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Part 1: General principles

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Introduction

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



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Energy Efficiency, Environment, Safety

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TITLE:

Application function blocks and logic diagrams for Upstream Oil & Gas processes – System Control Diagrams – Part 1: General principles

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**APPLICATION FUNCTION BLOCKS AND LOGIC DIAGRAMS IN OIL & GAS,
PROCESS AND POWER INDUSTRIES – SYSTEM CONTROL DIAGRAMS –****Part 1: General principles****FOREWORD**

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Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

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The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement available

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INTRODUCTION

The success of a process plant development project depends on good and efficient means of communication between the involved parties, during all phases of the project.

Present extensive use of computerized systems and 3D modelling provide efficient tools for specifying and handling of physical equipment in a standardized manner. However, the development of methods and tools to specify functional relationships has not reached a corresponding level.

During the plant development the process engineers specify the process through the development of the P&IDs. Throughout this work the process engineers specifies detailed pictures of the equipment involved and how they are connected. However, the P&IDs provide limited facilities for documentation of the overall control functionality as well as operational aspects of the process.

It is the control system engineer's task to design the control system to fulfil the process functionality required to achieve product specifications as well as the requirements imposed by the overall operating and control philosophy and manning levels. To conserve the functional relationships implicitly specified by the P&IDs, the control system engineers must transform the process engineers' understanding of plant behaviour into the control system design and implementation.

The operator's evaluation of the operational efficiency of the plant is a difficult task without any proper documentation of the overall control and monitoring functions available. Often, operational problems within the different systems cannot be identified until the system is in operation, leading to major modifications in late project phases in the worst case.

Due to the missing link between the functions implemented in the control system and the P&IDs defining the process flow, the process engineer's possibility to verify that all process aspects have been properly catered for in the implementation of the control system is very limited.

The SCD approach has been introduced in order to eliminate this missing link.

IEC 63131 defines a diagram type, *system control diagram* (SCD), that is used to describe the control of a process system in details. It covers both regular control, interlocks and interface to sequence.

The diagram can be regarded as a logic diagram as it is precise on how the function blocks are interconnected.

IEC 63131 consists of the following parts under the general title "*System Control Diagram*":

- Part 1: (this document) contains:
 - General requirements, including scope, normative references and definitions.
 - Reasons for creating SCD.
 - Design rules and guidelines for layout of diagram.
 - Rules for use of function block and logic elements.
 - Guideline for use of the diagram.
- Part 2: defines symbols used in the diagram:
 - General equipment symbols.
 - Diagram specific function block symbol.
 - Diagram specific elementary function block (arithmetic and logic) symbols.
 - Line types.
 - Reference symbols.
- Part 3: defines Function Block types for oil & gas, process and power industries:
 - Function block functionality requirements.

- 47 – Function block types.
- 48 – Terminals, operator interface e.g., status, alarms and parameters.

49 **How the diagram can be used:**

- 50 • Specification of how control logic shall be implemented.
- 51 • Useful in development of control logic as collaboration tool and to check that the control
- 52 system engineer has understood the functional requirements from the other disciplines,
- 53 process engineer, safety engineer, mechanical package vendor and operator.
- 54 • Basis for input to control system vendor in a machine-readable format. Digitalised
- 55 version of the SCD and relevant properties used in configuration of the control system.
- 56 • Follow up the logic implementation at control system vendor.
- 57 • Supporting the creation of graphical user interface for the control system.
- 58 • Support testing and commissioning.
- 59 • As built documentation of how the control logic has been implemented in a control
- 60 system.

61 **History:**

62 This standard is based on *Norsok I-005:2013/AC:2016 System Control Diagram*. The first
63 Edition of Norsok I-005 standard was issued in 1995 and was revised twice. The third edition
64 of Norsok I-005:2013/AC:2016 was published as IEC PAS 63131 (Edition 1.0 2017-11) by the
65 IEC in 2017.

66

Application function blocks and logic diagrams in oil & gas, process and power industries – System Control Diagram –

Part 1: General principles

1 Scope

This part of IEC 63131 specifies the functionality of SCD, design rules and how it can be used. This standard specifies a new diagram type for control logic applications with a corresponding new set of symbols.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60848, *GRAFCET specification language for sequential function charts*

IEC 61131-3, *Programmable controllers – Part 3: Programming languages*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61511 (all parts), *Functional safety – Safety instrumented systems for the process industry sector*

IEC 62682, *Management of alarm systems for the process industries*

IEC 63131-2, *Application function blocks and logic diagrams in oil & gas, process and power industries – System Control Diagrams – Part 2: Diagram symbols and drawing principles*.

3 Terms, definitions and abbreviated terms

For the purposes of this standard, the following terms, definitions and abbreviations apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 Terms and definitions

3.1.1

action alarm

alarm associated with an automatic action, both the alarm and action caused by one common discrete change of state

3.1.2

actual position

feedback-position of a final control element, independent of the state of the control output

3.1.3

alarm

audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a timely response

[SOURCE: IEC 62682]

3.1.4**alarm categories**

following categories are defined, not reflecting priority or criticality of the alarm:

Note 1 to entry: Action Alarm, Warning Alarm, and Fault Alarm defined elsewhere, are commonly used alarm categories.

3.1.5**auto mode**

operation of process objects automatically performed by the control logic

3.1.6**basic process control system****BPCS**

system which responds to input signals from the process, its associated equipment, other programmable systems and/or operators and generates output signals causing the process and its associated equipment to operate in the desired manner but which does not perform any SIF

Note 1 to entry: A BPCS includes all the devices necessary to ensure that the process operates in the desired manner.

Note 2 to entry: A BPCS typically may implement various functions such as process control functions, monitoring, and alarms.

[SOURCE: IEC 61511-1]

3.1.7**blocked mode**

function mode when blocking is active

3.1.8**blocking**

For type of functions that take signal from the field: signals from process variable limit checking are blocked within the function not allowing any related automatic safeguarding actions. Associated safeguarding function disabled.

For type of functions that drive the final element: disabling of a safeguarding action but allowing associated alarm annunciation as well as manual/automatic control.

3.1.9**confirmed position**

confirmative comparison between actual position and control output

Note 1 to entry: True if no mismatch, and false if there is a mismatch.

3.1.10**conflict**

function block state when a safeguarding action is requested, but prevented by an active blocking

3.1.11**control mode**

the operational state or method in which a control system or device operates to regulate or manipulate a process or system.

3.1.12**control philosophy**

the total concept on which a control system is based

Note 1 to entry: limitation to power plant is removed from definition.

[SOURCE: IEC 62270, ed. 2.0 (2013-09)]

3.1.13**control system**

system which responds to input signals from the process and/or from an operator and generates output signals causing the process to operate in the desired manner

159 Note 1 to entry: The control system includes sensors and final elements and may be either a BPCS or a SIS or a
160 combination of the two.

161 [SOURCE: IEC 61511-1]

162 **3.1.14**

163 **control options**

164 pre-defined properties of the function template defined during the configuration of the system
165 reflecting the specific control requirements

166 **3.1.15**

167 **designation**

168 distinguishing name, identifier, or title

169 [SOURCE: IEC 61511-1]

170 **3.1.16**

171 **de-energised**

172 at an electric potential equal to or not significantly different from that of earth at the worksite.
173 Ref IEC electropedia; 654-21-09

174 **3.1.17**

175 **device**

176 hardware, with or without software, capable of performing a specified function

177 Note 1 to entry: Examples are sensors, logic solvers, final elements, operator interfaces, and field wiring.

178 [SOURCE: IEC 61511-1]

179 **3.1.18**

180 **disabled mode**

181 function not available for control commands

182 **3.1.19**

183 **duty/standby mode**

184 intended for automatic supervision of final control element operating in parallel to increase the
185 system availability.

186 Note 1 to entry: One final control element will be assigned duty (priority 1) and will thus normally be in operation.
187 The other is assigned standby (priority 2) and will automatically be put in operation if duty fails. All final control
188 elements will have to be selected auto to obtain automatic duty/standby function.

189 **3.1.20**

190 **energised**

191 at an electric potential different from that of earth at the worksite and which presents and
192 electrical hazard. Ref IEC electropedia; 651-21-08

193 **3.1.21**

194 **event**

195 HMI indication caused by a discrete change of state

196 Note 1 to entry: Events may be associated with automatic actions.

197 **3.1.22**

198 **external setpoint mode**

199 sub-mode to auto mode used for controllers

200 Note 1 to entry: The setpoint is from external functions in the control logic. Typically used in cascading PID
201 controllers.

202 **3.1.23**

203 **fault alarm**

204 alarm associated to fault or failure in the instrument and/or control device

3.1.24**final element**

part of the BPCS or SIS that implements the physical action necessary to achieve or maintain a safe state

Note 1 to entry: Examples are valves, switch gear, and motors, including their auxiliary elements (such as solenoid valve and actuator used to operate a valve).

[SOURCE: IEC 61511-1]

3.1.25**final control element**

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

[SOURCE: ANSI/ISA-5.1]

Note 1 to entry: E.g., valve, pump. Where the final control element has only two positions (High position: flow, Low position: no flow), it is referred to as a binary final control element (motor: on/off, valve: open/close, electrical breaker: connected/disconnected).

3.1.26**function block****function block instance**

FB

software functional unit comprising an individual, named copy of a data structure and associated operations specified by a corresponding FB type.

Note 1 to entry: Typical operations of an FB include modification of the values of the data in its associated data.

[SOURCE: IEC 61804-2]

3.1.27**function block type**

FB-type

software functional unit consisting of:

- the definition of a data structure partitioned into input, output, and internal variables; and
- a set of operations or a set of methods to be performed upon the elements of the data structure when an instance of the function block type is called.

Note 1 to entry: The definition has been rephrased: *language element* changed to *software functional unit*.

Note 2 to entry: Symbol added.

[SOURCE: IEC 61131-3]

3.1.28**instrumented system**

system composed of sensors (e.g., pressure, flow, temperature transmitters), logic solvers (e.g., programmable controllers, distributed control systems, discrete controllers), and final elements (e.g., control valves, motor control circuits)

Note 1 to entry: Instrumented systems perform instrumented functions including control, monitoring, alarm and protective functions. Instrumented systems can be SIS (see 3.2.67) or BPCS (see 3.2.3).

[SOURCE: IEC 61511-1]

3.1.29**internal setpoint mode**

sub-mode to auto mode used for PID controllers

Note 1 to entry: The setpoint to be entered by the operator.

3.1.30**logic circuit**

functional digital circuits used to perform computational functions

254 [SOURCE: IEC 60194-2]

255 **3.1.31**

256 **logic diagram**

257 drawing that depicts the multistate device implementation of logic functions with logic symbols
258 and supplementary notations that show the details of signal flow and control, but not necessarily
259 the point-to-point wiring.

260 [SOURCE: IEC 60194-2]

261 **3.1.32**

262 **manual mode**

263 final control element manually controlled by an operator.

264 **3.1.33**

265 **motor control centre**

266 electrical relay assembly for control and protection of electrical equipment

267 **3.1.34**

268 **mode**

269 state of operation selected by the operator or resulting from an external event

270 Note 1 to entry: The following operation modes are defined:

271 **Auto:** see definition

272 **Outside:** see definition

273 **Manual:** see definition

274 **Duty/Standby:** see definition

275 **Blocked:** see definition

276 **Internal setpoint mode:** see definition

277 **External setpoint mode:** see definition

278 **Track:** see definition

279 **Safeguarding:** see definition

280 **Disabled:** see definition

281 **3.1.35**

282 **normally energised/de-energised**

283 The electric potential at the normal state of the plant in question, i.e., when equipment is
284 powered up and in operation within the design conditions.

285 **3.1.36**

286 **"output" track mode**

287 normal function output follows another external signal

288 **3.1.37**

289 **outside mode**

290 final control element operated from an external device, i.e., local panel.

291 **3.1.38**

292 **position**

293 state of final control element resulting from an external event

294 Note 1 to entry: The following positions are defined:

295 **Actual position:** see definition

296 **Confirmed position:** see definition

297 **3.1.39**

298 **process**

299 sequence of chemical, physical, or biological activities for the conversion, transport, or storage
300 of material or energy

3.1.40**pulse**

<digital> signal that switches from one digital state to the other and back again in a short period of time, and that remains in the original state for most of the time

[SOURCE: IEC 60194-2]

3.1.41**safety function**

function to be implemented by one or more protection layers, which is intended to achieve or maintain a safe state for the process, with respect to a specific hazardous event

[SOURCE: IEC 61511-1]

3.1.42**safety integrity level**

SIL

discrete level (one out of four) allocated to the SIF for specifying the safety integrity requirements to be achieved by the SIS

[SOURCE: IEC 61511-1]

3.1.43**safety instrumented function**

SIF

safety function to be implemented by a safety instrumented system (SIS)

Note 1 to entry: A SIF is designed to achieve a required SIL which is determined in relationship with the other protection layers participating to the reduction of the same risk.

[SOURCE: IEC 61511-1]

3.1.44**safety instrumented system**

SIS

instrumented system used to implement one or more SIFs

Note 1 to entry: A SIS is composed of any combination of sensor (s), logic solver (s), and final element (s) (e.g., see Figure 6). It also includes communication and ancillary equipment (e.g., cables, tubing, power supply, impulse lines, heat tracing).

Note 2 to entry: A SIS may include software.

Note 3 to entry: A SIS may include human action as part of a SIF (see ISA TR84.00.04:2015, part 1).

[SOURCE: IEC 61511-1]

3.1.45**sensor**

part of the BPCS or SIS that measures or detects the process condition

EXAMPLE Transmitters, transducers, process switches, and position switches.

[SOURCE: IEC 61511-1]

3.1.46**safeguarding mode**

final control element is in safe state

Note 1 to entry: The term safe is related to the protection of equipment, environment and human beings.

3.1.47**set command**

memory variable set to true state on being true

Note 1 to entry: Signal latch included in the common signal path between a group of initiators and a group of final control elements.