pilot-drain port

Figure 3 — Reducing valve with reverse flow test circuit

6 Accuracy

6.1 Instrument accuracy

Instrumentation shall be accurate to within the limits specified in ISO 9110-1:1990, Class B:

a) electrical resistance: ±2 % of the actual measurement;

b) pressure: ±1 % of the valve under test rated pressure;

c) temperature: ±2 % of the temperature to measure;

d) flow: ±2,5 % of the valve under test rated flow;

e) demand: ±1,5 % of the electrical demand signal required to achieve the rated pressure.

6.2 Dynamic range

For the dynamic tests, ensure that the measuring equipment, amplifiers and recording devices do not generate any damping, attenuation or phase shift of the output signal being recorded that can affect the measured value by more than 1 % of the measured value.

7 Electrical tests for valves without integrated electronics

7.1 General

As appropriate, perform the tests described in 7.2 to 7.4 on all valves without integrated electronics before proceeding to subsequent tests.

NOTE Tests 7.2 to 7.4 only apply to current-driven valves.

7.2 Coil resistance

7.2.1 Coil resistance (cold)

a) Soak the complete un-energized valve at the specified ambient temperature for at least 2 h.

b) Measure and record the electrical resistance between the two leads or terminals of each coil in the valve.

7.2.2 Coil resistance (hot)

a) Soak the complete, energized valve, mounted on a sub-plate as recommended by the manufacturer, at its maximum rated temperature and operate the complete valve, fully energised and without flow until the coil temperature stabilizes.

b) Measure and record the electrical resistance between the two leads or terminals of each coil in the valve. The resistance value shall be measured within 1 s of removing the supply voltage.

7.3 Coil inductance (optional test)

This test method shall not be considered to determine a definitive value of inductance. The value obtained shall be used for comparison purposes only.

Perform the test as follows:

a) Connect the coil to a constant voltage supply capable of delivering at least the rated current of the coil;

b) Hold the armature stationary at 50 % of its working stroke during the test;

c) Monitor the coil current using an oscilloscope or similar equipment;

d) Adjust the voltage so that the steady-state current equals the rated current of the coil;

e) Switch the voltage off then on and record the current transient behaviour;