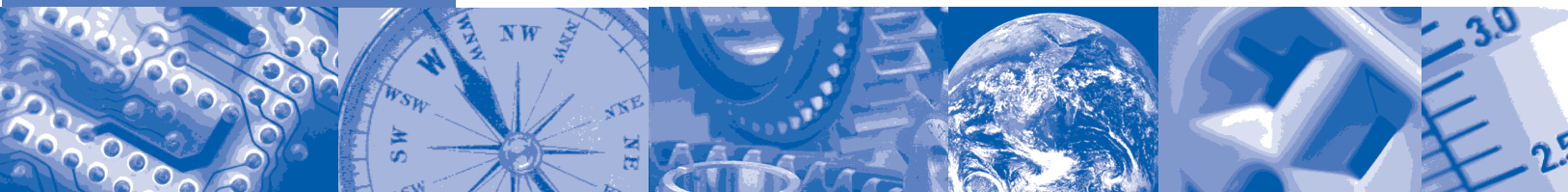


ANSI/ISA-75.25.01-2000



Test Procedure for Control Valve Response Measurement from Step Inputs



**ISA—The Instrumentation,
Systems, and
Automation Society**

Approved 10 January 2001



Documents
Document Sharing Hub

ANSI/ISA-75.25.01-2000
Test Procedure for Control Valve Response Measurement from Step Inputs

ISBN: 1-55617-742-9

Copyright © 2000 by ISA—The Instrumentation, Systems, and Automation Society. All rights reserved. Not for resale. Printed in the United States of America. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise), without the prior written permission of the Publisher.

ISA
67 Alexander Drive
P. O. Box 12277
Research Triangle Park, North Carolina 27709
USA

Preface

This preface, as well as all footnotes and annexes, is included for information purposes and is not part of ANSI/ISA-75.25.01-2000.

The standards referenced within this document may contain provisions which, through reference in this text, constitute requirements of this document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the standards indicated within this document. Members of IEC and ISO maintain registers of currently valid International Standards. ANSI maintain registers of currently valid U.S. National Standards.

This document has been prepared as part of the service of ISA—The Instrumentation, Systems, and Automation Society, toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms and asks that they be addressed to the Secretary, Standards and Practices Board; ISA; 67 Alexander Drive; P. O. Box 12277; Research Triangle Park, NC 27709; Telephone (919) 549-8411; Fax (919) 549-8288; E-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to USA users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce SI-acceptable metric units in all new and revised standards, recommended practices, and technical reports to the greatest extent possible. *Standard for Use of the International System of Units (SI): The Modern Metric System*, published by the American Society for Testing & Materials as IEEE/ASTM SI 10-97, and future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

It is the policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA standards, recommended practices, and technical reports. Participation in the ISA standards-making process by an individual in no way constitutes endorsement by the employer of that individual, of ISA, or of any of the standards, recommended practices, and technical reports that ISA develops.

CAUTION — ISA ADHERES TO THE POLICY OF THE AMERICAN NATIONAL STANDARDS INSTITUTE WITH REGARD TO PATENTS. IF ISA IS INFORMED OF AN EXISTING PATENT THAT IS REQUIRED FOR USE OF THE STANDARD, IT WILL REQUIRE THE OWNER OF THE PATENT TO EITHER GRANT A ROYALTY-FREE LICENSE FOR USE OF THE PATENT BY USERS COMPLYING WITH THE STANDARD OR A LICENSE ON REASONABLE TERMS AND CONDITIONS THAT ARE FREE FROM UNFAIR DISCRIMINATION.

EVEN IF ISA IS UNAWARE OF ANY PATENT COVERING THIS STANDARD, THE USER IS CAUTIONED THAT IMPLEMENTATION OF THE STANDARD MAY REQUIRE USE OF TECHNIQUES, PROCESSES, OR MATERIALS COVERED BY PATENT RIGHTS. ISA TAKES NO POSITION ON THE EXISTENCE OR VALIDITY OF ANY PATENT RIGHTS THAT MAY BE INVOLVED IN IMPLEMENTING THE STANDARD. ISA IS NOT RESPONSIBLE FOR IDENTIFYING ALL PATENTS THAT MAY REQUIRE A LICENSE BEFORE IMPLEMENTATION OF THE STANDARD OR FOR INVESTIGATING THE VALIDITY OR SCOPE OF ANY PATENTS BROUGHT TO ITS ATTENTION. THE USER SHOULD CAREFULLY INVESTIGATE RELEVANT PATENTS BEFORE USING THE STANDARD FOR THE USER'S INTENDED APPLICATION.



HOWEVER, ISA ASKS THAT ANYONE REVIEWING THIS STANDARD WHO IS AWARE OF ANY PATENTS THAT MAY IMPACT IMPLEMENTATION OF THE STANDARD NOTIFY THE ISA STANDARDS AND PRACTICES DEPARTMENT OF THE PATENT AND ITS OWNER.

ADDITIONALLY, THE USE OF THIS STANDARD MAY INVOLVE HAZARDOUS MATERIALS, OPERATIONS OR EQUIPMENT. THE STANDARD CANNOT ANTICIPATE ALL POSSIBLE APPLICATIONS OR ADDRESS ALL POSSIBLE SAFETY ISSUES ASSOCIATED WITH USE IN HAZARDOUS CONDITIONS. THE USER OF THIS STANDARD MUST EXERCISE SOUND PROFESSIONAL JUDGMENT CONCERNING ITS USE AND APPLICABILITY UNDER THE USER'S PARTICULAR CIRCUMSTANCES. THE USER MUST ALSO CONSIDER THE APPLICABILITY OF ANY GOVERNMENTAL REGULATORY LIMITATIONS AND ESTABLISHED SAFETY AND HEALTH PRACTICES BEFORE IMPLEMENTING THIS STANDARD.

THE USER OF THIS DOCUMENT SHOULD BE AWARE THAT THIS DOCUMENT MAY BE IMPACTED BY ELECTRONIC SECURITY ISSUES. THE COMMITTEE HAS NOT YET ADDRESSED THE POTENTIAL ISSUES IN THIS VERSION.

The following people served as members of ISA Subcommittee SP75.25:

NAME	COMPANY
C. Langford, Chairman	Cullen G. Langford, Inc.
W. Weidman, Managing Director	Parsons Energy & Chemicals Group
J. Beall	Eastman Chemical Co.
D. Bennett	Sampson Controls, Inc.
W. Bialkowski	Entech Control Engineering, Inc.
W. Black	Cashco, Inc.
M. Boudreaux	Exxon Mobil Chemical
S. Boyle	Neles Automation
D. Buchanan	Union Carbide Corporation
F. Cain	Flowserve Corporation
N. Cammy	UOP LLC
R. Champagne	Consultant
J. Jamison	Bantrel Inc.
S. Kempf	Harold Beck & Sons, Inc.
P. Maurath	Procter & Gamble Company
R. McEver	Bettis Corporation
N. McLeod	Elf Atochem
G. McMillan	Solutia, Inc.
J. Reed	Norriseal
K. Senior	Dupont Dow Elastomers

The following people served as members of ISA Committee SP75:

NAME	COMPANY
D. Buchanan, Chairman	Union Carbide Corporation
W. Weidman, Managing Director	Parsons Energy & Chemicals Group
A. Abromaitis	Red Valve Company, Inc.
H. Backinger	J. F. Kraus & Company
G. Barb	Retired
H. Baumann	H B Services Partners LLC
H. Boger	Masoneilan Dresser
G. Borden	Consultant

S. Boyle
 R. Brodin
 F. Cain
 C. Corson
 M. Coughran
 A. Engels
 H. Fuller
 J. George
 A. Glenn
 L. Griffith
 B. Guinon
 F. Harthun
 B. Hatton
 J. Jamison
 R. Jeanes
 J. Kersh
 C. Langford
 A. Libke
 R. Louviere
 O. Lovett
 A. McCauley
 R. McEver
 H. Miller
 T. Molloy
 L. Ormanoski
 J. Ozol
 W. Rahmeyer
 J. Reed
 K. Schoonover
 A. Shea
 E. Skovgaard
 H. Sonderegger
 R. Terhune

Neles Automation
 Fisher Controls International, Inc.
 Flowserve Corporation
 Fluor Daniel Inc.
 Fisher Controls
 Praxair, Inc.
 Valvcon Corporation
 Richards Industries
 Flowserve Corp.
 Consultant/Retired
 Shell Chemical
 Retired
 DeZurik Division Unit
 Bantrel, Inc.
 TXU Electric
 M. W. Kellogg Company
 Cullen G. Langford, Inc.
 DeZurik Valve Company
 Creole Engineering Sales Company
 Consultant/Retired
 Chagrin Valley Controls, Inc.
 Bettis Corporation
 Control Components, Inc.
 CMES Inc.
 Frick Company
 Commonwealth Edison
 Utah State University
 Norriseal
 Con-Tek Valves, Inc.
 Copes-Vulcan, Inc.
 Leslie Controls, Inc.
 Tyco Flow Control
 Retired

This standard was approved for publication by the ISA Standards and Practices Board on 30 December 2000:

NAME

M. Zielinski, Vice President
 D. Bishop
 P. Brett
 M. Cohen
 M. Coppler
 B. Dumortier
 W. Holland
 A. Iverson
 R. Jones
 V. Maggioli
 T. McAviney
 A. McCauley, Jr.
 G. McFarland
 D. Rapley
 R. Reimer

COMPANY

Fisher-Rosemount Systems, Inc.
 Consultant
 Honeywell, Inc.
 Senior Flexonics, Inc.
 Ametek, Inc.
 Schneider Electric SA
 Southern Company
 Ivy Optiks
 Dow Chemical Co.
 Feltronics Corp.
 Bateman Engineering, Inc.
 Chagrin Valley Controls, Inc.
 Westinghouse Process Control Inc.
 Rapley Consulting Inc.
 Rockwell Automation



J. Rennie
H. Sasajima
R. Webb
W. Weidman
J. Weiss
J. Whetstone
M. Widmeyer
R. Wiegler
C. Williams
G. Wood

Factory Mutual Research Corp.
Yamatake Corp.
Altran Corp.
Parsons Energy & Chemicals Group
EPRI
National Institute of Standards & Technology
EG&G Defense Materials
CANUS Corp.
Eastman Kodak Co.
Graeme Wood Consulting

Copyright The Instrumentation, Systems, and Automation Society

Contents

1	Scope and limitations	9
2	Purpose and limitations	9
3	Definitions	9
4	General test procedures	14
4.1	Test valve conditions.....	14
4.2	Test system.....	14
4.3	Measuring instrument requirements.....	15
4.4	Process variable.....	15
4.5	Nominal test positions	16
4.6	Examples of step response	16
5	Tests specified for each of three test environments	18
5.1	Bench tests	18
5.2	Laboratory tests	19
5.3	In-process tests.....	19
6	Detailed test procedures.....	20
6.1	Baseline test.....	20
6.2	Small step test.....	21
6.3	Response time tests.....	23
7	Presentation of test results	24
7.1	General information.....	24
7.2	Test results.....	25
8	References	27
	Annex A — Sliding Friction Measurement.....	29

This page intentionally left blank.



1 Scope and limitations

This standard defines the testing and reporting of step response of control valves that are used in throttling closed loop control applications. A control valve consists of the complete, ready-to-use assembly of the control valve body, actuator, and any required accessories. The most probable accessory is a valve positioner. For background, refer to technical report ISA-TR75.25.02-2000, Control Valve Response Measurement from Step Inputs.

If this standard is used for evaluation or acceptance testing, the parties may agree to documented variations from these requirements.

This standard does not define the acceptable control valve performance for process control nor does it restrict the selection of control valves for any application.

This standard defines methods and criteria for performing response tests and evaluating test results for three alternative environments – “bench testing”, “laboratory testing”, and “in-process testing”. “Bench testing” is testing without flow such as in a plant instrument shop, laboratory, or control valve manufacturing site. “Laboratory testing” is testing with flow in a laboratory. “In-process” testing is performed in a plant during normal plant operation with process flow.

2 Purpose and limitations

The purpose of this standard is to define how to test, measure, and report control valve response characteristics. This information can be used for process control applications to determine how well and how fast the control valve responds to the control valve input signal. It does not define acceptable process control, or restrict the selection of control valves to any application, since process requirements and user objectives vary widely.

The information is specifically applicable to closed loop feedback control but may have some application to open loop control applications. It does not address valves used in on-off control service.

Tests specified in this standard may not be sufficient to measure the performance required for all applications. Not all control valve applications will require this testing.

3 Definitions

The technical report ISA-TR75.25.02-2000 explains applicable terms and explores control valve static and dynamic response characteristics important for process control. That information will aid correct interpretation and application of the test results obtained from the tests defined in this standard. Other relevant standards are included in clause 8.

This standard and ISA-TR75.25.02-2000 make use of terms as defined in ANSI/ISA-51.1-1979 (R1993), Process Instrumentation Terminology, and some of the essential terms are repeated here for convenience. In the specific area of nonlinear dynamics, it was determined that some terms defined in ANSI/ISA-51.1-1979 (R1993) lacked the precision desired for these documents. Others were inconsistent with the terminology used in the nonlinear control literature. A common set of definitions is used in this standard and ISA-TR75.25.02-2000. Those used only in ISA-TR75.25.02-2000 are marked with (*).

3.1 backlash:*

in process instrumentation, a relative movement between connected mechanical parts, resulting from looseness when motion is reversed [ANSI/ISA-51.1-1979 (R1993)]. Sometimes also referred to as slop, lost motion, or free play.

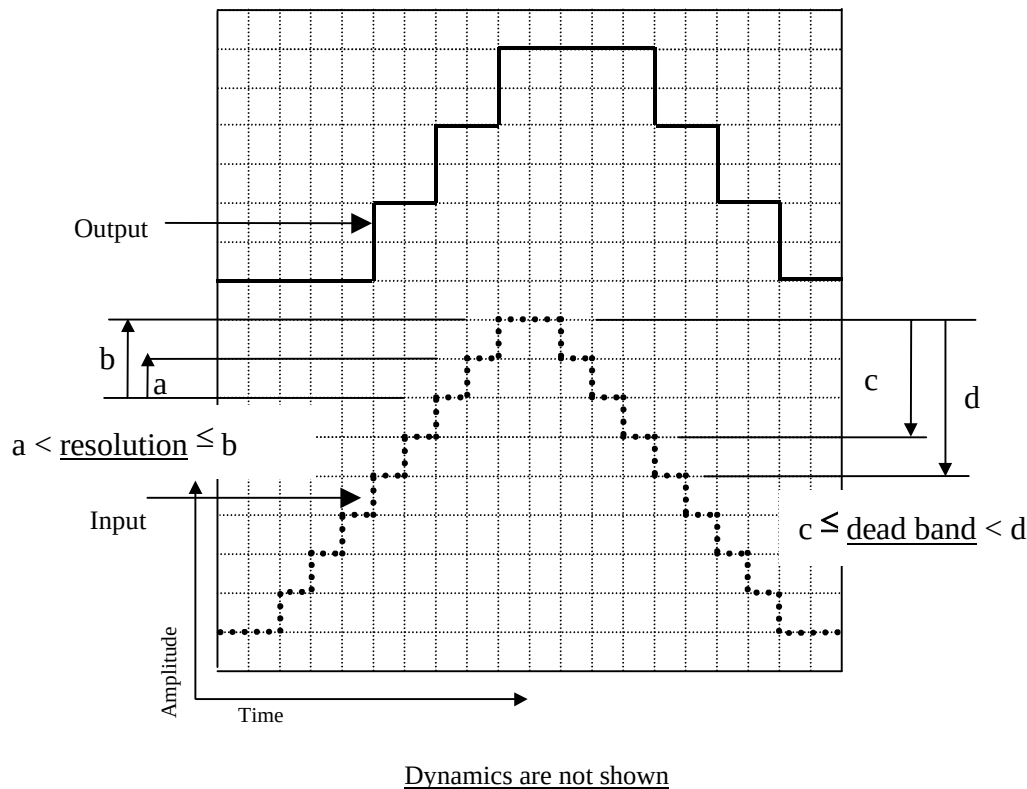


Figure 1 — Dead band and resolution

3.2 closed loop time constant:*

the time constant of the closed loop response of a control loop, used in tuning methods such as Internal Model Control (IMC) and Lambda Tuning. The closed loop time constant is a measure of the performance of a control loop.

3.3 dead band:

the range through which an input signal may be varied, with reversal of direction, without initiating an observable change in output signal [ANSI/ISA-S51.1-1979 (R1993)]. In this standard and ISA-TR75.25.02-2000, it is defined in percent of input span. Note that in some other literature this definition is used for dead zone.

3.4 dead time (T_d):

the time after the initiation of an input change and before the start of the resulting observable response.

3.5 dead zone:*

a zone of input for which no value of the output exists [ANSI/ISA-S51.1-1979 (R1993)].

3.6 dynamic response:

the time-dependent output signal change resulting from a defined time-dependent input signal change. Commonly used input signal changes include impulse, pulse, step, ramp, and sinusoid [McGraw-Hill "Dictionary of Scientific and Technical Terms", fifth edition, 1994]. Dynamic means that the control valve is