



International Society of Automation
Setting the Standard for Automation™

STANDARD

American National Standard
ANSI/ISA-5.1-2024

Instrumentation and Control Symbols and Identification

Approved: 17 JULY 2024

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ANSI/ISA-5.1-2024, Instrumentation and Control Symbols and Identification

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Preface

This preface, as well as the annex, is included for informational purposes and is not a normative part of ANSI/ISA-5.1-2024.

This document has been prepared as part of the service of ISA toward a goal of uniformity in the field of automation. 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, ISA Standards and Practices Board; standards@isa.org.

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professionals; provides education and training; publishes books and technical articles; hosts conferences and events; and provides networking and career development programs for its members and customers around the world.

ISA owns Automation.com, a leading online publisher of automation-related content. In addition, through a wholly owned subsidiary, ISA bridges the gap between standards and their implementation with the ISA Security Compliance Institute (www.isasecure.org) and the ISA Wireless Compliance Institute (www.isa100wci.org).

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On behalf of the ISA Standards and Practices Board, we wish to recognize and thank Tom McAviney for his years of dedication and knowledge in leading the development and understanding of this widely used ISA international standard.

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Introduction (informative)

General

This introduction is included for information only and is not a normative section of ANSI/ISA-5.1-2024. It is highly recommended that users compare the changes listed in Annex A against the 2022 revision of this standard to fully understand the exact changes made.

When integrated into a system, the designations of mandatory and nonmandatory symbols and identification form a dedicated language that communicates concepts, facts, intent, instructions, and knowledge about measurement and control systems that can be applied as appropriate in all industries. Consistency is the one criterion that should govern the selection and application of identification systems and graphic symbols.

The symbols and identification methods set forth in this standard are intended as conceptualizing aids, as design tools, as teaching devices, and as a concise and specific means of communication in all types and kinds of technical, engineering, procurement, construction, and maintenance documents. This includes but is not restricted to instrumentation and control on piping and instrumentation diagrams (P&IDs), functional diagrams, binary logic diagrams, electrical schematics, and loop diagrams.

The ISA5.1 Working Group greatly appreciates and respects the work completed by the past ISA5.1, ISA5.2, ISA5.3, and ISA77.40 Subcommittees/Working Groups and has tried to treat their work with the great respect it deserves.

Background of 2024 revision

This revision changes the title to “Instrumentation and Control Symbols and Identification” to emphasize that symbols for control are also included. This revision is published with significant changes to improve the readability of the document by organizing notes with corresponding tables, by providing definition consistency and clarification, by eliminating redundant text, by adding new symbols, notation, and identification for new automation technology, by adding new sections for Normative Reference, Abbreviation, and Bibliography, and by adding a Loop Instrument Diagrams Symbol Table.

This revision moves Annex A and Annex B from the 2022 revision into separate technical reports for easier maintenance and to reduce the size of the standard. The new technical reports are ISA-TR5.1.02, *Instrumentation and Control Identification System Guidelines*, and ISA-TR5.1.03, *Instrumentation and Control Graphic Symbols Guidelines*. Users are encouraged to read and utilize these TRs together with the standard.

Historical background

The symbols and identification systems described in this standard accommodate advances in technology and reflect the collective industrial experience gained since the original ISA Recommended Practice RP-5.1, published in 1949, was revised, affirmed, and subsequently published as ANSI/ISA-5.1-1984. The 1949 recommended practice and the 1984 standard were published as nonmandatory rather than as mandatory consensus documents.

The 1992 revision was published as a consensus standard. Function block and function designation of SAMA PMC 22.1-1981, “Functional Diagramming of Instrument and Control Systems,” were incorporated. Key elements of ISA-5.3-1983, *Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems* were incorporated.

The 2009 revision was published as a consensus standard and contains both mandatory and non-mandatory statements that have been reviewed and approved by a large group of practitioners in the field of instrumentation and control. Nonmandatory examples were moved to a new Annex B, “Graphic symbol guidelines” (Informative), to provide some limited assistance in the application or

removed for inclusion into future technical reports to provide special practices and requirements of particular interest groups and/or specific industries. The 2009 revision was published with significant changes as technological advancement resulted in the evolution from a hardware (instrument) centric standard to a hardware/software (automation) centric standard. Key elements of ISA-5.2-1976, *Binary Logic Diagrams for Process Operations*, were incorporated. Binary logic symbols of SAMA PMC 22.1-1981, "Functional Diagramming of Instrument and Control Systems," were incorporated. Graphic symbol dimension tables were incorporated to establish minimum mandatory dimensions for the symbols.

The 2022 revision of ISA-5.1 was published as an interim revision with only known usage clarifications and to correct technical and typographical errors so that the ISA5 Standards Committee could begin a new revision of this widely used international standard.

For a summary of the changes made to ISA-5.1-2022 in this revision, refer to Annex A.

ISA-TR5.1.01/ISA-TR77.40.01, *Functional Diagram Usage*, issued in 2012 and reaffirmed in 2016, was published as the first joint technical report under the ISA5 and ISA77 Committees. The purpose of this technical report is to provide advice and guidance in documenting application software through functional diagrams by expanding on and illustrating usage of function block symbols and functions and to prepare examples in development of complex function block symbols and functions.

1 Scope

This standard establishes a uniform means of depicting and identifying instruments or devices and their inherent functions, instrumentation systems and functions, and application software functions used for measurement, monitoring, and control, by presenting a designation system that includes identification schemes and graphic symbols.

1.1 General

1.1.1 This standard is intended to meet the different procedures of various users who need to identify and graphically depict measurement and control equipment and systems. These differences are recognized when they are consistent with the objectives of this standard, by providing alternative symbols and identification methods.

1.1.2 This document provides graphic symbols for representations of the instrumentation and control functions required for process or equipment measurement, indication, and control of variables used in any of the following applications.

- a) Instrumentation and control diagrams, which illustrate and identify instruments and related devices and their inherent functions, instrumentation systems and functions, and application software functions used for measurement, monitoring, and control. These illustrations can appear as part of process flow diagrams (PFDs) and piping and instrumentation diagrams (P&IDs), which include process equipment, mechanical equipment, and piping information.
- b) Functional diagrams, which depict application software functions (analog and binary signal processing) for implementation into the selected control systems.
- c) Binary logic diagrams, which depict interlocking and stepwise logic programming.
- d) Electrical schematics, which depict electrical circuitry for on-off control. These include ladder diagrams.
- e) Instrument loop diagrams, which depict a composite representation of instrument loop information, containing associated electrical, piping, and process equipment connections as well as other pertinent information, including ranges, alarms, and device configuration settings.

1.1.3 Examples of identification and symbol applications are available in associated technical reports ISA-TR5.1.02, *Instrumentation and Control Identification System Guidelines* and ISA-TR5.1.03, *Instrumentation and Control Graphic Symbols Guidelines* and are intended to illustrate basic concepts in the construction of the identification systems and diagrams covered by this standard that are applicable to all industries.

1.2 Application to industries

1.2.1 This standard is suitable for use in chemical, petroleum, power generation, metal refining, pulp and paper, and numerous other continuous, batch, and material-handling industries. These industries and others require the use of some or all of the diagrams listed in 1.1.2 to describe the relationship between processing equipment and the functionality of measurement and control equipment.

1.3 Application to work activities

1.3.1 This standard is suitable for use whenever reference to measurement and control instrumentation, control devices and functions, and application software and functions is required for identification and symbolization, such as:

- a) design sketches;

- b) teaching examples;
- c) technical papers, literature, and discussions;
- d) instrumentation, loop, logic, and functional diagrams;
- e) function descriptions;
- f) conceptual drawings including, but not limited to:
 - 1) PFDs; and
 - 2) utility flow diagrams (UFDs).
- g) construction drawings including, but not limited to:
 - 1) engineering flow diagrams (EFDs);
 - 2) mechanical flow diagrams (MFDs);
 - 3) P&IDs; and
 - 4) system flow diagrams (SFDs).
- h) specifications, purchase orders, manifests, and other lists;
- i) identification and tag numbering of instruments and control functions; and
- j) installation, operating and maintenance instructions, drawings, and records.

1.3.2 This standard provides sufficient information to enable anyone who has a reasonable amount of process and instrumentation knowledge, and who is reviewing documents depicting measurement and control, to understand the means and purpose of the instrumentation and controls shown.

1.3.3 The detailed knowledge of a specialist in instrumentation and/or control systems is not a prerequisite to understanding this standard.

1.4 Application to classes of instrumentation and to instrument functions

1.4.1 The identification and symbolism methods provided in this standard are applicable to all classes and types of measurement and control instruments and/or functions.

1.4.2 The methods can be used for, but are not limited to, describing and identifying:

- a) standalone instruments and their functions;
- b) shared display and shared control functions;
- c) higher level control functions; and
- d) application software display and control functions.

1.4.3 Classification of instrumentation:

1.4.4 Instrumentation can be classified as primary, secondary, auxiliary, or accessory for assigning loop and functional identities and symbols. Also, refer to Clause 3 in ISA-TR5.1.02.

1.4.5 Primary instrumentation consists of measuring, monitoring, controlling, or calculating devices and hardware and their inherent functions and application software functions that include, but are not limited to, transmitters, recorders, controllers, control valves, self-actuated safety and control devices, and application software functions that require or allow user-assigned identifications.

1.4.6 Secondary instrumentation consists of measuring, monitoring, or controlling devices and hardware that include, but are not limited to, level glasses, pressure gauges, thermometers, and pressure regulators.

1.4.7 Auxiliary instrumentation consists of devices and hardware that measure, control, or calculate and that are needed for effective operation of primary or secondary instrumentation; they include, but are not limited to, calculating devices, purge meters, sample handling systems, and instrument air sets.

1.4.8 Accessory instrumentation consists of devices and hardware that do not measure or control but are needed for effective operation of the measuring, monitoring, or control system; they include, but are not limited to, flowmeter tube run, straightening vanes, and seal pots.

1.5 Extent of loop and functional identification

1.5.1 This standard and ISA-TR5.1.02 provide identification codes and methods for the alphanumeric identification of monitoring and controlling loops, instruments, and functions.

1.5.2 These identification methods depend on tagging according to function and not according to construction or form. For example, a differential pressure transmitter is identified as a:

- a) flow transmitter when connected to an orifice plate to measure flow;
- b) level transmitter when connected to the side of a vessel to measure liquid level; or
- c) pressure differential transmitter when connected across a filter to measure pressure difference.

1.5.3 The user is free to apply added identification by serial, equipment, unit, area, or plant number, or any other additional means required for the unique identification of a loop, instrument, or function.

1.5.4 A unique function identification number shall be assigned to identify each:

- a) loop instrument or device and its integral and/or inherent functions; and
- b) *loop-configurable* function, which requires or allows a unique user-assigned microprocessor or computer address.

1.6 Extent of symbolization

1.6.1 This standard provides symbol sets for the graphic depiction of a limited or total functionality of instruments and devices, entire monitor or control loops, or control circuits.

1.6.2 The amount of detail to be shown by the use of symbols depends on the purpose and audience for which the document is being prepared.

1.6.3 Sufficient symbols shall be used to show the functionality of the instrumentation and/or control loop being depicted. It is not considered necessary to provide a symbol for each instrument device and each function required by a loop.

1.6.4 Additional construction, fabrication, installation, and operation details of an instrument are better described in a suitable specification, data sheet, installation/wiring drawing, sketch, or other document intended for those requiring such details rather than the drawings covered in this standard.

1.7 Inclusion and modification of this standard in user engineering and design documents

1.7.1 This standard can be used and, if used, shall be credited by a user/owner in the preparation of engineering, design, or project standards, guidelines, specifications, and other documents, either without exception or with exception per the following:

- a) without exception, in which case this standard in its entirety shall be mandatory with respect to:
 - 1) letters assigned a specific meaning in Table 1;
 - 2) symbols and their assigned meanings in Tables 2 through 19; and
 - 3) symbol dimensions in Tables 20 through 26.
- b) with exceptions, in which case the parts of this standard for which exception is:
 - 1) taken shall be fully described and detailed in the user/owner's standards, guidelines, or specifications and in drawing cover sheet legends and notes; and
 - 2) not taken shall be mandatory.

1.7.2 Symbols different from those given in this standard and user's choice letters when used, shall be fully described, and detailed in the user/owner's standards, guidelines, or specifications and in drawing cover sheet legends and notes.

1.7.3 A user shall choose a numbering scheme, graphic symbol, and other options where required, and document those choices.

1.7.4 When a previous issue of this standard is included by reference with or without exception in the user/owner's engineering and design standards, guidelines, or specifications, that issue, in part or in its entirety, shall be mandatory until such time as the user/owner's guidelines or standards are revised.

1.7.5 Symbols and the meanings of letters and symbols from previous versions of this standard that are different from those contained in this version can continue to be used provided they are clearly referenced in the user's engineering and design standards, practices, and/or guidelines.

2 Normative references

2.1.1 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.

ISA-5.4, *Instrument Loop Diagrams*

3 Terms, definitions, and abbreviated terms

3.1 Definitions

For the purposes of this standard, the following definitions apply. Applicable abbreviations are included. For additional information, see ISA-TR77.00.01-2019, *Fossil Fuel Power Plant Definitions and Basic Control Concepts*. Terms italicized in a definition are themselves defined elsewhere in this clause.

3.1.1

accessible

feature of a *device* or *function*, or a feature of an interactive shared system function, that can be used or seen by an operator for the purpose of performing control operations, such as *setpoint* changes, auto-manual transfer, or on-off operations

3.1.2

alarm

indicating *device* or *function* that provides a visible and/or audible indication if and when the value of a *measured* or *initiating variable* is outside of set limits, has changed from a safe to an unsafe condition, or has changed from a normal to an abnormal operating state or condition

Note 1 to entry: Actuation can be by a *discrete* or *analog signal* or *function*.

Note 2 to entry: Indication can be by any or all the following: annunciator *panels*, flashing lights, printers, buzzers, bells, horns, sirens, or shared graphic display systems.

3.1.3

analog signal

signal representing a variable that can be continuously observed and continuously represented

3.1.4

application software

software specific to a user application that is *configurable* and in general contains logic sequences, interlocks and limit expressions, control algorithms, and other code required to control the process using the appropriate inputs, outputs, calculations, and decisions

3.1.5

basic process control system

BPCS

instrumentation and systems that are installed to monitor and control normal production operations using, but not limited to, combinations of single-loop pneumatic and electronic monitors and controllers, programmable logic controllers and distributed control systems

Note 1 to entry: A BPCS is necessary to operate a plant or process.

Note 2 to entry: The BPCS can take the form of a DCS, PLC, SCADA, PC, etc. (See 3.2 for abbreviations.)

3.1.6

behind the panel

location that in a broad sense means “not normally accessible to an operator,” such as the rear of an instrument or control *panel*, an enclosed instrument rack or cabinet, or an instrument rack room within an area that contains a *panel*

3.1.7

binary logic

programming based on two-state or Boolean logic

3.1.8**binary signal**

signal that has only two individual positions or states, and when used in its simplest form, the term denotes an “on-off” or “high-low” state

3.1.9**bubble****balloon**

circle-based symbols (Table 2) used to denote and identify the purpose of an *instrument* or *function* that can contain a tag number

3.1.10**communication link****data link**

wire, cable, or electromagnetic network or bus system that connects dedicated microprocessor-based systems so that they share a common database and communicate according to a rigid protocol in a hierarchical and/or peer-to-peer relationship

Note 1 to entry: Wire or cable networks can be twisted pair, coaxial, telephone, or fiber optic.

Note 2 to entry: Electromagnetic networks can be radio or microwave.

3.1.11**computing device****computing relay**

device that performs one or more calculations or logic operations, or both, and transmits one or more resultant output signals

3.1.12**configurable**

devices or systems whose functional and/or communication characteristics can be selected or rearranged through the setting of program switches, *application software*, fill-in-the-blank forms, pull-down menus, entered values or text, and/or other methods, other than rewiring/reprogramming as a means of altering the configuration

3.1.13**controller**

device that operates automatically to regulate a controlled variable

3.1.14**control valve**

device, other than a common, hand-actuated *process* block valve or self-actuated check valve, that directly manipulates the flow of one or more fluid *process* streams

Note 1 to entry: The designation “hand control valve” is limited to hand-actuated valves that when used for process throttling require identification as an instrument or control device.

3.1.15**controlled variable**

quantity, property, or condition that is measured and controlled

Note 1 to entry: Controlled variables are a subset of measured variables.

3.1.16**converter**

device that receives information as one form of an *instrument* signal and transmits an output signal as another form, such as a current-to-pneumatic signal *converter*

Note 1 to entry: An instrument that changes a sensor's output to a standard signal is properly designated as a transmitter, not a converter; typically, a temperature element (TE) connects to a transmitter (TT), not to a converter (TY).

Note 2 to entry: A converter is sometimes referred to as a transducer, a completely general term not recommended for signal conversion.

3.1.17

detector

device that is used to detect the presence of something, such as flammable or toxic gases or individual parts; see also *primary element* and *sensor*

3.1.18

device

piece of *instrument hardware* that is designed to perform a specific action or function, such as a *controller*, indicator, *transmitter*, annunciator, or *control valve*

3.1.19

digital communication

signal that consists of binary digits transmitted to represent analog values or other information

3.1.20

discrete signal

signal that has any number of noncontinuous distinct or defined states or positions, but most typically having two distinct states

3.1.21

final control element

device, such as a *control valve*, that directly controls the value of the manipulated variable of a control *loop*

3.1.22

function

purpose of, or the action performed by, a *device* or *application software*

3.1.23

hardware

physical equipment directly involved in performing measuring, *monitoring*, and controlling *functions*

3.1.24

higher level control system

HLCS

system that provides sophistication above that of the BPCS, with *functions* typically based in hardware and software outside of the BPCS

Note 1 to entry: Control functions in the HLCS include, but are not limited to, statistical process control and model predictive control.

Note 2 to entry: A HLCS is not necessary to operate a plant or process.

3.1.25

identification

sequence of letters or numerals, or both, used to designate an individual *instrument*, *function*, or *loop*

3.1.26

initiating variable

quantity, property, or condition that is not measured or calculated but serves as the measured variable of a loop, a change of which initiates loop action

Note 1 to entry: For example, "hand," as in push button or switch, is an initiating variable.

3.1.27**instrument**

device used for direct or indirect *measurement*, *monitoring*, and/or control of a *process variable*, including *primary elements*, indicators, *controllers*, *final control elements*, *computing* devices, and electrical *devices* such as annunciators, *switches*, and push buttons

Note 1 to entry: The term does not apply to a device's internal components or parts, such as receiver bellows or resistors.

3.1.28**instrument, field****instrument, local**

instrument that is not mounted on a *panel* or console or in a control room but commonly in the vicinity of its *primary element* or *final control element*

3.1.29**instrument, standalone**

device or *hardware* that is a separate entity, such as a single-case *controller* or recorder

3.1.30**instrumentation**

collection of instruments, *devices*, *hardware*, or *functions* or their application for the purpose of measuring, *monitoring*, or controlling an industrial *process*, or any combination of these

3.1.31**interlock**

device or group of devices (*hardware*) or *function* or group of functions (application software) arranged to sense a limit or off-limit condition, or improper sequence of events and take a desired action

3.1.32**light, pilot****light, status**

light that indicates which of one or more normal conditions of a system or *device* exists

Note 1 to entry: It is not an alarm light, which indicates an abnormal condition.

3.1.33**local panel**

panel that is not a central or main *panel* and is commonly located in the vicinity of plant subsystems or subareas

Note 1 to entry: The term "local panel instrument" should not be confused with "local instrument."

3.1.34**loop**

instrumentation arranged as a combination of two or more instruments or *functions* so that signals pass from one to another for the purpose of *measurement* and indication or control of a *process variable*

Note 1 to entry: Term includes a self-contained device that measures and controls a process variable.

3.1.35**loop identification number**

unique combination of letters and numbers that are assigned to each monitoring and control *loop* in a facility to identify the process variable that is being monitored or controlled

3.1.36

manipulated variable

quantity or condition that is varied by a controller's output to change the value of the controlled variable

3.1.37

measured variable

quantity, property, or condition that is measured or calculated

Note 1 to entry: Measured variables are a subset of process variables.

3.1.38

measurement

determination of the existence and/or magnitude of a *process variable*

3.1.39

monitor (noun)

instrument or *device* used for indicating or recording of a *process variable* or quantity

3.1.40

monitor (verb)

to measure or sense the status or magnitude of one or more variables for the purpose of deriving useful information, and that sometimes means analyzer, indicator, or *alarm*

3.1.41

owner

company that operates or owns the production facilities where the instrumentation and control system is or will be installed

3.1.42

panel

freestanding or built-in structure consisting of one or more sections, cubicles, consoles, or desks that has groups of instrument *hardware* mounted on it, houses the operator-*process* interface, and is given a unique designation

3.1.43

primary element

external or internal *instrument* or system element that quantitatively converts the *measured variable* into a form suitable for *measurement*; see also *detector* and *sensor*

Note 1 to entry: An orifice plate is an external primary element.

Note 2 to entry: The sensor of a pressure transmitter is an internal primary element.

3.1.44

process

any operation or sequence of operations involving a change of energy, state, composition, dimension, or other properties, e.g., change in pressure, temperature, speed, electrical potential

Note 1 to entry: A process can be small or large in scale, e.g. a water heater or a refinery.

3.1.45

process variable

any property of a *process*; used in this standard to apply to all variable properties of the process and includes *measured variables* and *controlled variables*

3.1.46**program**

repeatable sequence of actions that defines the state of outputs as a relationship to the state of inputs

3.1.47**relay**

device, whose *function* is to pass on information in an unchanged form or in some modified form

Note 1 to entry: Relay is a term applied specifically to an electric, pneumatic, or hydraulic switching device that is actuated by a signal, and to functions performed by a relay.

3.1.48**safety instrumented system****SIS**

system composed of *sensors*, logic solvers, and *final control elements* for the purpose of taking the process to a safe state when predetermined conditions are violated

3.1.49**scan**

to sample, in a predetermined manner, each of several variables periodically or intermittently

Note 1 to entry: A scanning device is often used to ascertain the state or value of a group of variables and can be associated with other functions such as recording and alarming.

3.1.50**sensor**

separate or integral part or *function* of a *loop* or an *instrument* that first senses the value of a *process variable*, that assumes a corresponding predetermined and intelligible state, and/or generates an output signal indicative of or proportional to the *process variable*; see also *detector* and *primary element*

3.1.51**setpoint**

input variable that sets the desired value of the *controlled variable* manually, automatically, or by means of a *program* in the same units as the *controlled variable*

3.1.52**shared control**

feature of a control *device* or *function* that contains several preprogrammed algorithms, which are user retrievable, *configurable*, and connectable, and allows user-defined control strategies or *functions* to be implemented

Note 1 to entry: Term often used to describe the control features of a distributed control system, programmable logic controller, or other processor-based system.

Note 2 to entry: Control of multiple process variables can be implemented by sharing the capabilities of a single device of this kind.

3.1.53**shared display**

operator interface device, a video, light-emitting diode, liquid crystal, or other display unit, used to display process control information from several sources at the command of the operator

Note 1 to entry: Term often used to describe the visual features of a *distributed control system*, *programmable logic controller*, or other processor-based system.

3.1.54

**station, auto-manual
station, control**

device or function that provides switching between manual and automatic control modes of a control *loop*

3.1.55

station, manual loading

device or function that has a manually adjustable output, and can also have indicators, lights, and/or other functions, that is used to actuate and/or modulate one or more devices but does not provide switching between auto-manual modes of a control *loop*

3.1.56

switch

device that connects, disconnects, selects, or transfers one or more circuits and is not designated as a *controller*, a *relay*, or a *control valve*; the term is also applied to the *functions* performed by switches

3.1.57

tag number

unique combination of letters and numbers that are formed by adding letters to the *loop identification number* to define the purpose of each loop *device* and/or *function* that comprises a monitoring or control *loop*

Note 1 to entry: Synonymous terms include: instrument identification, instrument identification number, instrument tag number, instrument number, and tag name.

3.1.58

test point

process connection to which no *instrument* is permanently connected, but which is intended for the temporary or intermittent connection of an *instrument*

3.1.59

transducer

device, which can be a *primary element*, *transmitter*, *relay*, *converter*, or other *device*, that receives information in the form of one or more physical quantities, modifies the information or its form, or both if required, and produces a resultant output signal

3.1.60

transmitter

device that senses a *process variable* through the medium of a *sensor* or measuring element and has an output whose steady-state value varies only as a predetermined *function* of the *process variable*

Note 1 to entry: The sensor can be an integral part, as in a direct-connected pressure transmitter, or a separate part, as in a thermocouple.

3.1.61

user

entity that applies this standard for their company, or on behalf of their customer/client.

Note 1 to entry: Examples include engineering/consulting firms, operating process companies, manufacturing companies, etc.

3.2 Abbreviations – for terms not otherwise defined

DCS	distributed control system
PC	personal computer
PFD	process flow diagram
P&ID	piping (or process) and instrument diagram
PLC	programmable logic controller
SCADA	supervisory control and data acquisition

4 Identification letters

4.1 Identification letters table

4.1.1 This subclause provides in tabular form and accompanying notes the alphabetic building blocks of the instrument and function identification system in a concise, easily referenced manner.

4.1.2 Table 1, together with 4.1.5, defines and explains the meanings of the individual letters when used to identify loop and device functions.

4.1.3 The letters in Table 1 shall have the mandatory meanings assigned except the user shall assign:

- a) variables to the user's choice letters in column 1 and functions to the user's choice letters in columns 3, 4, and 5 when such letters are used; and
- b) meanings to the blanks in columns 2, 3, 4, and 5 when additional functions or modifiers are assigned.

4.1.4 When such assignments are made, they shall be documented in the user's engineering and design standards or guidelines and on drawing legend sheets.

Table 1 – Identification letters

NOTE Numbers in parentheses refer to the explanatory notes in 4.1.5.

	First letters (1)		Succeeding letters (13)		
	Column 1	Column 2	Column 3	Column 4	Column 5
	Measured/initiating variable	Variable modifier (10)	Readout/passive function	Output/active function	Function modifier
A	Analysis (2)(3)(4)		Alarm		
B	Burner, Combustion (2)		User's Choice (5)	User's Choice (5)	User's Choice (5)
C	User's Choice (3a)(5)			Control (21a)(21e)	Close (25b)
D	User's Choice (3a)(5)	Difference, Differential			Deviation (26)
E	Voltage (2)		Sensor, Primary Element		
F	Flow, Flow Rate (2)	Ratio			
G	User's Choice		Glass, Gauge, Viewing Device (14)		
H	Hand (2)				High (25a)(26a)(27)
I	Current (2)		Indicate (15)		
J	Power (2)		Scan (16)		
K	Time, Schedule (2)	Time Rate of Change (11)		Control Station (22)	
L	Level (2)		Light (17)		Low (25b)(26)(27)
M	User's Choice (3a)(5)				Middle, Intermediate (25c)(26)(27)
N	User's Choice (5)		User's Choice (5)	User's Choice (5)	User's Choice (5)
O	User's Choice (5)		Orifice, Restriction		Open (25a)
P	Pressure (2)		Point (Test Connection)		
Q	Quantity (2)	Integrate, Totalize	Integrate, Totalize		
R	Radiation (2)		Record (18)		Run
S	Speed, Frequency (2)	Safety (12)		Switch (21b)	Stop
T	Temperature (2)			Transmit	
U	Multivariable (2)(6)		Multifunction (19)	Multifunction (19)	
V	Vibration, Mechanical Analysis (2)(4)(7)			Valve, Damper, Louver (21c)(21e)	
W	Weight, Force (2)		Well, Probe		
X	On/Off or Unclassified (8)	X-axis	Accessory Devices (20), Unclassified (8)	Unclassified (8)	Unclassified (8)
Y	Event, State, Presence (2)(9)	Y-axis		Auxiliary Devices (21d)(23)(24)	
Z	Position, Dimension (2)	Z-axis, Safety Instrumented System (28)		Driver, Actuator, Unclassified final control element	

4.1.5 Notes for Table 1 – Identification letters:

The following notes, indicated in Table 1 by parentheses, are to be used as an aid in understanding the meanings of the letters when they are used in certain positions in loop identification letter(s) or functional identifications.

- (1) First letters are a measured/initiating variable and, if required, a combination of a measured/initiating variable and a variable modifier that shall be referred to by the combined meaning.
- (2) The specific meanings given for measured/initiating variables [A], [B], [E], [F], [H], [I], [J], [K], [L], [P], [Q], [R], [S], [T], [U], [V], [W], [Y], and [Z] shall not be modified.
- (3) Measured/initiating variable analysis [A] shall be used for all types of process stream composition and physical property analysis. The type of analyzer, and for stream component analyzers the components of interest, shall be defined outside the tagging bubble.
 - (a) “User’s choice” measured/initiating variables [C], [D], and [M] can be assigned to identify conductivity, density, and moisture analysis, respectively, when it is the user’s common practice.
- (4) Measured/initiating variable analysis [A] shall not be used to identify vibration or other types of mechanical or machinery analysis, which shall be identified by measured/initiating variable vibration or mechanical analysis [V].
- (5) “User’s choice” letters [C], [D], [M], [N], and [O] that cover unlisted repetitive meanings that can have one meaning as a measured or initiating variable and another as a succeeding letter shall be defined only once. For example, [N] can be defined as “modulus of elasticity” as a measured/initiating variable or “oscilloscope” as a readout/passive function.
- (6) Measured/initiating variable multivariable [U] identifies an instrument or loop that requires multiple points of measurement or other inputs to generate single or multiple outputs, such as a controller that uses multiple pressure and temperature measurements to regulate the switching of multiple on-off valves.
- (7) Measured/initiating variable vibration or mechanical analysis [V] is intended to perform the function in machinery monitoring that measured/initiating variable analysis [A] performs in process monitoring, and except for vibration, it is expected that the variable of interest will be defined outside the tagging bubble.
- (8) First letter [X] default use is for on/off, for example on/off valve [XV]. Alternately, first letter or succeeding letter for unclassified devices or functions [X] for nonrepetitive meanings that are used only once or to a limited extent can have any number of meanings that shall be defined outside the tagging bubble or by a note in the document. For example, [XR-2] can be a stress recorder, and [XX-4] can be a stress oscilloscope.
- (9) Measured/initiating variable event, state, or presence [Y] is intended for use when control or monitoring responses are not driven by time or time schedule—but are driven by events, presence, or state.
- (10) Measured/initiating variable and variable modifier combinations shall be selected according to how the property being measured is modified or changed.

- (11) Variable modifier time or time schedule [K] in combination with a measured/initiating variable signifies a time rate of change of the measured or initiating variable; [WK] represents a rate-of-weight-change loop.
- (12) Variable modifier safety [S] is technically not a measured variable but is used to identify self-actuated emergency protective primary and final control elements only when used in conjunction with measured/initiating variables flow [F], pressure [P], or temperature [T]. And because of the critical nature of such devices, [FS, PS, and TS] shall be considered as measured/initiating variables in all loop identification number construction schemes:
 - (a) Flow safety valve [FSV] applies to valves intended to protect against an emergency excess flow or loss of flow condition. Pressure safety valve [PSV] and temperature safety valve [TSV] apply to valves intended to protect against emergency pressure and temperature conditions. This applies regardless of whether the valve construction or mode of operation places it in the category of safety valve, relief valve, or safety relief valve.
 - (b) A self-actuated pressure valve that prevents operation of a fluid system at a higher-than-desired pressure by bleeding fluid from the system is a backpressure control valve [PCV], even if the valve is not intended to be used normally. However, this valve is designated a pressure safety valve [PSV] if it protects against emergency conditions hazardous to personnel and/or equipment that are not expected to arise normally.
 - (c) Pressure rupture disc [PSE] and fusible link [TSE] apply to all sensors or primary elements intended to protect against emergency pressure or temperature conditions.
 - (d) [S] shall not be used to identify safety instrumented systems (SISs) and components; see (28).
- (13) The grammatical form of succeeding letter meanings shall be modified as required; for example, “indicate” [I] can be read as “indicator” or “indicating,” and “transmit” [T] can be read as “transmitter” or “transmitting.”
- (14) Readout/passive function glass, gauge, or viewing device [G] should be used instead of readout/passive function indicate [I] for self-contained instruments or devices that provide a local-only view of the process variable, such as level gauges, pressure gauges, temperature gauges, and flow gauges/sight glasses.
 - (a) Also used to identify devices that provide an uncalibrated view of plant operations, such as television monitors.
- (15) Readout/passive function indicate [I] applies to the analog or digital readout of an actual measurement or input signal to a standalone instrument or a shared control system’s video display unit.
 - (a) In the case of a manual loading station, it should be used for the dial or setting indication of the output signal being generated, [HIC] or [HIK].
- (16) Readout/passive function scan [J] when used shall indicate a noncontinuous periodic reading of two or more measured/initiating variables of the same or different kinds, such as multipoint temperature and pressure recorders.

- (17) Readout/passive function light [L] identifies devices or functions that are intended to indicate normal operating status, such as motor on-off or actuator position, and is not intended for alarm indication.
- (18) Readout/passive function record [R] applies to any permanent or semi-permanent electronic or paper media storage of information or data in an easily retrievable form.
- (19) Readout/passive and output/active function multifunction [U] is used to:
- (a) identify control loops that have more than the usual indicate/record and control functions; and
 - (b) save space on drawings by not showing tangent bubbles for each function.
- A note describing the multiple functions should be on the drawing if needed for clarity.
- (20) Readout/passive function accessory [X] is intended to identify hardware and devices that do not measure or control but are required for the proper operation of instrumentation.
- (21) There are differences in meaning to be considered when selecting between output/active functions for control [C], switch [S], valve, damper, or louver [V], and auxiliary device [Y].
- (a) Control [C] means an automatic device or function that receives an input signal representing a measured/initiating variable and generates a variable output signal that is used to modulate or switch a valve [V] or auxiliary device [Y] at a predetermined setpoint for ordinary process control.
 - (b) Switch [S] means a device or function that connects, disconnects, or transfers one or more air, electronic, electric, or hydraulic signals, that can be manually actuated or automatically actuated directly by a measured or initiating variable, or indirectly by a measured or initiating variable transmitter.
 - (c) Valve, damper, or louver [V] means a device that modulates, switches, or turns on/off a process fluid stream after receiving an output signal generated by a controller [C], switch [S], or auxiliary device [Y].
 - (d) Auxiliary device [Y] means an automatic device or function actuated by a controller [C], transmitter [T], or switch [S] signal that connects, disconnects, transfers, computes, and/or converts air, electronic, electric, or hydraulic signals or circuits.
 - (e) The succeeding letters CV shall not be used for anything other than a self-actuated control valve.
- (22) Output/active function control station [K] shall be used for:
- (a) designating an operator-accessible control station used with an automatic controller that does not have an integral operator-accessible auto-manual and/or control mode switch; or
 - (b) split architecture or fieldbus control devices where the controller functions are located remotely from the control station.
- (23) Output/active function auxiliary devices and functions [Y] include, but are not limited to, solenoid valves, relays, and computing and converting devices and functions.

- (24) Output/active function auxiliary devices [Y] for signal computing and converting when shown in a diagram or drawing shall be defined outside their bubbles with an appropriate symbol from Table 16 – Signal Processing Function Blocks and when written in text shall include a description of the mathematical operation from Table 16.
- (25) Function modifiers high [H], low [L], and middle or intermediate [M] when applied to positions of valves and other open-close devices, are defined as follows:
 - (a) high [H], the valve is in or approaching the fully open position; open [O] can be used as an alternative;
 - (b) low [L], the valve is in or approaching the fully closed position; closed [C] can be used as an alternative; and
 - (c) middle or intermediate [M], the valve is traveling or located in between the fully open or closed position.
- (26) Function modifier deviation [D] when combined with readout/passive function [A] (alarm) or output/active function [S] (switch) indicates a measured variable has deviated from a controller or other setpoint more than a predetermined amount.
 - (a) Function modifiers high [H] or low [L] shall be added if only a positive or negative deviation, respectively, is of importance.
- (27) Function modifiers high [H], low [L], and middle or intermediate [M] when applied to alarms correspond to values of the measured variable, not to values of the alarm-actuating signal, unless otherwise noted.
 - (a) A high-level alarm derived from a reverse-acting level transmitter signal is an LAH, even though the alarm is actuated when the signal falls to a low value.
 - (b) The terms shall be used in combination as appropriate to indicate multiple levels of actuation from the same measurement, for example high [H] and high-high [HH], low [L] and low-low [LL], or high-low [HL].

NOTE “HL” is used for an alarm having two setpoints (limits). For example, FAHL is one alarm indicating the flow is outside a normal operating range, either high or low, while FAH and FAL are two separate alarms, each having its own setpoint.
- (28) Variable modifier [Z] is technically not a measured variable but is used to identify the components of SISs.
 - (a) [Z] shall not be used to identify the safety devices noted in (12).

5 Graphic symbols

5.1 General

5.1.1 The graphic symbols shown in the tables are generally drawn full size for use in full-size sketches or drawings. Actual symbol full-size dimensions are provided in Clause 6.

5.1.2 The device and function symbols shown in Table 2 are based on the 7/16-inch or 11-mm circle format. Refer to 6.1.

5.1.3 When selecting symbol sizing, consideration shall be given to the size and readability of symbols and text if the drawing will be used in a reduced-size format.

5.1.4 All symbols shall maintain the size ratios shown in the tables when reduced or increased in size.

5.1.5 Illustrations in these tables can include representation of relative process piping or equipment in addition to the symbol being defined. This representation is shown in grey (“ghosted”) to communicate that it is not part of the symbol but illustrates how the symbol is applied in context in diagrams.

5.1.6 Illustrations in these tables can include representation of instrumentation or components mounted inside of a tank, vessel or other mechanical equipment by the use of dashed rather than solid lines.

5.1.7 Symbols are shown in this document as they would be oriented in a diagram having flow from left to right. For instances where flow is other than left to right, the symbols that have a process flow directional aspect, e.g., flow measurement instrumentation and self-contained regulators, should be rotated appropriately.

5.2 Tables to be used for common applications

5.2.1 Instrumentation and control diagrams shall be constructed from the symbols shown in:

- a) Tables 2 and 3 – Instrumentation devices and functions;
- b) Tables 4, 5, 6, 7, and 8 – Measurement elements and transmitters;
- c) Tables 9 and 10 – Lines, instrument to process or instrument to instrument;
- d) Tables 11, 12, 13, and 14 – Final control elements; and
- e) Table 16 – Signal processing function blocks.

5.2.2 Functional diagrams shall be constructed from the symbols shown in:

- a) Table 2 – Instrument device and function symbols;
- b) Table 10 – Line symbols;
- c) Table 15 – Functional diagramming symbols;
- d) Table 16 – Signal processing function block symbols;
- e) Table 17 – Binary logic symbols; and
- f) For special symbols, reference ISA-TR5.1.01/ISA-TR77.40.01, *Functional Diagram Usage*.

5.2.3 Binary logic diagrams shall be constructed from the symbols shown in:

- a) Table 2 – Instrumentation devices and functions;
- b) Table 10 – Line symbol; and
- c) Table 17 – Binary logic symbols.

5.2.4 Electrical schematics shall be constructed from the symbols shown in:

- a) Table 2 – Instrumentation devices and functions; and
- b) Table 18 – Electrical schematic symbols.

5.2.5 Instrument loop diagrams shall be constructed from the symbols shown in:

- a) Tables 2 and 3 – Instrumentation devices and functions;
- b) Tables 4, 5, 6, 7, and 8 – Measurement elements and transmitters;
- c) Tables 9 and 10 – Lines, instrument to process or instrument to instrument;
- d) Tables 11, 12, 13, and 14 – Final control elements; and
- e) Table 19 – Instrument loop diagrams.

5.2.6 Symbols can be developed to show devices and functions not covered by this standard or to simplify the depiction of frequently used instrumentation. Such uses shall be fully detailed by sketches or notes on the drawing legend and detail sheets.

5.2.7 If new or revised symbols are developed, they should be submitted to standards@isa.org for consideration in the next revision of this standard.

5.3 Instrumentation device and function symbols

5.3.1 This subclause provides symbols for instrumentation devices and functions in tabular form with accompanying notes.

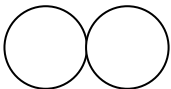
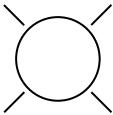
Table 2 – Instrumentation device and function symbols

NOTE Numbers in parentheses refer to explanatory notes in 5.3.2.

No.	Shared display, Shared control (1)		High level control systems and application software (4)	Standalone (5)	Location and accessibility (6)
	Basic process control system or primary choice (2)	Safety instrumented system or alternate choice (3)			
1					• Located in field. • Not panel, cabinet, or console mounted. • Visible at field location. • Normally operator accessible.
2					• Located in or on front of central or main panel or console. • Visible on front of panel or on video display. • Normally operator accessible at panel front or console.
3					• Located in rear of central or main panel. • Located in cabinet behind the panel. • Not visible on front of panel or on video display. • Not normally operator accessible at panel or console.
4					• Located in or on front of secondary or local panel or console. • Visible on front of panel or on video display. • Normally operator accessible at panel front or console.
5					• Located in rear of secondary or local panel. • Located in field cabinet. • Not visible on front of panel or on video display. • Not normally operator accessible at panel or console.

Table 3 – Instrumentation device or function symbols, miscellaneous

NOTE Numbers in parentheses refer to explanatory notes in 5.3.2.

No	Symbol	Description
1		- Signal processing function: - Locate in upper right or left quadrant of Table 2 symbols just outside the symbol. - Attach to Table 2 symbols where affected signals are connected. - Insert signal processing symbol from Table 16. - Expand symbol by 50% increments for larger function symbols.
2		- Panel-mounted patchboard plug-in point. - Console matrix point. - C-12 equals patchboard column and row, respectively, as an example.
3	(7) (8) 	- Generic interlock logic function. - Undefined interlock logic function. - If a number is added, e.g., I-9, inside or immediately outside of the diamond, it refers to a separate documented description of the interlock function.
4	(7) (8) 	“AND” interlock logic function.
5	(7) (8) 	“OR” interlock logic function.
6	a)  b) 	a) Standalone instruments - Instruments or functions sharing a common housing. - It is not mandatory to show a common housing. - Notes shall be used to identify instruments in common housings not using this symbol. b) Shared display, shared control - Functions within the same shared display, shared control system (BPCS or SIS). - Use applicable symbols from Table 2 “Shared display, shared control” columns. - This is an alternate to showing separate, unattached symbols, perhaps to reduce signal line clutter on a drawing. - Should not be used where the signal flow to/from symbols can become unclear. a) and b) - Horizontal orientations of two symbols are shown. Orientation can be vertical, and more than two adjoining symbols can be used as needed.
7		- Pilot light. - Circle shall be replaced with any symbol from the standalone column in Table 2 if location and accessibility need to be shown.