

# INTERNATIONAL STANDARD



**Industrial-process control valves –  
Part 2-3: Flow capacity – Test procedures**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2015 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [www.iec.ch/glossary](http://www.iec.ch/glossary)

More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).

# INTERNATIONAL STANDARD



---

**Industrial-process control valves –  
Part 2-3: Flow capacity – Test procedures**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 23.060.40; 25.040.40

ISBN 978-2-8322-3055-8

**Warning! Make sure that you obtained this publication from an authorized distributor.**

## CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references .....	6
3 Terms and definitions .....	6
4 Symbols .....	7
5 Test system.....	8
5.1 Test specimen .....	8
5.2 Test section .....	8
5.3 Throttling valves .....	9
5.4 Flow measurement.....	10
5.5 Pressure taps .....	10
5.6 Pressure measurement .....	10
5.7 Temperature measurement .....	10
5.8 Valve travel.....	11
5.9 Installation of test specimen.....	11
6 Accuracy of tests .....	12
7 Test fluids.....	12
7.1 Incompressible fluids .....	12
7.2 Compressible fluids .....	12
8 Test procedure for incompressible fluids.....	12
8.1 Test procedure for flow coefficient $C$ .....	12
8.2 Test procedure for liquid pressure recovery factor $F_L$ and combined liquid pressure recovery factor and piping geometry factor $F_{LP}$ .....	14
8.3 Test procedure for piping geometry factor $F_p$ .....	15
8.4 Test procedure for liquid critical pressure ratio factor $F_F$ .....	15
8.5 Test procedure for Reynolds number factor $F_R$ for incompressible flow .....	15
8.6 Test procedure for valve style modifier $F_d$ .....	15
9 Data evaluation procedure for incompressible fluids .....	16
9.1 Non-choked flow .....	16
9.2 Choked flow .....	16
9.3 Calculation of flow coefficient $C$ .....	17
9.4 Calculation of liquid pressure recovery factor $F_L$ and the combined liquid pressure recovery factor and piping geometry factor $F_{LP}$ .....	17
9.5 Calculation of piping geometry factor $F_p$ .....	18
9.6 Calculation of liquid critical pressure ratio factor $F_F$ .....	18
9.7 Calculation of Reynolds number factor $F_R$ .....	18
9.8 Calculation of valve style modifier $F_d$ .....	18
10 Test procedure for compressible fluids .....	19
10.1 Test procedure for flow coefficient $C$ .....	19
10.2 Test procedure for pressure differential ratio factors $x_T$ and $x_{TP}$ .....	20
10.3 Test procedure for piping geometry factor $F_p$ .....	21
10.4 Test procedure for Reynolds number factor $F_R$ .....	22
10.5 Test procedure for valve style modifier $F_d$ .....	22
10.6 Test procedure for small flow trim .....	22
11 Data evaluation procedure for compressible fluids.....	23

11.1	Flow equation .....	23
11.2	Calculation of flow coefficient $C$ .....	23
11.3	Calculation of pressure differential ratio factor $x_T$ .....	23
11.4	Calculation of pressure differential ratio factor $x_{TP}$ .....	24
11.5	Calculation of piping geometry factor $F_p$ .....	24
11.6	Calculation of Reynolds number factor $F_R$ for compressible fluids .....	24
11.7	Calculation of valve style modifier $F_d$ .....	24
11.8	Calculation of flow coefficient $C$ for small flow trim .....	24
Annex A (normative) Typical examples of test specimens showing appropriate pressure tap locations .....		26
Annex B (informative) Engineering data .....		28
Annex C (informative) Derivation of the valve style modifier, $F_d$ .....		31
Annex D (informative) Laminar flow test discussion .....		35
Annex E (informative) Long form $F_L$ test procedure .....		36
E.1	General .....	36
E.2	Test procedure .....	36
E.3	Graphical data reduction .....	36
Annex F (informative) Calculation of $F_p$ to help determine if pipe/valve port diameters are adequately matched .....		39
Bibliography .....		41
Figure 1 – Basic flow test system .....		8
Figure 2 – Test section piping requirements .....		9
Figure 3 – Recommended pressure tap connection .....		11
Figure A.1 – Typical examples of test specimens showing appropriate pressure tap locations .....		27
Figure B.1 – Dynamic viscosity of water .....		28
Figure C.1 – Single seated, parabolic plug (flow tending to open) .....		34
Figure C.2 – Swing-through butterfly valve .....		34
Figure E.1 – Typical flow results .....		37
Table 1 – Test specimen alignment .....		11
Table 2 – Minimum inlet absolute test pressure in kPa (bar) as related to $F_L$ and $\Delta p$ .....		13
Table 3 – Numerical constants $N$ .....		25
Table B.1 – Properties for water .....		28
Table B.2 – Properties of air .....		29
Table B.3 – Test section piping .....		30
Table C.1 – Numerical constant, $N$ .....		34
Table F.1 – Tabulated values of $F_p$ if upstream and downstream pipe the same size .....		40
Table F.2 – Tabulated values of $F_p$ if downstream pipe larger than valve .....		40

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL-PROCESS CONTROL VALVES –****Part 2-3: Flow capacity – Test procedures**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60534-2-3 has been prepared by subcommittee 65B: Measurement and control devices, of IEC technical committee 65: Industrial-process measurement, control and automation.

This third edition cancels and replaces the second edition published in 1997, of which it constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Addition of informative Annexes B, C, D, E and F.
- b) Organizational and formatting changes were made to group technically related subject matter.

The text of this standard is based on the following documents:

FDIS	Report on voting
65B/1025/FDIS	65B/1028/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60534 series, published under the general title *Industrial-process control valves*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## INDUSTRIAL-PROCESS CONTROL VALVES –

### Part 2-3: Flow capacity – Test procedures

#### 1 Scope

This part of IEC 60534 is applicable to industrial-process control valves and provides the flow capacity test procedures for determining the following variables used in the equations given in IEC 60534-2-1:

- a) flow coefficient  $C$ ;
- b) liquid pressure recovery factor without attached fittings  $F_L$ ;
- c) combined liquid pressure recovery factor and piping geometry factor of a control valve with attached fittings  $F_{LP}$ ;
- d) piping geometry factor  $F_P$ ;
- e) pressure differential ratio factors  $x_T$  and  $x_{TP}$ ;
- f) valve style modifier  $F_d$ ;
- g) Reynolds number factor  $F_R$ .

#### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60534-1, *Industrial-process control valves – Part 1: Control valve terminology and general considerations*

IEC 60534-2-1:2011, *Industrial-process control valves – Part 2-1: Flow capacity – Sizing equations for fluid flow under installed conditions*

IEC 60534-8-2, *Industrial-process control valves – Part 8-2: Noise considerations – Laboratory measurement of noise generated by hydrodynamic flow through control valves*

IEC 61298-1, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 1: General considerations*

IEC 61298-2, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 2: Tests under reference conditions*

#### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60534-1, IEC 60534-2-1, IEC 61298-1, and IEC 61298-2 apply.