

---

---

**Aerospace fluid systems and  
components — Variable displacement  
hydraulic motors — General  
specifications**

iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

ISO 22181:2021

<https://standards.iteh.ai/catalog/standards/iso/730288cc-0e56-4b55-a53a-4307e2954f5a/iso-22181-2021>



iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

ISO 22181:2021

<https://standards.iteh.ai/catalog/standards/iso/730288cc-0e56-4b55-a53a-4307e2954f5a/iso-22181-2021>



**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](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

Page

<b>Foreword</b>	<b>vi</b>
<b>Introduction</b>	<b>vii</b>
<b>1 Scope</b>	<b>1</b>
<b>2 Normative references</b>	<b>1</b>
<b>3 Terms and definitions</b>	<b>2</b>
<b>4 Classification</b>	<b>7</b>
<b>5 General requirements</b>	<b>7</b>
5.1 Order of precedence	7
5.2 Hydraulic system characteristics	7
5.3 Airworthiness regulations	8
5.4 Qualification	8
<b>6 Functional requirements</b>	<b>8</b>
6.1 Hydraulic fluid	8
6.2 Pressures	8
6.2.1 Rated supply pressure	8
6.2.2 Rated differential pressure	8
6.2.3 No-load break-out pressure	8
6.2.4 Motor return port pressure	9
6.2.5 Case drain pressure	9
6.3 Flows	9
6.3.1 Rated consumption	9
6.3.2 Case drain flow	9
6.3.3 Shaft seal leakage	10
6.3.4 External leakage	10
6.4 Speed and direction of rotation	10
6.4.1 Speed	10
6.5 Torque	11
6.5.1 Rated torque	11
6.5.2 Break-out torque	11
6.5.3 Stalling torque	11
6.5.4 Maximum stalling torque	11
6.5.5 Torque pulsations	11
6.6 Variable output load control	11
6.6.1 General	11
6.6.2 Response time	12
6.6.3 Stability	12
6.7 Motor overall efficiency	12
6.8 Dynamic characteristics	13
6.8.1 General	13
6.8.2 Dynamic braking	13
6.8.3 Rapid reversals	13
6.9 Passive operation	13
6.10 Fluid and ambient temperature	13
6.10.1 Fluid temperature	13
6.10.2 Ambient temperature	13
6.11 Acoustic noise level	14
6.12 Rated endurance	14
6.13 Environmental requirements	14
<b>7 Detail design requirements</b>	<b>15</b>
7.1 Dimensionally critical components	15
7.2 Maintainability features	15
7.3 Seals	15

7.4	Lubrication.....	15
7.5	Balance.....	15
7.6	Self-contained failure.....	16
7.7	Safety wire sealing.....	16
7.8	Electro-conductive bonding.....	16
7.9	Marking.....	16
7.9.1	Nameplate.....	16
7.9.2	Modification standard.....	16
7.9.3	Fluid identification.....	16
7.9.4	Ports.....	16
<b>8</b>	<b>Strength requirements.....</b>	<b>17</b>
8.1	General.....	17
8.2	Proof pressure.....	17
8.2.1	Motor case.....	17
8.2.2	Motor inlet port.....	17
8.2.3	Motor return port.....	17
8.3	Ultimate pressure.....	17
8.3.1	Motor case.....	17
8.3.2	Motor inlet port.....	17
8.3.3	Motor return port.....	17
8.4	Pressure impulse (fatigue).....	17
8.5	Port strength.....	18
<b>9</b>	<b>Construction requirements.....</b>	<b>18</b>
9.1	Materials.....	18
9.1.1	General.....	18
9.1.2	Metals.....	18
9.2	Corrosion protection.....	18
9.2.1	General.....	18
9.2.2	Ferrous and copper alloys.....	19
9.2.3	Aluminium alloys.....	19
9.3	Castings.....	19
<b>10</b>	<b>Installation requirements.....</b>	<b>19</b>
10.1	Dimensions.....	19
10.2	Mass.....	19
10.3	Mounting.....	20
10.4	Orientation.....	20
10.5	Drive shaft.....	20
10.6	Ports.....	20
<b>11</b>	<b>Maintenance requirements.....</b>	<b>21</b>
11.1	Maintenance concept.....	21
11.2	Service life limitations and storage specifications.....	21
<b>12</b>	<b>Reliability requirements.....</b>	<b>21</b>
12.1	Equipment compliance.....	21
12.2	Requirements.....	21
<b>13</b>	<b>Quality assurance provisions.....</b>	<b>21</b>
13.1	Responsibility for inspection.....	21
13.2	Classification of tests.....	21
13.3	Test stand requirements.....	22
<b>14</b>	<b>Acceptance tests.....</b>	<b>22</b>
14.1	General.....	22
14.2	Examination of the product.....	22
14.3	Test programme.....	23
14.3.1	General.....	23
14.3.2	External leakage requirements.....	23
14.3.3	Break-in run.....	23

14.3.4	Proof pressure and overspeed tests.....	23
14.3.5	Operational tests at rated conditions.....	24
14.3.6	Break-out torque test.....	24
14.3.7	Teardown inspection examination.....	24
14.3.8	Run-in.....	25
14.3.9	Speed control test.....	25
14.3.10	Performance data.....	25
14.3.11	Fluid contamination test.....	26
14.4	Storage and packaging.....	27
<b>15</b>	<b>Qualification procedures.....</b>	<b>27</b>
15.1	General.....	27
15.2	Qualification procedure.....	27
15.2.1	Qualification by analogy.....	27
15.2.2	Motor qualification test report.....	27
15.2.3	Samples and program of qualification tests.....	27
15.3	Qualification testing.....	28
15.3.1	Dimensional check.....	28
15.3.2	Expanded envelope acceptance tests.....	28
15.3.3	Overspeed test.....	28
15.3.4	Operational test at overpressure.....	29
15.3.5	Calibration.....	29
15.3.6	Endurance testing.....	31
15.3.7	Environmental tests.....	34
15.3.8	Structural tests.....	35
15.3.9	Combination tests.....	37
15.3.10	Supplementary tests.....	37
<b>Bibliography</b>	.....	<b>38</b>

## Document Preview

ISO 22181:2021

<https://standards.iteh.ai/catalog/standards/iso/730288cc-0e56-4b55-a53a-4307e2954f5a/iso-22181-2021>

## 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](http://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](http://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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 10, *Aerospace fluid systems and components*.

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](http://www.iso.org/members.html).

<https://standards.iteh.ai/catalog/standards/iso/730288cc-0e56-4b55-a53a-4307e2954f5a/iso-22181-2021>

## Introduction

It is noted that, while ISO standards refer to SI units, large segments of the aerospace industry refer to other measurement systems as a matter of common working practice. All dimensions used in this document are in SI units with the non-SI units given in addition for the convenience of those users more familiar with these.

It is further noted that the standard ISO decimal symbol “,” (comma) is not used as common working practice for inch dimensions. A decimal point is used in the inch dimensions in this document as in many other aerospace standards.

NOTE The use of non-SI units and the decimal point in this document does not constitute general acceptance of measurement systems other than SI within International Standards.

iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

[ISO 22181:2021](https://standards.iteh.ai/catalog/standards/iso/730288cc-0e56-4b55-a53a-4307e2954f5a/iso-22181-2021)

<https://standards.iteh.ai/catalog/standards/iso/730288cc-0e56-4b55-a53a-4307e2954f5a/iso-22181-2021>





# Aerospace fluid systems and components — Variable displacement hydraulic motors — General specifications

## 1 Scope

This document establishes the general requirements for variable displacement uni-directional and bi-directional hydraulic motors, suitable for use in aircraft hydraulic systems at pressures up to 35 000 kPa (5 000 psi).

These requirements include:

- design requirements;
- test requirements.

Primary and secondary function motors (see [Clause 4](#)) are covered in this document; however, actuators with internal rotation angle limits and low-speed motors are not covered.

This document is intended to be used in conjunction with the detail specification that is particular to each application.

## 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 2093, *Electroplated coatings of tin — Specification and test methods*

ISO 2669, *Environmental tests for aircraft equipment — Steady-state acceleration*

ISO 2671, *Environmental tests for aircraft equipment — Part 3.4 : Acoustic vibration*

ISO 2685, *Aircraft — Environmental test procedure for airborne equipment — Resistance to fire in designated fire zones*

ISO 3323, *Aircraft — Hydraulic components — Marking to indicate fluid for which component is approved*

ISO 3601-1, *Fluid power systems — O-rings — Part 1: Inside diameters, cross-sections, tolerances and designation codes*

ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment*

ISO 7320, *Aerospace — Couplings, threaded and sealed, for fluid systems — Dimensions*

ISO 8078, *Aerospace process — Anodic treatment of aluminium alloys — Sulfuric acid process, undyed coating*

ISO 8079, *Aerospace process — Anodic treatment of aluminium alloys — Sulfuric acid process, dyed coating*

ISO 8399-1, *Aerospace — Accessory drives and mounting flanges (Metric series) — Part 1: Design criteria*

ISO 8399-2, *Aerospace — Accessory drives and mounting flanges (Metric series) — Part 2: Dimensions*

ISO 8625-1, *Aerospace — Fluid systems — Vocabulary — Part 1: General terms and definitions related to pressure*

ISO 8625-2, *Aerospace — Fluid systems — Vocabulary — Part 2: General terms and definitions relating to flow*

ISO 8625-3, *Aerospace — Fluid systems — Vocabulary — Part 3: General terms and definitions relating to temperature*

ISO 11218, *Aerospace — Cleanliness classification for hydraulic fluids*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8625-1, ISO 8625-2, ISO 8625-3, 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

##### **variable displacement hydraulic motor**

mechanical actuator that converts hydraulic pressure and flow into torque and angular velocity (rotation) and whose speed is controlled by varying the displacement of the hydraulic motor

Note 1 to entry: The use of a variable displacement hydraulic motor permits the optimization of hydraulic flow demand.

Note 2 to entry: The motor's output torque, direction of rotation (if bi-directional) and associated operating speed and resultant flow consumption is controlled by a servo valve which varies the motor's displacement which is typically operated in closed loop control.

Note 3 to entry: The specifications, design, manufacture and qualification of the servo valve is outside the scope of this document.

##### 3.1.1

##### **uni-directional hydraulic motor**

*variable displacement hydraulic motor* (3.1) that generates output torque via the drive shaft in only one direction

##### 3.1.2

##### **bi-directional hydraulic motor**

*variable displacement hydraulic motor* (3.1) that generates output torque via the drive shaft to both clockwise and anti-clockwise directions

Note 1 to entry: Except for *bi-directional over-centre hydraulic motors* (3.1.3), bi-directional operation is typically achieved by reversing the differential pressure across the inlet/outlet ports, thus reversing the output torque.

Note 2 to entry: Except for *bi-directional over-centre hydraulic motors* (3.1.3), the position of the swashplate is controlled in each direction by a dedicated controller.

##### 3.1.3

##### **bi-directional over-centre hydraulic motor**

*bi-directional hydraulic motor* (3.1.2) whose direction of rotation of the output drive shaft is controlled by the angle of the motor swashplate which can go over centre

Note 1 to entry: This may be accomplished by controlling the position of the swashplate in each direction by a single controller.

**3.2****purchaser**

organization that has the engineering responsibility for the system that includes the motor

Note 1 to entry: Typically, the purchaser is a system *supplier* (3.4), an aircraft manufacturer or a contractor.

**3.3****detail specification**

document compiled by the *purchaser* (3.2) that specifies the following:

- a) technical requirements;
- b) acceptance and qualification test requirements;
- c) reliability, testability and maintainability requirements;
- d) quality requirements;
- e) packaging requirements;
- f) other requirements

Note 1 to entry: Technical requirements include performance requirements and design requirements.

**3.4****supplier**

organization that provides the motor

Note 1 to entry: Typically, the supplier is the manufacturer of the motor who will be responsible for the design, production, and qualification of the motor.

**3.5.1****motor inlet port**

port that receives flow from the hydraulic system to supply the motor

**3.5.2****motor return port**

port that returns flow back to the system reservoir

**3.5.3****motor case drain port**

port that drains internal leakage flow to the system reservoir

Note 1 to entry: Not all motors have a case drain port; instead the case drain fluid is supplied to the motor outlet port.

**3.5.4****shaft seal leakage port**

port that routes any shaft seal leakage from the motor to an overboard drain, collector tank, ecology bottle, etc.

**3.6.1****rated temperature**

maximum continuous temperature of the fluid to be supplied at the inlet port of the motor

**3.6.2****normal operating temperature**

temperature of the fluid to be supplied at the inlet port of the motor at which full performance of the motor is required

### 3.6.3

#### **minimum continuous temperature**

minimum temperature of the fluid at the supply port of the motor at which the motor is able to function

Note 1 to entry: This temperature is generally higher than the minimum *survival temperature* ([3.6.5](#)).

### 3.6.4

#### **extreme operating temperature**

temperature of the fluid to be supplied at the inlet port of the motor at which the motor runs with an agreed degraded performance

### 3.6.5

#### **survival temperature**

ambient temperature at which the motor is not required to run, but runs without degradation at the *normal operating temperature* ([3.6.2](#))

### 3.7.1

#### **design operating pressure**

normal maximum steady pressure

Note 1 to entry: Excluded are reasonable tolerances, transient pressure effects such as may arise from the following:

- pressure ripple;
- reactions to system functioning;
- demands that may affect fatigue.

### 3.7.2

#### **rated supply pressure**

system rated pressure, which is normally the hydraulic power generation system *design operating pressure* ([3.7.1](#))

### 3.7.3

#### **rated differential pressure**

differential pressure measured between the motor inlet and outlet ports required to produce the *rated torque* ([3.11.1](#))

### 3.7.4

#### **no-load break-out pressure**

differential pressure required for starting the output shaft, without interruption, with the case drain port at the *rated case drain pressure* ([3.7.6.1](#)) and the return port at the *nominal motor return pressure* ([3.7.5.1](#))

Note 1 to entry: This corresponds to *break-out torque* ([3.11.2](#)).

### 3.7.5.1

#### **nominal motor return pressure**

pressure generated at the return port as the motor returns flow back to the system

### 3.7.5.2

#### **rated motor return pressure**

maximum pressure at the return port

Note 1 to entry: This is applicable to uni-directional motors only.

Note 2 to entry: This is a stressing term only as the *nominal motor return pressure* ([3.7.5.1](#)) is generally considerably less than the rated motor return pressure.

### 3.7.6.1

#### **rated case drain pressure**

nominal pressure at which the motor case is required to operate continuously in the system