

AMERICAN NATIONAL STANDARD

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**Instrumentation Symbols
and Identification**

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ANSI/ISA-5.1-2009

ANSI/ISA-5.1-2009, Instrumentation Symbols and Identification

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Preface (informative)

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Users may find the following book of value in applying ANSI/ISA-5.1-2009:

Control System Documentation: Applying Symbols and Identification, Thomas McAviney
www.isa.org/books.

Users of this standard are asked to send comments or suggestions to standards@isa.org.

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On behalf of the ISA5 Committee and the ISA Standards & Practices Board, we wish to recognize and thank James Carew for his outstanding work, technical expertise, and commitment in leading the revision of this widely used ISA standard, and Thomas McAviney for his valuable technical and editorial contributions.

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Contents

1	Purpose	13
2	Scope	13
3	Definitions	17
4	Identification letters table.....	25
5	Graphic symbol tables.....	31
6	Graphic symbol dimension tables	76
Annex A	Identification system guidelines (informative annex).....	85
Annex B	Graphic symbol guidelines (informative annex)	111
Table 4.1	— Identification letters	30
Table 5.1.1	— Instrumentation device and function symbols	36
Table 5.1.2	— Instrumentation device or function symbols, miscellaneous	37
Table 5.2.1	— Measurement symbols: primary elements and transmitters	38
Table 5.2.2	— Measurement symbols: measurement notations (4).....	39
Table 5.2.3	— Measurement symbols: primary elements	40
Table 5.2.4	— Measurement symbols: secondary instruments.....	43
Table 5.2.5	— Measurement symbols: auxiliary and accessory devices	44
Table 5.3.1	— Line symbols: instrument to process and equipment connections.....	45
Table 5.3.2	— Line symbols: instrument-to-instrument connections	46
Table 5.4.1	— Final control element symbols.....	48
Table 5.4.2	— Final control element actuator symbols.....	50
Table 5.4.3	— Self-actuated final control element symbol	52
Table 5.4.4	— Control valve failure and de-energized position indications.....	55
Table 5.5	— Functional diagramming symbols.....	56
Table 5.6	— Signal processing function block symbols.....	57
Table 5.7	— Binary logic symbols.....	64
Table 5.8	— Electrical schematic symbols	72
Table 6.1	— Dimensions for Tables 5.1.1 and 5.1.2	78
Table 6.2	— Dimensions for Tables 5.2.1, 5.2.2, 5.2.3, 5.2.4, and 5.2.5	79
Table 6.3	— Dimensions for Tables 5.3.1 and 5.3.2	80
Table 6.4	— Dimensions for Tables 5.4.1, 5.4.2, 5.4.3, and 5.4.4	81
Table 6.5	— Dimensions for Table 5.5	82
Table 6.6	— Dimensions for Table 5.6	82
Table 6.7	— Dimensions for Table 5.7	83
Table 6.8	— Dimensions for Table 5.8	84
Table A.1	— Typical Loop and Instrument Identification/Tag Numbers	99

Table A.2 — Allowable letter/number combinations for loop numbering schemes 100

Table A.3.1 — Allowable succeeding letter combinations for readout/passive functions (1) (4b)..... 103

Table A.4 — Loop and Identification Tag Number suffixes (1) (2)..... 109

Introduction (informative)

(1) This introduction, as well as any footnotes, endnotes, and informative annexes, is included for information purposes and as background on the evolution of this standard and not as a normative part of ANSI/ISA-5.1-2009.

(2) The instrumentation symbolism 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, and then reaffirmed in 1992.

(3) This 2009 version attempts to strengthen this standard in its role as a communication tool in all industries that depend on measurement and control systems to operate and safeguard their manufacturing processes, machines, and other equipment. Communication presupposes and is facilitated by a common language. This 2009 version of the standard continues to build on the foundation for that common language.

(4) When integrated into a system, the designations and symbols presented here form a dedicated language that communicates concepts, facts, intent, instructions, and knowledge about measurement and control systems in all industries.

(5) The 1949 recommended practice and the 1984 standard were published as non-mandatory rather than as mandatory consensus documents. As such, they had many of the strengths and the weaknesses of such standards. Their primary strength was that they could be used in widespread, interdisciplinary ways. Their main weakness was that they were not specific enough, in some cases, to satisfy the special requirements of particular interest groups.

(6) This revision is 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. This group was well versed in the use of identification and symbol systems as a means of communicating the intent of measurement and control systems to all that need such information. It is hoped that the consensus reached by this group regarding what is mandatory and what is not will enhance the strengths and lessen the weaknesses of the previous issues.

(7) Versions of this standard have been in use for more than fifty years, and most of the identification letter and symbol meanings or definitions that were contained in ISA-RP5.1-1949 and ISA-5.1-1984 (R 1992), have taken on a proprietary nature and have become accepted industry practice and assumed to be mandatory. The meanings and definitions of new symbols will be mandatory. This action is being taken in response to questions and comments that occur frequently because of unclear definitions.

(8) Mandatory definitions or meanings for letters used in identification and for symbols used in graphic depiction of measurement and control devices and functions are given. Mandatory minimum symbol dimensions are given. Informative identification and graphic symbol guidelines include alternate identification and symbol definitions and usage methods. Consistency is the one criterion that should govern the selection and application of identification and graphic schemes.

(9) This standard has been viewed in the past as being oriented to the oil and chemical process industries. This perception, while not intended, resulted from the fact that people who wrote the original and previous revisions were mainly working in those industries. It is the intent of the ISA5 committee that ISA Technical Reports will be used to address this type of problem. It is hoped that the technical report format will be specific enough to satisfy the special requirements of particular interest groups by providing examples and guidelines for use of the identification and symbolization methods for specific industries. These industries include, but are not limited to, metal refining, power generation, pulp and paper, and discrete parts manufacturing. The technical report format presents the best approach for making this standard applicable to industries that may have many usages and accepted practices that are not used in

the process industries.

(10) The extensive examples in previous versions of this standard that illustrated identification and symbolization definitions and methods have been removed and will be moved to technical reports that will be prepared after publication of this revised standard.

(11) The symbols and identification methods contained in this standard have evolved by the consensus method and are intended for wide application throughout all industries. The symbols and designations are used 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, and not just piping and instrumentation diagrams (P&IDs).

(12) Previous versions of this standard have been flexible enough to serve all of the uses just described, and it must continue to do so into the future. To this end, this revision clarifies the definitions of symbols, identification, and definitions for concepts that were previously described, such as, for example, shared display/control, distributed control, and programmable control. It also adds definitions for new symbols required for functional diagramming of instruments and simple electrical circuit diagrams.

(13) This revision extensively changes the format of ANSI/ISA-5.1-1984 (R 1992). Clauses 1, 2, and 3 are essentially the same as previously written with some additions and modifications. Clauses 4, 5 and 6 and informative Annexes A and B are new or extensively revised.

(14) Clause 4, "Identification letter tables," was previously Clause 5, "Tables." It is almost the same as the previous version and deals only with Table 4.1, "Identification letters," which was previously Table 1, "Identification letters."

(15) Clause 5, "Graphic symbol tables," is a new clause that contains new symbols and the symbols that were previously in Clause 6, "Drawings," presented in a table format that includes text describing the application of the symbols but no examples of their use.

(16) Clause 6, "Graphic symbol dimension tables," is a new clause that establishes minimum mandatory dimensions for the symbols shown in the tables in Clause 5 when used in the preparation of full-size engineering drawings.

(17) Annex A, "Identification system guidelines (Informative)," was previously Clause 4, "Outline of the Identification System," and presents the most commonly used instrumentation and function identification methods. Included are expanded "Allowable loop and function letter combination" tables and added "Allowable loop letter scheme" tables.

(18) Annex B, "Graphic symbol guidelines" (Informative), is a new informative clause that replaces the examples formerly given in Clause 6, "Drawings," to provide some limited assistance in the application of the symbols in Clause 5.

(19) Definitions for identification letters and symbols are now mandatory to reduce the confusion caused by giving meanings to identification and symbols not intended by this standard. At the same time, the number of symbology and tagging bubbles required to depict a measurement or control scheme was allowed to range from "everything must be shown" to the "minimum required to convey the instrumentation and functionality required." Guidelines are intended to aid in the application of identification and symbology and to include some of the known methods as alternate usages.

(20) The meanings of 'shared display, shared control,' and 'programmable logic control' have been clarified and expanded because of changes in technology and usage since their inception in ISA-5.3-1983, "Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems." The commonly assumed meanings of 'circle-in-square' as distributed control system (DCS) functions and of 'diamond-in-square' as programmable logic controller (PLC) functions are no longer

accurate because they no longer reflect the currently acceptable meanings. DCSs and PLCs can both perform continuous and binary control functions. The same functions are performed by personal computers (PC) and by fieldbus and devicebus devices. Both 'circle-in-square' and 'diamond-in-square' symbols are classified as 'shared display, shared control.' 'Circle-in-square' will depict either (a) primary control system choice or (b) basic process control system (BPCS). 'Diamond-in-square' will depict either (a) alternate control system choice or (b) safety instrumented system (SIS). Users who continue to use the symbols as in the past should change to the revised meanings as soon as possible.

(21) This revision uses, with permission, information from the excellent SAMA (Scientific Apparatus Makers Association) PMC 22.1-1981, "Functional Diagramming of Instrument and Control Systems," a document still used by many control system engineers and designers. SAMA symbols and descriptions for functional diagramming of Instruments and control loops and for signal processing symbols and function blocks were adapted in ANSI/ISA-5.1-1984 (R 1992) for use in loop schematic diagrams. This revision adds the SAMA symbols and descriptions for logic function enclosures for use in functional diagrams, logic diagrams, and application software functions. Guidelines for a limited number of applications of the symbols will be found in Annex B, "Graphic symbol system guidelines (Informative)."

(22) The binary line symbols, which were introduced in ANSI/ISA-5.1-1984 (R 1992) to aid the batch processing industries, have been removed because of their general lack of use and acceptance and the many objections to their use. If their use is desired within the batch processing industries, an ISA Technical Report could be produced to cover this unique need.

(23) The many examples contained in Clause 6 of ANSI/ISA-5.1-1984 (R 1992) have been reduced in number and are now located in Annex B. It is hoped that ISA Technical Reports will be prepared based on this standard to cover the application of identification and symbolization methods and practices in the detail required by users in those many industries beyond the process industries, who depend on this standard in their daily work.

(24) The ISA5 committee and ISA5.1 subcommittee recognize and deeply appreciate the work of previous ISA5.1 subcommittees, and have tried to treat their work with the great respect it deserves.

(25) ISA5 and ISA5.1 also acknowledge the work done by the past ISA5.2 and ISA5.3 subcommittees in developing ISA-5.2-1976 (R1992), "Binary Logic Diagrams for Process Operations," and ISA-5.3-1983, "Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems." The key elements of ISA-5.3-1983 were incorporated in ANSI/ISA-5.1-1984 (R 1992) and have been expanded in this revision. The key elements of ISA-5.2-1976 are incorporated and integrated with the logic symbols from SAMA PMC 22.1-1981 for symbolizing and describing binary functions. Guidelines for the application of the binary system can be found in Annex B (Informative), Graphic symbol system guidelines.

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1 Purpose

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.

2 Scope

2.1 General

2.1.1 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 symbol and identification methods.

2.1.2 A limited number of examples are provided that illustrate how to:

- a) Design an identification system and construct an identification number.
- b) Use graphic symbols to construct:
 - 1) Instrumentation schematic diagrams of the instruments, devices, and functions required for monitoring and control loops.
 - 2) Functional diagrams of instruments, loops, and application software functions.
 - 3) Binary logic diagrams.
 - 4) Ladder diagrams of electrical circuits.
- c) Add information and simplify diagrams.

2.1.3 Examples of identification and symbol applications are intended to illustrate basic concepts in the construction of the identification systems and diagrams covered by this standard that are applicable to all user industries.

2.2 Application to industries

2.2.1 This standard is suitable for use in the chemical, petroleum, power generation, metal refining, pulp and paper, and numerous other continuous, batch, discrete-part processing, and material-handling industries. These industries and others require the use of control system schematics, functional diagrams, and electrical schematics to describe the relationship to processing equipment and the functionality of measurement and control equipment.

2.3 Application to work activities

2.3.1 This standard is suitable for use whenever reference to measurement and control instrumentation, control devices and functions, and software applications 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) Process Flow Diagrams (PFD)
 - 2) Utility Flow Diagrams (UFD).
- g) Construction drawings including but not limited to:
 - 1) Engineering Flow Diagrams (EFD).
 - 2) Mechanical Flow Diagrams (MFD).
 - 3) Piping and Instrumentation Diagrams (P&ID).
 - 4) System Flow Diagrams (SFD).
- h) Specifications, purchase orders, manifests, and other lists.
- i) Identification and tag numbering of instruments and control functions.
- j) Installation, operating and maintenance instructions, drawings, and records.

2.3.2 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 shown.

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

2.4 Application to classes of instrumentation and to instrument functions

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

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

- a) Discrete instruments and their functions.

- b) Shared display and control functions.
- c) Distributed control functions.
- d) Computer control functions.
- e) Programmable logic controller display and control functions.
- f) Application software display and control functions.

2.5 Classification of instrumentation

2.5.1 Instrumentation may be classified as primary, secondary, auxiliary, or accessory for assigning Loop and Functional Identities and symbols as defined in Clause 4 and shown in Annex A.

2.5.2 Primary instrumentation consists of measuring, monitoring, controlling, or calculating devices and hardware and their inherent functions and 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.

2.5.3 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.

2.5.4 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.

2.5.5 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.

2.6 Extent of loop and functional identification

2.6.1 This standard provides identification codes and methods for the alphanumeric identification of monitoring and controlling loops, instruments and functions.

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

- a) Flow transmitter when connected to an orifice plate when measuring flow.
- b) Level transmitter when connected to the side of a vessel when measuring liquid level.

2.6.3 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.

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

- a) Loop instrument or device and its integral and/or inherent functions.

- b) *Loop-configurable* function, which requires or allows a unique user-assigned microprocessor or computer address.

2.7 Extent of symbolization

2.7.1 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.

2.7.2 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.

2.7.3 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.

2.7.4 Additional construction, fabrication, installation, and operation details of an instrument are better described in a suitable specification, data sheet, loop diagram, installation/wiring drawing, or sketch, or other document intended for those requiring such details.

2.8 Inclusion and modification of this standard in User engineering and design documents

2.8.1 This standard may be used and, if used, shall be credited by a User/Owner in the preparation of engineering, design, or project standards, guidelines, and specifications, 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 4.1.
- 2) Symbols and their assigned meanings in Tables 5.1 through 5.8.
- 3) Symbol dimensions in Tables 6.1 through 6.8.

- 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 standards, guidelines, or specifications and in drawing cover sheet legends and notes.
- 2) Not taken shall be mandatory.

2.8.2 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.

2.8.3 A User must choose a numbering scheme, graphic symbol, and other choices where required, and document those choices.

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

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

3 Definitions

3.1 Definitions

For the purposes of this standard, the following definitions apply. For additional information, see ISA-51.1-1979 (R 1993), "Process Instrumentation Terminology," and ANSI/ISA-75.05.01-2000 (R 2005), "Control Valve Terminology." Terms *italicized* in a definition are themselves defined elsewhere in this clause.

3.1.1 accessible:

a feature of a *device* or function, a feature of an interactive shared system function, or a feature 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:

an 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.

a) actuation may be by a *binary* or *analog device* or *function*.

b) indication may be by any or all of the following: annunciator *panels*, flashing lights, printers, buzzers, bells, horns, sirens, or shared graphic display systems.

3.1.3 analog:

a signal or *device* that has no *discrete* positions or states and changes value as its input changes value and when used in its simplest form, as in "*analog* signal" as opposed to "*binary* signal"; the term denotes a continuously varying quantity.

3.1.4 application *software*:

software specific to a user application that is *configurable* and in general contains logic sequences, permissive and limit expressions, control algorithms, and other code required to control the appropriate input, output, calculations, and decisions; see also *software*

3.1.5 assignable:

a system feature permitting channeling or directing of a signal from one *device* to another without the need for changes in wiring either by means of patching, switching, or via keyboard commands to the system.

3.1.6 auto-manual station:

a *manual loading station* or *control station* that also provides switching between manual and automatic control modes of a control *loop*; see also *manual station*.

3.1.7 balloon:

an alternate term for the circular symbol used to denote and identify the purpose of an *instrument* or *function* that may contain a tag number; see preferred term *bubble*.

3.1.8 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*.

(a) A BPCS is necessary to operate a plant or process.

3.1.9 behind the *panel*:

a 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*.

3.1.10 binary:

a signal or *device* that has only two *discrete* positions or states, and when used in its simplest form, as in "*binary* signal" as opposed to "*analog* signal," the term denotes an "on-off" or "high-low" state.

3.1.11 board:

a freestanding structure consisting of one or more sections, cubicles, or consoles that has groups of *discrete instruments* mounted on it, houses the operator-*process* interface, and is chosen to have a unique designation; see *panel*.

3.1.12 bubble:

the preferred term for the circle-based symbols used to denote and identify the purpose of an *instrument* or function that may contain a tag number; see alternate term *balloon*.

3.1.13 communication link:

a wire, cable, or electromagnetic network or bus system that connects dedicated microprocessor-based and computer-based systems so that they share a common database, and communicates according to a rigid protocol in a hierarchical and/or peer-to-peer relationship; see *datalink*.

a) wire or cable networks may be twisted pair, coaxial, telephone, or fiber optic.

b) electromagnetic networks may be radio or microwave.

3.1.14 computer control system:

a system in which all control action takes place within a control computer, such as a mainframe computer or mini-computer, which may be single or redundant.

3.1.15 computing *device*:

the preferred term for a *device* that performs one or more calculations or logic operations, or both, and transmits one or more resultant output signals; see also *computing relay*.

3.1.16 computing *relay*:

an alternate term for a *device* that performs one or more calculations or logic operations, or both, and transmits one or more resultant output signals; see also *computing device*.

3.1.17 computing function:

a *hardware* or *software* function that performs one or more calculations or logic operations, or both, and transmits one or more resultant output signals.

3.1.18 configurable:

a term for *devices* or systems whose functional and/or communication characteristics can be selected or rearranged through 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 as a means of altering the configuration.

3.1.19 controller:

a *device* having an output that varies to regulate a controlled variable in a specified manner that may be a self-contained *analog* or *digital instrument*, or may be the equivalent of such an *instrument* in a shared-control system.

- a) an automatic *controller* varies its output automatically in response to a direct or indirect input of a measured *process variable*.
- b) a manual *controller*, or *manual loading station*, varies its output in response to a manual adjustment; it is not dependent on a measured *process variable*.
- c) a *controller* may be an integral element of other functional elements of a control *loop*.

3.1.20 control station:

a *manual loading station* that also provides *switching* between manual and automatic control modes of a control *loop*; see also *auto-manual station*.

- a). the operator interface of a *distributed control system* may be referred to as a *control station*.

3.1.21 control valve:

a *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*.

- a) the designation "hand *control valve*" shall be limited to hand-actuated valves that when used for *process throttling* require *identification* as an *instrument* or control *device*.

3.1.22 converter:

a *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*.

- a). 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].

- b) a *converter* is sometimes referred to as a *transducer*, a completely general term not recommended for signal conversion.

3.1.23 datalink:

a wire, cable, or electromagnetic network or bus system that connects field-located *devices* with dedicated microprocessors so that they share a common database and communicate according to a rigid protocol in a hierarchical and/or peer-to-peer relationship to other such *devices* and/or compatible microprocessor-based systems; see also *communication link*.

- wire or cable networks may be twisted pair, coaxial, telephone, or fiber optic.
- electromagnetic networks may be radio or microwave.

3.1.24 detector:

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

3.1.25 device:

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

3.1.26 digital:

a signal or *device* that generates or uses *binary* digit signals to represent continuous values or *discrete* states.

3.1.27 discrete instrument

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

3.1.28 discrete signals:

signals that have any number of non-continuous distinct or defined states or positions.

- a) *Binary* signals are a subset.

3.1.29 distributed control system (DCS):

instrumentation, input/output *devices*, control *devices* and operator interface *devices*, which in addition to executing stated control and indication functions, also permit transmission of control, *measurement*, and operating information to and from single or multiple-user specifiable locations, connected by single or multiple *communication links*.

3.1.30 field instrument:

an *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*; see *local instrument*.

3.1.31 final control element:

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

3.1.32 function:

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

3.1.33 hardware:

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

3.1.34 high level control system (HLCS):

A system that provides sophistication above that of the BPCS; with *functions* typically based in process computer or higher level hardware that interacts with the process by manipulating setpoints in the BPCS.

(a) Control *functions* in the HLCS include, but are not limited to, statistical process control and model predictive control.

(b) An HLCS is not necessary to operate a plant or process.

3.1.35 identification:

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

3.1.36 instrument:

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

a) the term does not apply to a *devices* internal components or parts, such as receiver bellows or resistors.

3.1.37 instrumentation:

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

3.1.38 local instrument:

an 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*; see *field instrument*.

3.1.39 local panel:

a *panel* that is not a central or main *panel* and is commonly located in the vicinity of plant subsystems or sub-areas.

a) the term "*local panel instrument*" should not be confused with "*local instrument*".

3.1.40 loop:

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

a) a self-contained *device* that measures and controls a *process variable*.

3.1.41 manual loading station:

a *device* or *function* that has a manually adjustable output, and may 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*.

3.1.42 measurement:

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

3.1.43 monitor:

a general term for an instrument or instrument system used 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*.

3.1.44 monitor light:

a light that indicates which of a number of normal, but not abnormal, conditions of a system or *device* exists; see also *pilot light*.

3.1.45 panel:

a 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.

3.1.46 panel-mounted:

an instrument or other *device* that is mounted on a *panel* or console and is *accessible* for an operator's normal use.

a) a *function* that is normally *accessible* to an operator in a shared-display system is the equivalent of a *discrete panel-mounted device*.

3.1.47 pilot light:

a light that indicates which of a number of normal conditions of a system or *device* exists; it is not an *alarm* light, which indicates an abnormal condition. See also *monitor light*.

3.1.48 primary element:

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

- a) an orifice plate is an external *primary element*
- b) the *sensor* of a *transmitter* is an internal *primary element*.

3.1.49 process:

any operation or sequence of operations involving a change of energy, state, composition, dimension, or other properties that may be defined with respect to zero or some other defined initial value.

3.1.50 *process variable*:

any measurable property of a *process*; used in this standard to apply to all variables other than instrument signals between *devices* in a *loop*.

3.1.51 *program*:

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

3.1.52 *programmable logic controller*:

a *controller*, usually with multiple inputs and outputs, that contains an alterable *program* that is typically used to control *binary* and/or *discrete* logic or sequencing *functions*, and may also be used to provide continuous control *functions*.

3.1.53 *relay*:

a *device*, whose *function* is to pass on information in an unchanged form or in some modified form, often used to mean the preferred term *computing device*.

a) *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*.

3.1.54 *safety instrumented system*:

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

3.1.55 *scan*:

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

a) a *scanning device* is often used to ascertain the state or value of a group of variables, and may be associated with other *functions* such as recording and *alarming*.

3.1.56 *sensor*:

a 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*.

3.1.57 *setpoint*:

an 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.

3.1.58 *shared control*:

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

a) often used to describe the control features of a *distributed control system*, *programmable logic controller*, or other microprocessor or mainframe computer based system.

b) control of multiple *process variables* can be implemented by sharing the capabilities of a single *device* of this kind.

3.1.59 shared display:

the operator interface device, a video, light-emitting diode, liquid crystal, or other display unit, used to display process control information from a number of sources at the command of the operator, often used to describe the visual features of a *distributed control system*, *programmable logic controller*, or other *microprocessor* or *mainframe computer* based system.

3.1.60 software:

the *programs*, codes, procedures, algorithms, patterns, rules, and associated documentation required for the operation or maintenance of microprocessor or computer systems; see also *application software*.

3.1.61 software link:

the interconnection of system components via communication networks or *functions* via *software* or *keyboard* instruction.

3.1.62 supervisory setpoint control system:

the generation of *setpoint* and/or other control information by a *computer control system* for use by *shared control*, *shared display* or other regulatory control *devices*.

3.1.63 switch:

a *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*.

3.1.64 test point:

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

3.1.65 transducer:

a general term for a *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.

3.1.66 transmitter:

a *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*.

a) the *sensor* can be an integral part, as in a direct-connected pressure *transmitter*, or a separate part, as in a thermocouple.

4 Identification letters table

4.1 Identification letters table

4.1.1 This clause provides in tabular form the alphabetic building blocks of the Instrument and Function Identification System in a concise, easily referenced manner.

4.1.2 Table 4.1, together with Clause 4.2, defines and explains the meanings of the individual letters when used to identify loop and device functions.

4.1.3 The letters in Table 4.1 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.
- b) Meanings to the blanks in columns 2, 3, 4, and 5 when additional functions or modifiers are assigned.
- c) When such assignments are made they shall be documented in the User's engineering and design standards or guidelines and on drawing legend sheets.

4.2 Table 4.1 — Identification letters explanatory notes

The following notes, indicated in Table 4.1 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] are 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 may have one meaning as a Measured or Initiating Variable and another as a Succeeding-Letter shall be defined only once. For example, [N] may be defined as "modulus of elasticity" as a Measured/Initiating Variable and "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 PLC 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 or Succeeding-Letter for unclassified devices or functions [X] for non-repetitive meanings that are used only once or to a limited extent may have any number of meanings that shall be defined outside the tagging bubble or by a note in the document. For example, [XR-2] may be a stress recorder and [XX-4] may 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 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) Direct measured variables that shall be considered as Measured/Initiating Variables for Loop Numbering shall include but are not limited to:

- (a) Differential [D] — pressure [PD] or temperature [TD].
- (b) Total [Q] — flow totalizer [FQ], when directly measured, such as by a positive displacement flowmeter.
- (c) X-axis, y-axis, or z-axis [X], [Y], or [Z] — vibration [VX], [VY], and [VZ], force [WX], [WY], or [WZ] or position [ZX], [ZY], or [ZZ].

(12) Derived or calculated from other direct measured variables that should not be considered as Measured/Initiating Variables for Loop Numbering shall include but are not limited to:

- (a) Difference [D] — temperature [TD] or weight [WD].
- (b) Ratio [F] — Flow [FF], pressure [PF], or temperature [TF].
- (c) Time rate of change [K] — pressure [PK], temperature [TK], or weight [WK].

(13) 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-loss loop.

(14) Variable Modifier safety [S] is technically not a direct-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 and components, see (30).

(15) The grammatical form of Succeeding Letter meanings shall be modified as required; for example, 'indicate' [I] may be read as 'indicator' or 'indicating,' and 'transmit' [T] may be read as 'transmitter' or 'transmitting.'

(16) Readout/Passive Function glass, gauge, or viewing device [G] should be used instead of Readout/Passive Function indicate [I] for instruments or devices that provide a secondary view, such as level glasses, pressure gauges, thermometers, and flow sight glasses.

(a) Also used to identify devices that provide an uncalibrated view of plant operations, such as television monitors.

(17) Readout/Passive Function indicate [I] applies to the analog or digital readout of an actual measurement or input signal to a discrete instrument or a distributed control system's video display unit.

(a) In the case of a manual loader, it should be used for the dial or setting indication of the output signal being generated, [HIC] or [HIK].

(18) Readout/Passive Function scan [J] when used shall indicate a non-continuous periodic reading of two or more Measured/Initiating Variables of the same or different kinds, such as multipoint temperature and pressure recorders.

(19) 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.

(20) 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.

(21) 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.

(b) Save space on drawings by not showing tangent bubbles for each function.

(c) A note describing the multiple functions should be on the drawing if needed for clarity.

(22) 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.

(23) 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 generated by 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, or circuits that may 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.

(24) 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.

(b) Split architecture or fieldbus control devices where the controller functions are located remotely from the operator station.

(25) Output/Active Function auxiliary devices and functions [Y] include, but are not limited to, solenoid valves, relays, and computing and converting devices and functions

(26) 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 5.6 Mathematical Function Blocks and when written in text shall include a description of the mathematical function from Table 5.6.

(27) 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] may be used as an alternative.

(b) Low [L] the valve is in or approaching the fully closed position; closed [C] may be used as an alternative.

(c) Middle or intermediate [M] the valve is traveling or located in between the fully open or closed position.

(28) 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.

(29) 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].
- (30) Variable Modifier [Z] is technically not a direct-measured variable but is used to identify the components of Safety Instrumented Systems.
- (a) [Z] shall not be used to identify the safety devices noted in (14).

Table 4.1 — Identification letters

Note: Numbers in parentheses refer to the preceding explanatory notes in Clause 4.2.

	First letters (1)		Succeeding letters (15)		
	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 (23a)(23e)	Close (27b)
D	User's Choice (3a)(5)	Difference, Differential, (11a)(12a)			Deviation (28)
E	Voltage (2)		Sensor, Primary Element		
F	Flow, Flow Rate (2)	Ratio (12b)			
G	User's Choice		Glass, Gauge, Viewing Device (16)		
H	Hand (2)				High (27a)(28a)(29)
I	Current (2)		Indicate (17)		
J	Power (2)		Scan (18)		
K	Time, Schedule (2)	Time Rate of Change (12c)(13)		Control Station (24)	
L	Level (2)		Light (19)		Low (27b)(28)(29)
M	User's Choice (3a)(5)				Middle, Intermediate (27c)(28) (29)
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 (27a)
P	Pressure (2)		Point (Test Connection)		
Q	Quantity (2)	Integrate, Totalize (11b)	Integrate, Totalize		
R	Radiation (2)		Record (20)		Run
S	Speed, Frequency (2)	Safety(14)		Switch (23b)	Stop
T	Temperature (2)			Transmit	
U	Multivariable (2)(6)		Multifunction (21)	Multifunction (21)	
V	Vibration, Mechanical Analysis (2)(4)(7)			Valve, Damper, Louver (23c)(23e)	
W	Weight, Force (2)		Well, Probe		
X	Unclassified (8)	X-axis (11c)	Accessory Devices (22), Unclassified (8)	Unclassified (8)	Unclassified (8)
Y	Event, State, Presence (2)(9)	Y-axis (11c)		Auxiliary Devices (23d)(25)(26)	
Z	Position, Dimension (2)	Z-axis (11c), Safety Instrumented System (30)		Driver, Actuator, Unclassified final control element	

5 Graphic symbol tables

5.1 Graphic symbol tables

5.1.1 This clause provides in tabular form the graphic building blocks that are used to construct diagrams for measurement and control loops, instruments, and functions in a concise, easily referenced manner.

5.1.2 The graphic symbol sets included in this clause are intended to be used to prepare:

- a) Instrumentation diagrams.
- b) Functional diagrams.
- c) Binary logic diagrams.
- d) Electrical schematics.

5.1.3 The graphic symbols shown in the tables are drawn full size for use in full size sketches or drawings.

5.1.4 The device and function symbols shown in Table 5.1.1 are based on the traditional 7/16-inch or 11mm circle format but may be changed to the often-used 1/2-inch or 12mm circle format.

5.1.5 Consideration shall be given to the size of reduced P&IDs when selecting symbol sizing.

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

5.2 Tables to be used for common applications

5.2.1 Instrumentation diagrams that represent instrumentation devices and functions shall be constructed from the symbols shown in:

- a) Tables 5.1.1 and 5.1.2 — Measurement and control devices or functions.
- b) Tables 5.2.1, 5.2.2, 5.2.3, and 5.2.4 — Measurement elements and transmitters.
- c) Tables 5.3.1 and 5.3.2 — Lines, instrument to process or instrument to instrument.
- d) Tables 5.4.1, 5.4.2, 5.4.3, and 5.4.4 — Final control elements.
- e) Table 5.6 — Signal processing function blocks.

5.2.2 Functional diagrams that represent monitoring and control loops shall be constructed from the symbols shown in:

- a) Table 5.5 — Functional diagramming symbols.
- b) Table 5.6 — Signal processing function block symbols.
- c) Table 5.7 — Binary logic symbols.

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

- a) Table 5.1.1 — Measurement and control devices or functions.
- b) Table 5.7 — Binary logic symbols.

5.2.4 Electrical schematics that represent electrical circuits shall be constructed from the symbols shown in:

- a) Table 5.1.1 — Measurement and control devices or functions.
- b) Table 5.8 — Electrical schematic symbols.

5.2.5 Symbols may 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.

5.2.6 If new or revised symbols are developed they should be submitted to the ISA-5.1 committee for inclusion in the next revision of this standard.

5.3 Graphic symbol table explanatory notes

The following notes, indicated in Tables 5.1 through 5.8 by parentheses, shall be used as an aid in understanding the meanings of the symbols.

5.3.1 Tables 5.1.1 and 5.1.2 — Instrumentation device and function symbols:

- (1) Devices and functions that are represented by these bubble symbols are:
 - (a) Used in shared display, shared control, configurable, microprocessor-based, and data-linked instrumentation where the functions are accessible by the operator via a shared display or monitor.
 - (b) Configured in control systems that include, but are not limited to, distributed control systems (DCS), programmable logic controllers (PLC), personal computers (PC), and intelligent transmitters and valve positioners.
- (2) The user shall select and document one of the following for use of these symbols in a:
 - (a) Primary shared-display, shared-control system.
 - (b) Basic Process Control System (BPCS).
- (3) The user shall select and document one of the following for use of these symbols in an:
 - (a) Alternate shared-display, shared-control system.
 - (b) Safety Instrumented System (SIS).
- (4) Devices and functions represented by these bubble symbols are configured in computer systems that include, but are not limited to:

- (a) Process controllers, process optimizers, statistical process control, model-predictive process control, analyzer controllers, business computers, manufacturing execution systems, and other systems that interact with the process by manipulating setpoints in the BPCS.
 - (b) High Level Control System (HLCS)
- (5) Discrete devices or functions that are hardware-based and are either stand-alone or are connected to other instruments, devices, or systems that include, but are not limited to, transmitters, switches, relays, controllers, and control valves.
- (6) Accessibility includes viewing, setpoint adjustment, operating mode changing, and any other operator actions required to operate the instrumentation.
- (7) Functions represented by these symbols are used for simple interlock logic:
- (a) A description of the logic should be shown nearby or in the notes section of the drawing or sketch if the intended logic is not clearly understandable.
 - (b) These symbols are not recommended for depicting complex DCS, PLC, or SIS applications that require other than 'AND' and 'OR' signal gates.
- (8) A logic number, letter, or number/letter combination identification shall be used if more than one logic scheme is used on the project by:
- (a) Replacing [I], [A], and [O] with the logic identification.
 - (b) Appending the logic identification outside the symbol.

5.3.2 Tables 5.2.1, 5.2.2, 5.2.3, 5.2.4, and 5.2.5 — Measurement symbols

- (1) Measurements are depicted by:
- (a) Bubbles only.
 - (b) Bubbles and graphics.
- (2) These symbols shall be used for process or equipment measurements if:
- (a) A graphic symbol does not exist.
 - (b) The user does not use graphic symbols.
- (3) Transmitter [T] may be controller [C], indicator [I], recorder [R], or switch [S].
- (4) User engineering and design standards, practices, and/or guidelines shall document which choices are selected.

5.3.3 Tables 5.3.1 and 5.3.2 — Line symbols:

- (1) Power supplies shall be shown when:
- (a) Different from those normally used, e.g., 120 Vdc when normal is 24 Vdc.
 - (b) When a device requires an independent power supply.

- (c) Affected by controller or switch actions.
- (2) Arrows shall be used if needed to clarify direction of signal flow.
- (3) Users engineering and design standards, practices and/or guidelines shall document which symbol has been selected.
- (4) The line symbols connect devices and functions that are integral parts of dedicated systems, such as distributed control systems (DCS), programmable logic controllers (PLC), personal computer systems (PC), and computer control systems (CCS) over a dedicated communication link.
- (5) The line symbols connect independent microprocessor-based and computer-based systems to each other over a dedicated communications link, using but not limited to the RS232 protocol.
- (6) The line symbols connect “intelligent” devices, such as microprocessor-based transmitters and control valve positioners that contain control functionality, to other such devices and to the instrumentation system, using but not limited to Ethernet fieldbus protocols.
- (7) The line symbols connect “smart” devices, such as transmitters, to instrumentation system input signal terminals and provide a superimposed digital signal that is used for instrument diagnostics and calibration.

5.3.4 Tables 5.4.1, 5.4.2, 5.4.3 and 5.4.4 — Final control element symbols:

- (1) Users engineering and design standards, practices, and/or guidelines shall document which symbols have been selected.
- (2) Element symbols 1 through 14, when combined with actuator symbols 1 through 16, represent process control valves.
- (3) Element symbol 2, when combined with actuator symbols 20 and 21, represent pressure safety valves.
- (4) Element symbols 15 through 19, when combined with actuator symbols 13, 14, and 15, represent on-off solenoid valves.
- (5) Element symbol 21, when combined with actuator symbols 1 through 16, represents a variable speed control unit.
- (6) Element symbol 21 represents a motor that manipulates or controls a process variable.
- (7) Actuator symbols 1 through 16, when combined with element symbols 1 through 14, represent process control valves and with element symbol 21 represents a variable speed control unit.
- (8) Actuator symbols 17, 18, and 19, when combined with element symbols 15 through 19, represent on-off solenoid valves.
- (9) Actuator symbols 20 and 21, when combined with element symbol 2, represent pressure safety valves.
- (10) The symbols are applicable to all types of control valves and actuators.

5.3.5 Table 5.5 — Functional diagramming symbols:

- (1) Signal flow is assumed to be from top-to-bottom or from left-to-right.

- (2) Symbols are shown in a vertical diagram format.
- (3) Symbols shall be rotated 90 degrees counterclockwise in a horizontal diagram format.
- (4) Insert signal processing symbol from Table 5.6 at (*).

5.3.6 Table 5.6 — Signal processing function block symbols:

- (1) Symbols in small squares and rectangles are as used with symbol #1 from Table 5.1.2.
- (2) Symbols in large rectangles are as used with symbol #5 from Table 5.5.
- (3) Users engineering and design standards, practices and/or guidelines shall document which symbol has been selected.

5.3.7 Table 5.7 — Binary logic symbols:

- (1) True signals are equal to binary one, and false signals are equal to binary zero.
- (2) Alternate symbols shall be used only for “AND” and “OR” gates.
- (3) Users engineering and design standards, practices and/or guidelines shall document which symbol has been selected.

5.3.8 Table 5.8 — Electrical schematic symbols

- (1) All devices are shown in the unactuated or de-energized condition.
- (2) Switch contacts 2, 3, and 4 shall be actuated by:
 - (a) Hand.
 - (b) Actuator symbols 5 and 6.
- (3) Actuator symbols 5 and 6 shall actuate switch symbols 2, 3, and 4.
- (4) Switch symbols 7, 8, and 9 shall be actuated by:
 - (a) Hand.
 - (b) Actuator symbols 11 through 16.
 - (c) Bubble symbol for device or function assigned to actuate the switch symbol.
- (5) Actuator symbols 11 through 16 shall actuate switch symbols 7, 8, and 9.
- (6) Users engineering and design standards, practices and/or guidelines shall document which symbol has been selected.

Table 5.1.1 — Instrumentation device and function symbols

Note: Numbers in parentheses refer to explanatory notes in Clause 5.3.1.

No.	Shared display, Shared control (1)		C Computer Systems and Software (4)	D Discrete (5)	Location & accessibility (6)
	A	B			
	Primary Choice or Basic Process Control System (2)	Alternate Choice or Safety Instrumented System (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 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 5.1.2 — Instrumentation device or function symbols, miscellaneous

Note: Numbers in parentheses refer to explanatory notes in Clause 5.3.1.

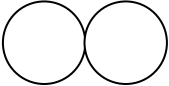
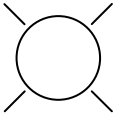
No	Symbol	Description
1		- Signal processing function: - Locate in upper right or left quadrant of symbols above. - Attach to symbols above where affected signals are connected. - Insert signal processing symbol from Table 5.6 - Expand symbol by 50% increments for larger function symbols.
2		- Panel-mounted 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.
4	(7) (8) 	'AND' interlock logic function.
5	(7) (8) 	'OR' interlock logic function.
6		- 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.
7		- Pilot light. - Circle shall be replaced with any symbol from column D in Table 5.1.1 if location and accessibility needs to be shown.

Table 5.2.1 — Measurement symbols: primary elements and transmitters

Note: Numbers in parentheses refer to explanatory notes in Clause 5.3.2.

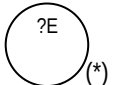
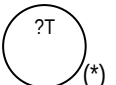
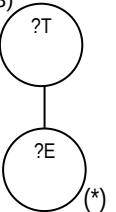
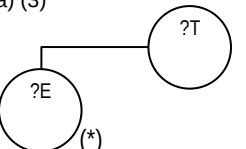
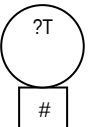
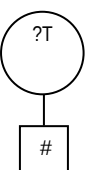
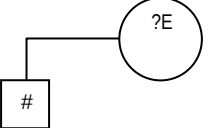
No	Symbol	Description
1	(1a) (2) 	- Generic primary element, bubble format. - Notation (*) from Table 5.2.2 should be used to identify type of element. - Connect to process or other instruments by symbols from Tables 5.3.1 and 5.3.2. - Insert in or on process flow line, vessel, or equipment.
2	(1a) (2) (3) 	- Transmitter with integral primary element, bubble format. - Notation (*) from Table 5.2.2 should be used to identify type of element. - Connect to process or other instruments by symbols from Tables 5.3.1 and 5.3.2. - Insert in or on process flow line, vessel, or equipment.
3	(1a) (2) (3) 	- Transmitter with close coupled primary element, bubble format - Notation (*) from Table 5.2.2 should be used to identify type of element. - Connecting line shall be equal to or less than 0.25 inches (6 millimeters). - Connect to process or other instruments by symbols from Tables 5.3.1 and 5.3.2. - Insert element in or on process flow line, vessel, or equipment.
4	(1a) (3) 	- Transmitter with remote primary element, bubble format. - Notation (*) from Table 5.2.2 should be used to identify type of element. - Connecting line shall be equal to or greater than 0.5 inches (12 millimeters). - Connect to process or other instruments by symbols from Tables 5.3.1 and 5.3.2. - Insert element in or on process flow line, vessel, or equipment.
5	(1b) (3) 	- Transmitter with integral primary element inserted in or on process flow line, vessel, or equipment, bubble/graphic format. - Insert primary element symbol from Table 5.2.3 at #. - Connect to other instruments by symbols from Table 5.3.2.
6	(1b) (3) 	- Transmitter with close-coupled primary element inserted in or on process flow line, vessel, or equipment, bubble/graphic format. - Insert primary element symbol from Table 5.2.3 at #. - Connecting line shall be equal to or less than 0.25 inches (6 millimeters). - Connect to other instruments by symbols from Table 5.3.2.
7	(1b) (3) 	- Transmitter with remote primary element inserted in or on process flow line, vessel, or equipment, bubble/graphic format. - Insert primary element symbol from Table 5.2.3 at #. - Connecting line may be any signal line from Table 5.2.3. - Connecting line shall be equal to or greater than 0.5 inches (12 millimeters). - Connect to other instruments by symbols from Table 5.3.2.

Table 5.2.2 — Measurement symbols: measurement notations (4)

Note: Numbers in parentheses refer to explanatory notes in Clause 5.3.2

Analysis			
AIR = Excess air	H ₂ O = Water	O ₂ = Oxygen	UV = Ultraviolet
CO = Carbon monoxide	H ₂ S = Hydrogen sulfide	OP = Opacity	VIS = Visible light
CO ₂ = Carbon dioxide	HUM = Humidity	ORP = Oxidation reduction	VISC = Viscosity
COL = Color	IR = Infrared	pH = Hydrogen ion	=
COMB = Combustibles	LC = Liquid chromatograph	REF = Refractometer	=
COND = Elec. conductivity	MOIST = Moisture	RI = Refractive index	=
DEN = Density	MS = Mass spectrometer	TC = Thermal conductivity	=
GC = Gas chromatograph	NIR = Near infrared	TDL = Tunable diode laser	=
Flow			
CFR = Constant flow regulator	OP = Orifice plate	PT = Pitot tube	VENT = Venturi tube
CONE = Cone	OP-CT = Corner taps	PV = Pitot venturi	VOR = Vortex Shedding
COR = Coriolis	OP-CQ = Circle quadrant	SNR = Sonar	WDG = Wedge
DOP = Doppler	OP-E = Eccentric	SON = Sonic	=
DSO = Doppler sonic	OP-FT = Flange taps	TAR = Target	=
FLN = Flow nozzle	OP-MH = Multi-hole	THER = Thermal	=
FLT = Flow tube	OP-P = Pipe taps	TTS = Transit time sonic	=
LAM = Laminar	OP-VC = Vena contracta taps	TUR = Turbine	=
MAG = Magnetic	PD = Positive displacement	US = Ultrasonic	=
Level			
CAP = Capacitance	GWR = Guided wave radar	NUC = Nuclear	US = Ultrasonic
d/p = Differential pressure	LSR = Laser	RAD = Radar	=
DI = Dielectric constant	MAG = Magnetic	RES = Resistance	=
DP = Differential pressure	MS = Magnetostrictive	SON = Sonic	=
Pressure			
ABS = Absolute	MAN = Manometer	VAC = Vacuum	=
AVG = Average	P-V = Pressure-vacuum	=	=
DRF = Draft	SG = Strain gage	=	=
Temperature			
BM = Bi-metallic	RTD = Resistance temp detector	TCK = Thermocouple type K	TRAN = Transistor
IR = Infrared	TC = Thermocouple	TCT = Thermocouple type T	=
RAD = Radiation	TCE = Thermocouple type E	THRM = Thermistor	=
RP = Radiation pyrometer	TCJ = Thermocouple type J	TMP = Thermopile	=
Miscellaneous			
Burner, Combustion	Position	Quantity	Radiation
FR = Flame rod	CAP = Capacitance	PE = Photoelectric	α = Alpha radiation
IGN = Igniter	EC = Eddy current	TOG = Toggle	β = Beta radiation
IR = Infrared	IND = Inductive	=	γ = Gamma radiation
TV = Television	LAS = Laser	=	n = Neutron radiation
UV = Ultraviolet	MAG = Magnetic	=	=
=	MECH = Mechanical	=	=
=	OPT = Optical	=	=
=	RAD = Radar	=	=
=	=	=	=
Speed	Weight, Force		
ACC = Acceleration	LC = Load cell	=	=
EC = Eddy current	SG = Strain gauge	=	=
PROX = Proximity	WS = Weigh scale	=	=
VEL = Velocity	=	=	=
=	=	=	=