BRITISH STANDARD

BS 1646-3: 1984

Symbolic representation for process measurement control functions and instrumentation —

Part 3: Specification for detailed symbols for instrument interconnection diagrams

Confirmed December 2011

UDC 53.08:681.2:003.62

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Industrial-process Measurement and Control Standards Committee (PCL/-) to Technical Committee PCL/4 upon which the following bodies were represented:

Association of Consulting Engineers

Beama Transmission and Distribution Association

British Industrial Measuring and Control Apparatus Manufacturers' Association (BEAMA)

Energy Industries Council

Institute of Measurement and Control

Institution of Gas Engineers

Ministry of Defence

This British Standard, having been prepared under the direction of the Industrial-process Measurement and Control Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 January 1984

The following BSI references relate to the work on this standard:
Committee reference PCL/4
Draft for comment 79/23678 DC

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Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

Foreword

This British Standard has been prepared under the direction of the Industrial-process Measurement and Control Standards Committee and is technically equivalent to the international Organization for Standardization (ISO) draft international standard ISO/DIS 3511/3 *"Process measurement control functions and instrumentation — Symbolic representation — Part 3: Detailed symbols for instrument interconnection diagrams"*.

The decision to publish now rather than await the publication of the corresponding ISO standard, recognises the urgent need of the industry for a standard with world-wide application based on an international text. It is anticipated that any differences with the finally published ISO version will be of a minor nature. The standard incorporates minor editorial and drawing changes which have been submitted to the ISO technical committee in order to correct errors in the draft international standard.

For ease of production the text of the draft international standard has been used for this British Standard; some terminology and certain conventions are not identical with those used in British Standards.

Cross-references

International standard	Corresponding British Standard
IEC 117[a]	BS 3939 *Graphic symbols for electrical power, telecommunications and electronics diagrams (Technically equivalent)*

[a] Undated in the text

The Technical Committee has reviewed the provisions of IEC 113-5, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

The logic elements in accordance with IEC 117-15, referred to in **3.13**, are identical with those given in BS 3939-21.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

This British Standard has been devised to provide a universal means of communication among the various interests involved in the design, manufacture, installation and operation of measurement and control equipment used in the process industries.

Requirements within the industries vary considerably; in recognition of this, this British Standard is presented in three parts as follows:

— *Part 1: Basic requirements (directed towards the needs of those employing comparatively simple measurements and control means);*

— *Part 2: Extension of basic requirements;*

— *Part 3: Detailed symbols for instrument interconnection diagrams.*

The three parts together are intended to:

a) meet the requirements of those who, possibly employing more sophisticated measurement and control means, may wish to depict such aspects as the measurement techniques embodied in a particular instrument, or the means — hydraulic, pneumatic, electrical, mechanical — used for its actuation;

b) provide standard symbolic representation for process measurement control functions and instrumentation. These symbols are not intended to replace graphic symbols for electrical equipment as contained in IEC Publication 117.

1 Scope and field of application

This part of BS 1646 specifies instrument symbols for use on interconnection diagrams used for the design, installation, and maintenance of process measurement and control systems.

These detailed symbols are not normally intended for drawings that use the functional symbols given in BS 1646-1 and BS 1646-2. However, the symbols specified in this part of BS 1646 show, by detailing the components, the external connections between units of equipment.

Information on the internal connections in units is not normally included, but references to the appropriate circuit or wiring diagrams may be provided.

When an instrument is composed of more than one functional part, the different symbols may be combined, for example, recorder controller.

The dimensions of the symbols are unspecified, provided the ratio of the side lengths is maintained according to this part of BS 1646[1)].

If not otherwise stated, contact symbols should be shown open.

The diagrams may employ single line or multi-line representation and may be combined with, or replaced by tables, providing clarity is maintained.

For further assistance see IEC 113-5, *Preparation of interconnection diagrams and tables.*

2 Definitions

The following defintions are used solely for the purposes of this part of BS 1646, to assist in the application and understanding of the symbol system.

2.1
point of measurement

the point in a process at which a measurement is or may be made

2.2
instrument

a device or combination of devices used directly or indirectly to measure, display and/or control a variable. This term does not apply to internal components of the instruments, for example resistor or receiver bellows

[1)] This rule has been adopted provisionally until such time as technical committee ISO/TC 10 prepares an International Standard for the representation of graphical symbols used on technical drawings.

2.3
panel-mounted instrument

an instrument that is mounted in a group normally accessible to the operator

2.4
locally mounted instrument

an instrument that is not panel-mounted

2.5
correcting unit

the unit comprising those elements (actuating and correcting) which adjust the correcting conditions, in response to a signal from the controller

2.6
actuating element

that part of the correcting unit which adjusts the correcting element, for example a response to a signal from the controller

2.7
correcting element

that part of the correcting unit which directly adjusts the value of the correcting conditions

2.8
alarm

a device which is intended to attract attention to a defined abnormal condition by means of a discrete audible and/or visible signal, but which does not itself institute corrective action

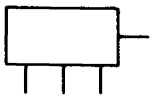
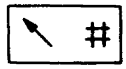
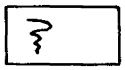
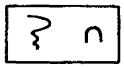
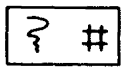
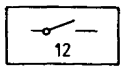
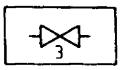
2.9
set value

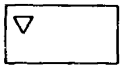
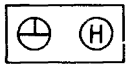
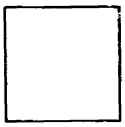
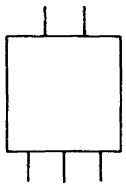
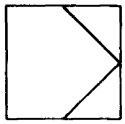
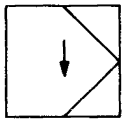
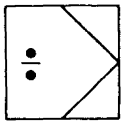
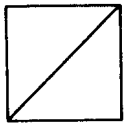
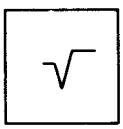
the value of the controlled condition to which the controller is set

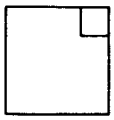
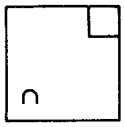
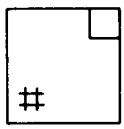
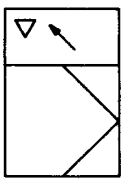
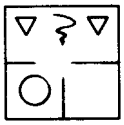
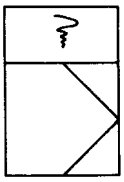
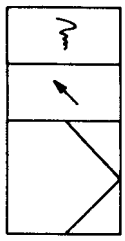
2.10
interconnection diagram

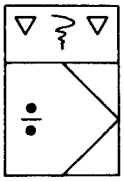
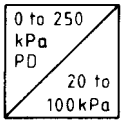
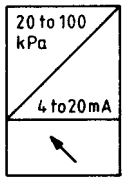
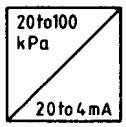
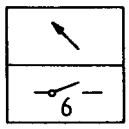
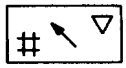
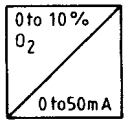
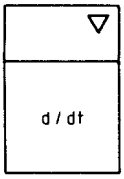
diagram representing the connections between the different units of an installation

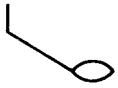
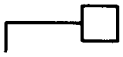
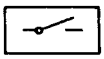
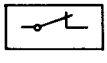
3 Symbols

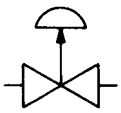
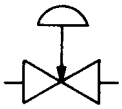
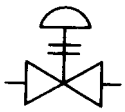
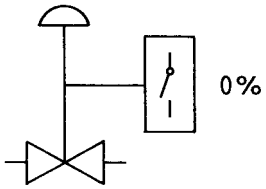
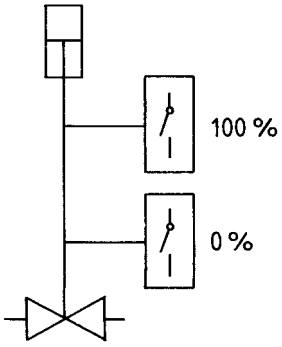
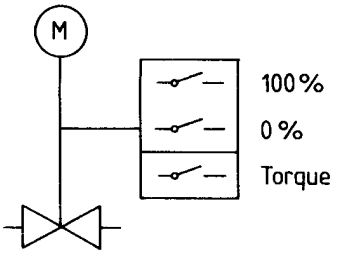
Number	Description	Use of equipment or explanation of symbol	Symbol
3.1	Instruments		
3.1.1	Non-converting instruments	Examples: indicators, recorders, counters	
3.1.1.1	Basic symbol	Preferred ratio of sides 1 : 2	
3.1.1.1.1	Basic symbol with connections	Terminals may be placed on any basic symbol	
3.1.1.2	Indicator	Arrow points upwards to left	
3.1.1.2.1	Analogue indicator		
3.1.1.2.2	Digital Indicator		
3.1.1.3	Recorder	State number of records if more than one	
3.1.1.3.1	Analogue recorder		
3.1.1.3.2	Digital recorder		
3.1.1.4	Counter		
3.1.1.5	Measuring point selection switch (electrical)	State number of measuring points (for example, 12 points)	
3.1.1.6	Measuring point selection valve (gas or liquid)	State number of measuring points (for example, 3 points)	

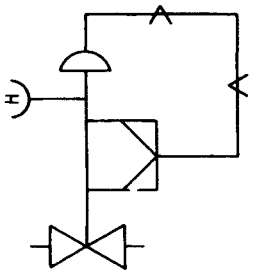
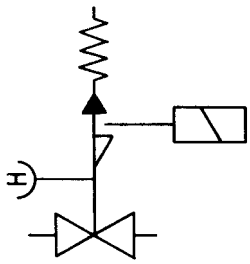
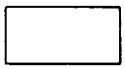
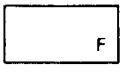
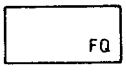
Number	Description	Use of equipment or explanation of symbol	Symbol
3.1.1.7	Switch for alarm signal or initiator	**Position** **Input** Left = minimum Right = maximum If symbol is turned 90°, Lower = minimum Upper = maximum	
3.1.1.8	Manual control station		
3.1.1.9	Manual control station with hand/auto or remote/local switch		
3.1.2	Converting instruments	Examples: transmitters, controllers, relays	
3.1.2.1	Basic symbol	Preferred ratio of sides 1 : 1	
3.1.2.1.1	Basic symbol with connections	Terminals may be placed on any basic symbol	
3.1.2.2	Controller, closed-loop	The apex of the inscribed V is on the output-signal side. The apex angle shall be 90°.	
3.1.2.3	Controller with increasing input signal giving increasing output signal	When symbol is turned, the arrow indicating the direction of output action shall remain in the vertical up position	
3.1.2.4	Controller with increasing input signal giving decreasing output signal	When symbol is turned, the arrow indicating the direction of output action shall remain in the vertical down position.	
3.1.2.5	Ratio controller		
3.1.2.6	Converter, transmitter, transducer, etc.	State type and range of input and output signals	
3.1.2.7	Computing relay	State computing function: $+, -, \times, \times^n, \int, \frac{d}{dt}, \sqrt{}$, etc. For example, square root extractor	

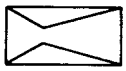
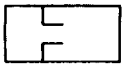
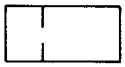
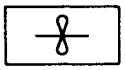
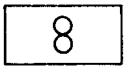
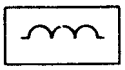
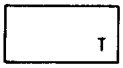
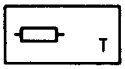
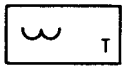
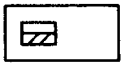
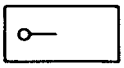
Number	Description	Use of equipment or explanation of symbol	Symbol
3.1.2.8	Amplifier		
3.1.2.9	Signal memory		
3.1.2.9.1	Analogue signal memory		
3.1.2.9.2	Digital signal memory		
3.1.3	Logic elements		According to IEC Publication 117, Part 15
3.1.4	Examples of instruments		
3.1.4.1	Indicating controller with switch for minimum signal		
3.1.4.2	Recorder and counter with switches for minimum and maximum signal		
3.1.4.3	Recording controller		
3.1.4.4	Indicating controller with recorder for second measured variable		

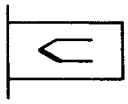
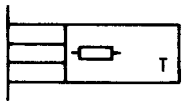
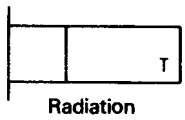
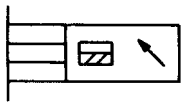
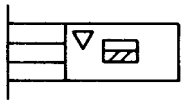
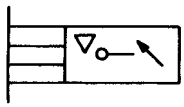
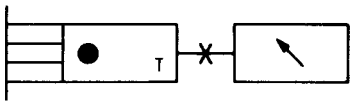
Number	Description	Use of equipment or explanation of symbol	Symbol
3.1.4.5	Recording ratio controller with switches for minimum and maximum signal		
3.1.4.6	Transmitter: input, 0 to 250 kPa differential pressure; output, 20 to 100 kPa standard signal		
3.1.4.7	Signal converter with output indicator: input, 20 to 100 kPa; output, 4 to 20 mA		
3.1.4.8	Signal converter: input, 20 to 100 kPa; output, 20 to 4 mA		
3.1.4.9	Indicator with selector switch for 6 measuring points		
3.1.4.10	Digital indicator with switch for maximum signal		
3.1.4.11	Oxygen transmitter: input 0 to 10 % O_2; output 0 to 50 mA		
3.1.4.12	Rate-of-change relay with high-rate switch		
3.2	Correcting units		
3.2.1	Correcting elements		
3.2.1.1	Valve	If type of valve is to be shown, the relevant ISO symbol shall be used	
3.2.2	Actuating element	A vertical line shall be connected to the correcting element symbol	

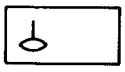
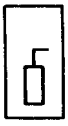
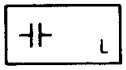
Number	Description	Use of equipment or explanation of symbol	Symbol
3.2.2.1	Manual actuator		
3.2.2.2	Diaphragm actuator		
3.2.2.3	Solenoid actuator	Preferred side relationship 1 : 2	
3.2.2.4	Piston actuator	Preferred side relationship 1 : 2	
3.2.2.5	Rotary motor actuator		
3.2.2.6	Spring actuator		
3.2.2.7	Float actuator		
3.2.2.8	Weight actuator		
3.2.2.9	Centrifugal force actuator		
3.2.3	Accessories		
3.2.3.1	Lock-up to block movement to the left	The separate vertical line should connect to the symbol for an actuator such as a solenoid	
3.2.3.2	Lock-up initially permitting movement to left and right, but which blocks return to left after movement to right	The separate vertical line should connect to the symbol for an actuator such as a solenoid	
3.2.3.3	Limit switch	"Make" contact, closed when actuated	
3.2.3.4	Limit switch	"Break" contact, open when actuated	

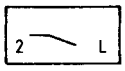
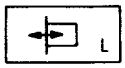
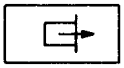
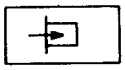
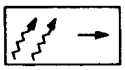
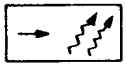
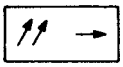
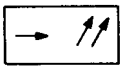
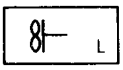
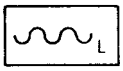
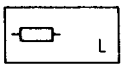
Number	Description	Use of equipment or explanation of symbol	Symbol
3.2.3.5	Correcting element takes fail-safe position when actuation energy fails	Opens on failure	
		Closes on failure	
		Retains position on failure	
3.2.4	Examples of correcting-unit assemblies. When confusion may occur between mechanical and electrical connections, a double line may be used for mechanical connections. Switches shall be shown in non-actuated position. Orientation of switch symbol is optional.		
3.2.4.1	Correcting units with integrally mounted switches		
3.2.4.1.1	Control valve with diaphragm actuator with integrally mounted switch actuated in valve-closed (0 %) position. Contact closes when switch is actuated.		
3.2.4.1.2	Control valve with piston actuator with integrally mounted switches actuated in valve-closed (0 %) position and valve-opened (100 %) position. Contacts close when switches are actuated.		
3.2.4.1.3	Control valve operated by rotary motor with integrally mounted switch with two contacts, one actuated in valve-closed (0 %) and the other in valve-opened (100 %) position, and with torque switch. Contacts close when switches are actuated		

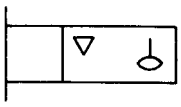
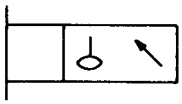
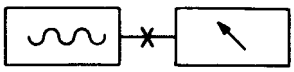
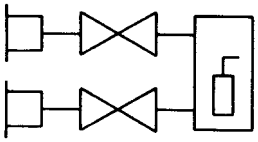
Number	Description	Use of equipment or explanation of symbol	Symbol
3.2.4.2	Control valve with diaphragm actuator, positioner, and with manual operation		
3.2.4.3	Control valve, spring-actuated to open, hand-actuated to close. Normal operating position for valve is in closed position and latched. Latch is released by a solenoid when solenoid is actuated.		
3.3	Detectors and connections for detectors		
3.3.1	Basic symbol for detectors	Ratio of sides 1 : 2. If necessary, the letter of the measuring function may be inserted in the symbol for detector (see BS 1646-1)	
3.3.1.1	Basic symbol for nozzle or boss on line or vessel	Ratio of sides 1 : 1	
3.3.1.2	Protecting well for detectors		
3.3.1.3	Nozzle or boss with well for detector		
3.3.1.4	Insertion pipe		
3.3.1.5	Nozzle or boss with insertion pipe		
3.3.2	Detectors for flow and volumetric flow	If necessary, the letter of the measuring function may be inserted in the symbol for detector (see BS 1646-1)	
3.3.2.1	Flow (general)		
3.3.2.2	Volumetric flow-meter (general)	This symbol must be used in conjunction with mechanical integrator, transmitter, or other functional element	

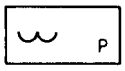
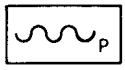
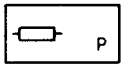
Number	Description	Use of equipment or explanation of symbol	Symbol
3.3.2.3	Venturi tube		
3.3.2.4	Flow nozzle		
3.3.2.5	Orifice plate		
3.3.2.6	Variable-area meter		
3.3.2.7	Turbine meter		
3.3.2.8	Positive displacement meter		
3.3.2.9	Electromagnetic flowmeter		
3.3.3	Detectors for temperature	If necessary, the letter of the measuring function may be inserted in detector symbol (see BS 1646-1)	
3.3.3.1	General		
3.3.3.2	Thermocouple		
3.3.3.3	Resistance element		
3.3.3.4	Liquid filled		
3.3.3.5	Gas filled		
3.3.3.6	Bi-metallic		
3.3.3.7	Glass thermometer		

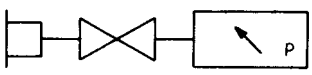
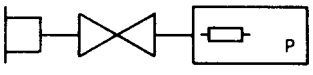
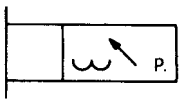
Number	Description and interpretation of the examples	symbol
3.3.4	Examples of detectors for temperature	
3.3.4.1	Detector for skin-temperature measurement by means of thermocouple	
3.3.4.2	Nozzle with well and resistance element	
3.3.4.3	Nozzle with temperature detection by means of radiation	
3.3.4.4	Nozzle with indicating bi-metallic thermometer and well	
3.3.4.5	Nozzle with blind bi-metallic thermometer with switch for minimum alarm and with well	
3.3.4.6	Nozzle with indicating glass thermometer with switch for minimum alarm and with well	
3.3.4.7	Nozzle with thermometer, for example gas filled, with capillary and indicator	

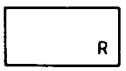
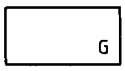
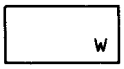
Number	Description	Use of equipment or explanation of symbol	Symbol
3.3.5	Detectors for level	If necessary, the letter of measured variable may be inserted in the dector symbol (see BS 1646-1)	
3.3.5.1	General		
3.3.5.2	Float		
3.3.5.3	Displacer		
3.3.5.4	Electrode (capacitive)		

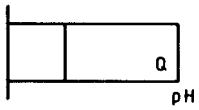
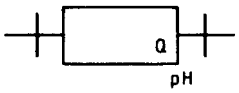
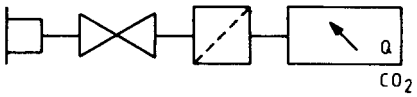
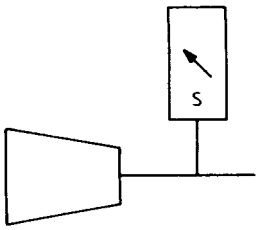
Number	Description	Use of equipment or explanation of symbol	Symbol
3.3.5.5	Electrode (conductive)	Indicate the number of electrodes per connection, (for example, 2)	
3.3.5.6	Sonic integral source and detector		
3.3.5.7	Sonic separate source and detector		
3.3.5.7.1	Source		
3.3.5.7.2	Detector		
3.3.5.8	Radioactive source and detector	Further indication as to type of radiation may be added	
3.3.5.8.1	Source		
3.3.5.8.2	Detector		
3.3.5.9	Photoelectric light source and detector		
3.3.5.9.1	Source		
3.3.5.9.2	Detector		
3.3.5.10	Propeller		
3.3.5.11	Membrane type (diaphragm)		
3.3.5.12	Resistance, for example strain gauge		

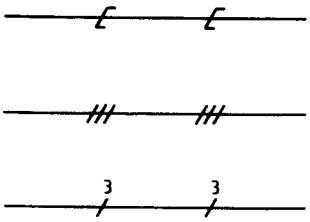
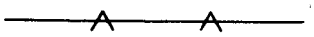
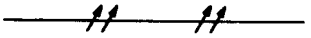
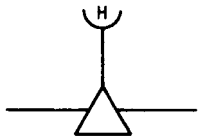
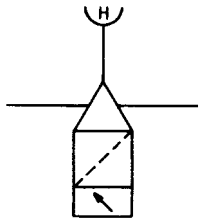
Number	Description and interpretation of the examples	Symbol
3.3.6	Examples of detectors for level	
3.3.6.1	Nozzle with float and minimum alarm (float switch)	
3.3.6.2	Nozzle with float and indicator	
3.3.6.3	Membrane with capillary and indicator	
3.3.6.4	Nozzles with valves and displacer in chamber	

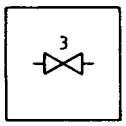
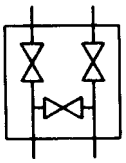
Number	Description	Use of equipment or explanation of symbol	Symbol
3.3.7	Detectors for pressure	If necessary the letter of the measured variable may be inserted in the symbol for the detector (see BS 1646-1)	
3.3.7.1	General		
3.3.7.2	Liquid-filled system bulb		
3.3.7.3	Membrane type (diaphragm)		
3.3.7.4	Pressure-sensitive strain gauge		

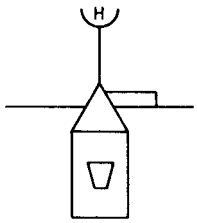
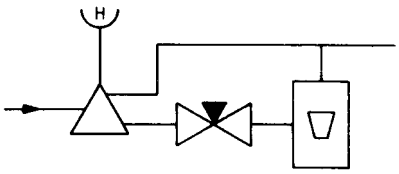
Number	Description and interpretation of the examples	Symbol
3.3.8	Examples of detectors for pressure	
3.3.8.1	Nozzle with block valve and indicating pressure gauge	
3.3.8.2	Nozzle with block valve and strain-gauge detector	
3.3.8.3	Nozzle with pressure gauge with liquid-filled system	

Number	Description	Use of equipment or explanation of symbol	Symbol
3.3.9	Detectors for other measured or initiating variables	See BS 1646-1 and BS 1646-2 for letters indicating the required variables	
3.3.9.1	General for quality	The letter Q may be supplemented by a further indication of the measured variable	
3.3.9.2	General for nuclear radiation		
3.3.9.3	General for speed or frequency		
3.3.9.4	General for gauging, position, or length		
3.3.9.5	General for weight or force		
3.3.9.6	General for other measurement variables		

Number	Description and interpretation of the examples	Symbol
3.3.10	Examples of detectors for other measuring functions	
3.3.10.1	Nozzle with pH detector	
3.3.10.2	pH detector mounted between flanges in process line	
3.3.10.3	Nozzle with valve, filter, and CO_2 indicator	
3.3.10.4	Speed indicator (tachometer) on turbine shaft	

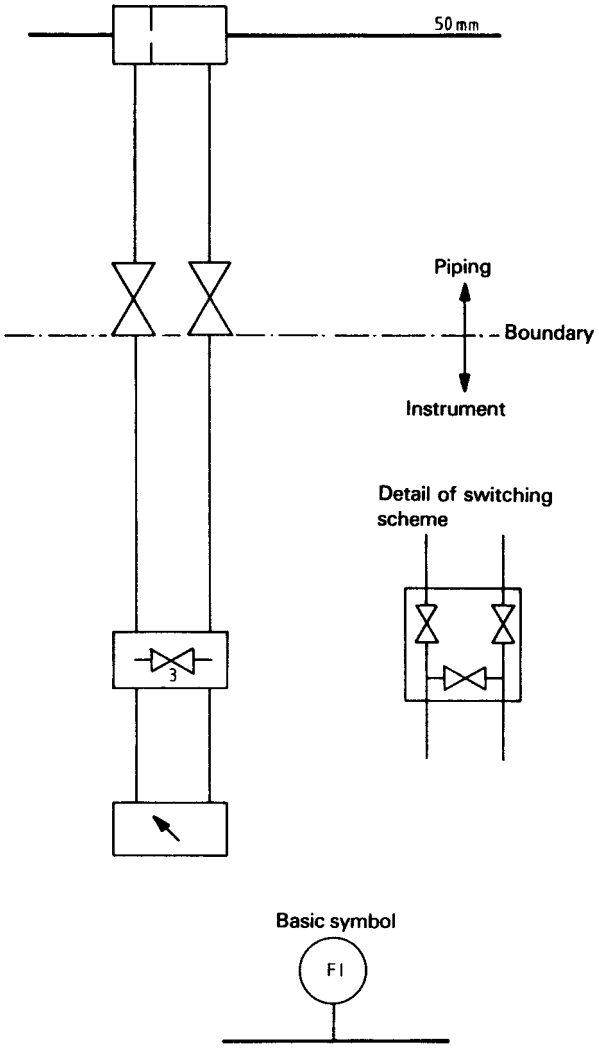
Number	Description	Use of equipment or explanation of symbol	Symbol
3.4	Lines		
3.4.1	Process lines		
3.4.2	Measuring lines		
3.4.2.1	Signal lines, general		
3.4.3		When it is necessary to distinguish between different kinds of signal lines, notes may be added or the following lines may be applied	
3.4.3.1	Electric	1) General (E) 2) Shows the number of separate electrical signal lines following the same route	
3.4.3.2	Pneumatic (A)		
3.4.3.3	Hydraulic (L)		
3.4.3.4	Capillary		
3.4.3.5	Conducted radiation	Example: radio waves in wave guide, visible light in optical fibres	
3.5	Auxiliary devices		
3.5.1	Miscellaneous		
3.5.1.1	Reducer: differential pressure valve		
3.5.1.2	Reducer, hand-adjusted		
3.5.1.3	Differential pressure valve with external connection for reference pressure		
3.5.1.4	Filter		
3.5.1.5	combination of hand-adjustable reducer filter and pressure indicator		

Number	Description	Use of equipment or explanation of symbol	Symbol
3.5.1.6	Condensate pot, sediment trap; capacity vessel, seal pot, etc.	Position symbol horizontally or vertically as needed	
3.5.1.7	Fixed restriction		
3.5.1.8	Adjustable restriction		
3.5.1.8	Valve manifold	Example shows a 3-valve manifold If required, indicate internal arrangement	 

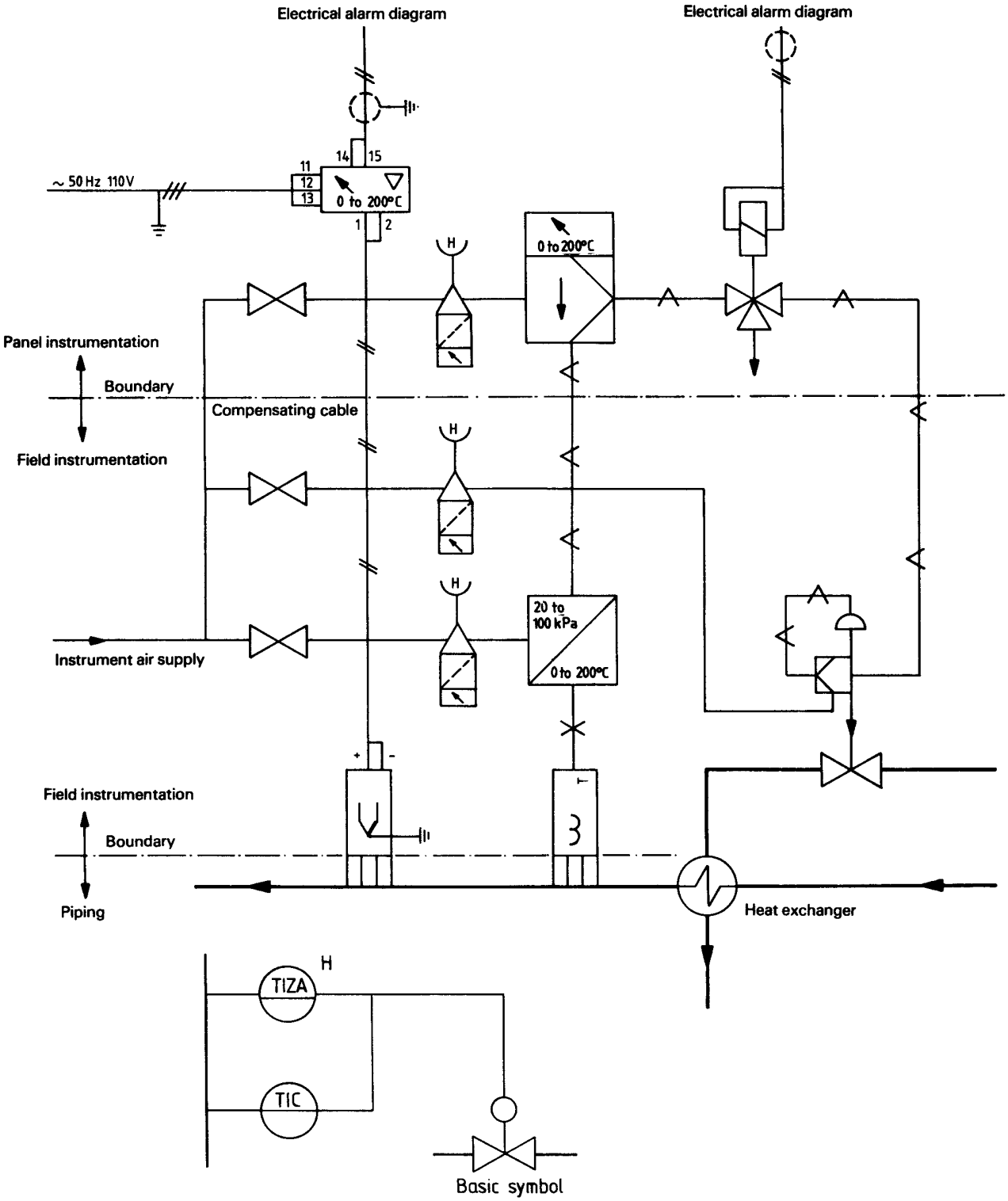
Number	Description and interpretation of the examples	Symbol
3.5.2	Examples of auxiliary devices	
3.5.2.1	Combination of hand-adjustable differential pressure valve, and variable-area flow meter.	
3.5.2.2	Combination of hand-adjustable differential pressure valve, variable-area flow meter, and needle valve	

Annex A Example of the use of graphical symbols

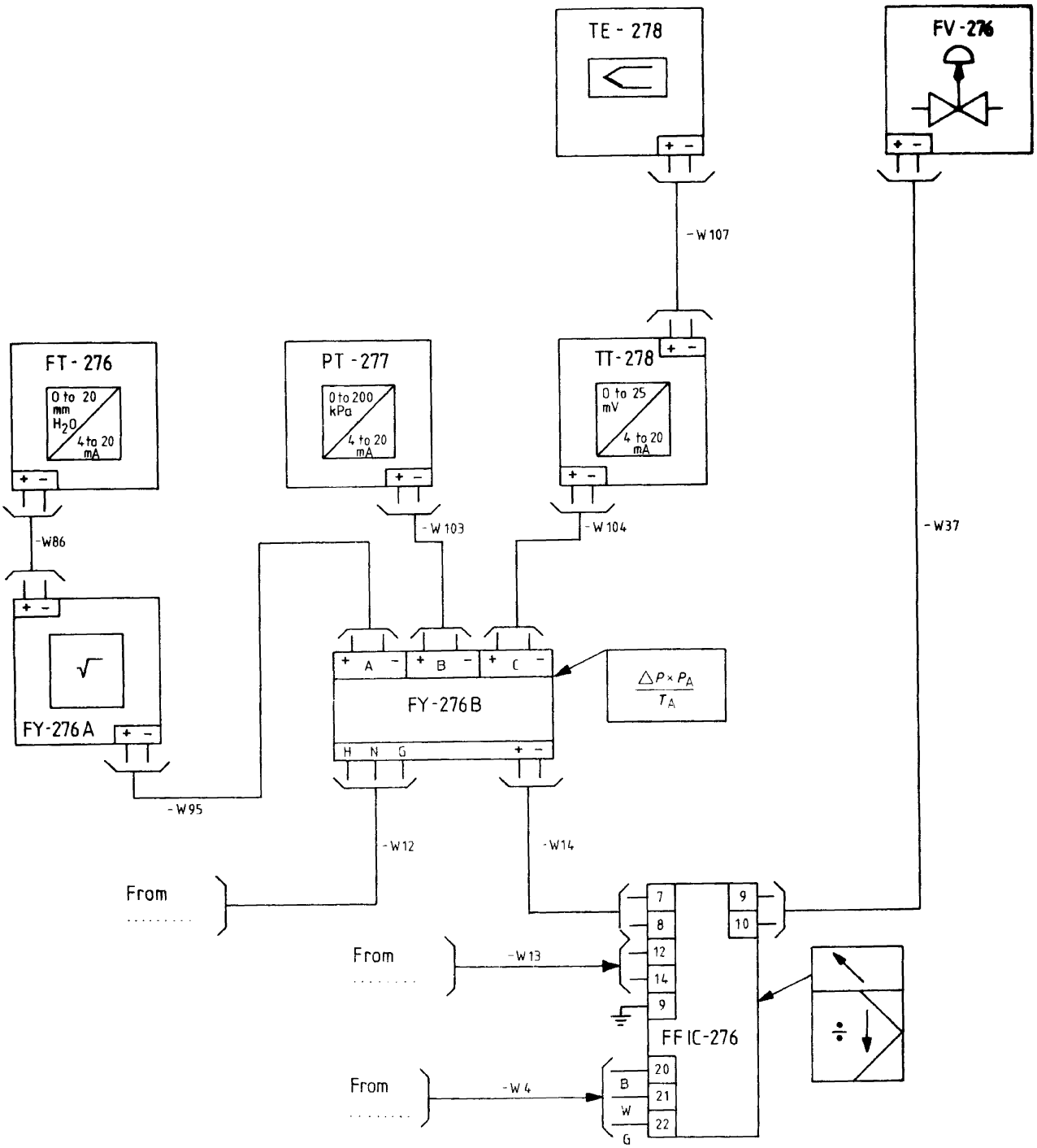
A.1 Flow measurement



A.2 Temperature control and alarm

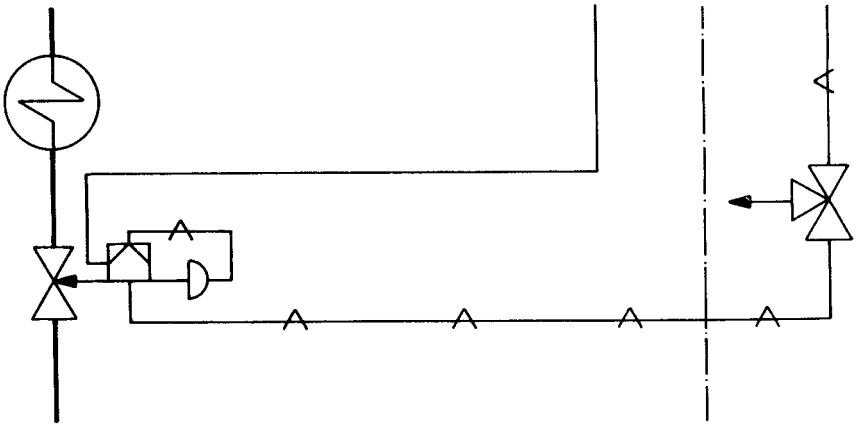


A.3 Wiring diagram

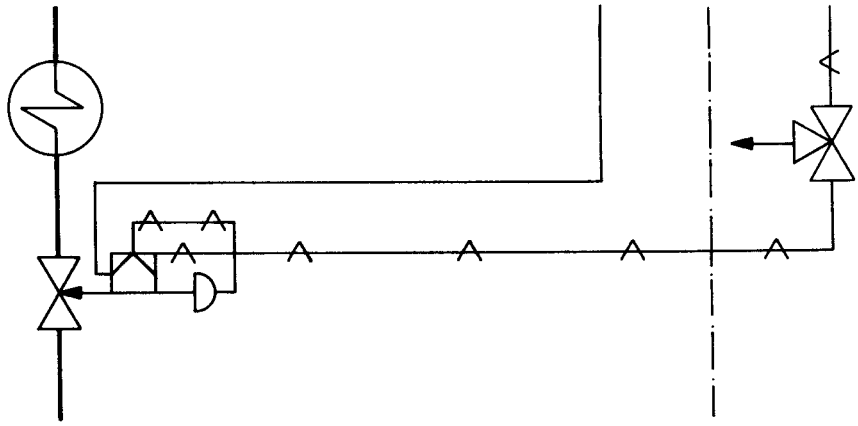


NOTE Symbols may be indicated outside the device symbol only if the space is limited.

A.4 Variations possible



a) acceptable



b) undesirable; crossing of lines is to be avoided if possible

Publications referred to

BS 1646, *Symbolic representation for process measurement control functions and instrumentation.*
BS 1646-1, *Basic requirements.*
BS 1646-2, *Specification for additional basic requirements.*
See also foreword.

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