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SYSTEM CONTROL DIAGRAM

FOREWORD

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IEC PAS 63131 has been processed by IEC technical committee 65: Industrial-process measurement, control and automation.

Norsok I-005:2013/AC:2016 has served as a basis for the elaboration of this PAS. The structure and editorial rules used in this PAS reflect the practice of the organization which submitted it.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document
Draft PAS	**Report on voting**
65/669/DPAS	65/672/RVDPAS

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This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single period up to a maximum of 3 years, at the end of which it shall be published as another type of normative document, or shall be withdrawn.

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INTRODUCTION

This PAS is based on Norsok I-005:2013/AC:2016. Edition 1 of Norsok I-005:2013/AC:2016 was issued in 1995 and it has been widely used in the Norwegian Oil and Gas industry since then together with some international use on FPSOs and other fixed Oil and Gas installations.

The main objective for this PAS is to define a limited set of complete operational control functions (objects) and an explanatory condensed logical diagram, suitable for use in the continuous control process industry – e.g. Oil and Gas processes.

The main drivers for establishing this as a standard are the advantage of efficient engineering, implementation, and commissioning, as well as reuse of the control application across different suppliers of control systems. The diagrams give an unambiguous logical representation that is suited for data transfer.

This PAS also includes a method of documenting sequences (ref. IEC 60848) and their interaction with the control objects.

This PAS will provide the means to fill the gap between the P&ID's and the Functional requirement diagrams. (Ref IEC 61804.) The control functions definitions include required behavior descriptions of control modes, interlocking (Safeguarding), blocking and other operator commands. It gives a standardized operator interface on a functional level.

The logic diagrams carry a simplified process sketch as background, inherited from PFD/P&ID's, which enables reviews of the control applications in a multi-discipline environment.

This PAS can also be used as basis for defining a companion standard to OPC-UA (IEC 62541).

NORSOK I-005:2013 Rev. 3 was adopted as NORSOK Standard in February 2013.

Annex A, B, D and F are normative. Annex C, E and G are informative.

The success of a 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 modeling 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 process the process engineers acquire a thorough understanding of the total plant behaviour. However, the P&IDs provide limited facilities for documentation of the overall functionality as well as operational aspects of the plant.

It is the control system engineer's task to design the control system so as to fulfill 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 have to transform the process engineers understanding of plant behaviour into the control system design and implementation.

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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.

The logic and arithmetic functions available for implementing the required control system functionality are accurate, but vendor specific. In-depth system knowledge is required to understand both the available functions as well as their interconnections. There is no intuitive link between the control system functions and their interconnections, and the process flow itself. The interactions between the process and the control functions are identified through single tags only.

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. The SCD approach represents a structured methodology based on the development of the SCD.

This PAS consists of the definition of two elements:

- the function templates;
- the diagram.

The functional requirements are defined through Annex A "SCD Function Standard" while the drawing requirements are defined through Annex B "SCD drawing standard" and Annex D "SCD legend".

This PAS will also establish a general framework for implementation of the SCD approach in terms of Annex C "Project execution guidelines" and Annex E "Application guidelines".

Annex C "Project execution guidelines" defines a strategy for project execution and is intended for project responsible engineers. Annex E "Application guidelines" provides a basis for application design and is intended for application engineers responsible for developing SCDs.

Annex G "Readers manual" contains a simplified introduction for engineers and operators using SCDs for verification and documentation of control functionality.

Annex F "SCD Control function template behaviour" defines the functions in an unambiguous manner.

The main updated items in the 2012 edition of NORSOK I-005 standard are as follows:

- 7 new function templates have been defined;
  a) HA – analogue input command
  b) HB – binary input command
  c) KB – sequence logic interface
  d) MAS – analogue measurement acquisition from subsystems
  e) OA – analogue output
  f) SBB – breaker control
  g) SBC – coordinator for SBE
- 2 existing function templates have been deleted;
  a) CB – binary control (replaced by recommended use of MA, ref Figure F.19)

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b) YA – process input calculation (replaced by recommended use of # function, ref Figure E.3)

- CA function has been expanded with a terminal for feed forward (XFF), position high feedback XGH and confirmed high/low (BCH/BCL);
- for CS function terminal name BG has been corrected to YG;
- SB function have been expanded with a terminal for external fault and OS command for suppress;
- SBE function terminals have been aligned to fit the new SBC function, following input terminals have been removed XP1H, XP2H, XP1L, XP2L, BP1, BP2, BP1F, BP2F and expanded with terminals for safeguarding high;(LSH/FSH)
- further elementary functions have been defined, NOR, NAND, XOR and Analogue select;
- Annex A function standard have been rewritten to a new format;
- Annex B drawing standard have been more firm defined and expanded by
  a) size for all symbols have been defined,
  b) layer and colour use have been defined,
  c) "dot" introduced as alternative for S split symbol,
  d) "wall" introduced for multiple I/O connections,
  e) sequence symbols are defined.
- generally this PAS has been rephrased where it has been found unclear;
- application guideline is redone in accordance with the updates in this edition;
- function template behaviour figures redone where they have been unclear or erroneous;
- for the general appearance of this PAS the IEC IECSTD format has been adapted;
- Appendix E is updated to reflect the changes in Appendix A and B.
- Appendix F is updated to include the changes in Appendix A and errors corrected.

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SYSTEM CONTROL DIAGRAM

1 Scope

This PAS is intended to cover functional as well as drawing related requirements for use of SCDs.

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

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

ISO 128-20, *Technical drawings – General principles of presentation – Part 20: Basic conventions for lines*

ISO 3511 (all parts), *Process measurement control functions and instrumentation – Symbolic representation*

ISO 5457, *Technical product documentation – Sizes and layout of drawing sheets*

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

Norsk olje og gass 070, *Guidelines for the Application of IEC 61508 and IEC 61511 in the petroleum activities on the continental shelf*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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 flow element, independent of the state of the control output

3.1.3
alarm
HMI annunciation requiring operator response, caused by a discrete change of state

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3.1.4
alarm categories
following categories are defined, not reflecting priority or criticality of the alarm:

Action alarm: see definition
Warning alarm: see definition
Fault alarm: see definition

3.1.5
alarm hysteresis
degree of normalization required to reset an active alarm state, measured from the alarm activation limit

Note 1 to entry: Normally expressed in terms of a fraction (%) of the operating range

3.1.6
alarm suppression
see definition of suppression 3.1.46

3.1.7
auto mode
operation of process objects automatically performed by the control logic

3.1.8
blocked mode
function is in blocked mode when blocking is active

3.1.9
blocking
For input functions: alarm status signals from process variable limit checking are blocked within the function, giving annunciation, but not allowing all related automatic safeguarding actions. Associated safeguarding function disabled. Related alarm annunciation not disabled, i.e. no external signal outputs are blocked

For output functions: disabling of a safeguarding action, but allowing associated alarm annunciation as well as manual/automatic control. Blocking applies to both individual action alarms and input signals effecting safeguarding and disable functions

3.1.10
can
expression in the content of a document conveying expected or conceivable material, physical or causal outcome

3.1.11
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.

3.1.12
conflict
requested safeguarding action being prevented because blocking is active

3.1.13
control options
pre-defined properties of the function template defined during the configuration of the system reflecting the specific control requirements

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3.1.14
deviation warning
state calculated in a modulating controller by subtracting the measured value from the set point value

Note 1 to entry: A warning will be announced if deviation is outside working area.

3.1.15
disabled mode
function not available for control commands

3.1.16
disable transition mode
transition high/low function not available

Note 1 to entry: Safeguarding commands will not be affected in this mode.

3.1.17
duty/standby mode
intended for automatic supervision of flow element operating in parallel to increase the system availability

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

3.1.18
dynamic information
information displayed on the VDUs reflecting the state of the process or system

3.1.19
enabled mode
function available for external/remote control commands

3.1.20
event
HMI indication caused by a discrete change of state

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

3.1.21
external setpoint mode
sub-mode to auto mode used for controllers

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

3.1.22
fault alarm
alarm associated to fault or failure in the instrument and/or control device

3.1.23
flow element
device used to control/shut down or manipulate a flow of fluid or electric energy

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

3.1.24
force command
action overruling any other signal

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Note 1 to entry: The mode is reset to its original state when signal is no longer true.

3.1.25
function blocks
a function block is a configured package of defined logic functionality, with input terminals (receiving actions from other parts of the SAS logic or from the physical field interface) and output terminals (initiating actions toward other parts of the SAS logic or to the physical field interface).

Note 1 to entry: Function blocks are generally capable of being manipulated by the operator, via the SAS HMI.

3.1.26
function template
function assembly including detailed requirements for operation and control

Note 1 to entry: The general definition of any function block type is called a "function template", or just "template". A template is brought into practical use as a function block when a copy of the template is inserted into the SAS software configuration as a tagged object and given parameter values and logical connections

3.1.27
internal setpoint mode
sub-mode to auto mode used for PID controllers

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

3.1.28
lock command
action overruling any other signal while being true

Note 1 to entry: The new mode is maintained when lock signal is no longer true.

3.1.29
manual mode
flow element manually controlled by a operator

3.1.30
may
expression in the content of a document conveying consent or liberty (or opportunity) to do something

Note 1 to entry: Permissions are expressed using the verbal forms specified in ISO/IEC Directives Part 2:2016, 7.4, Table 5.

3.1.31
motor control centre
electrical relay assembly for control and protection of electrical equipment

3.1.32
mode
state of operation selected by the operator or resulting from an external event

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

Auto: see definition
Outside: see definition
Manual: see definition
Duty/Standby: see. definition
Blocked: see definition
Suppress: see definition
Internal setpoint mode: see definition
External setpoint mode: see definition
Track: see definition
Safeguarding: see definition
Disabled: see definition

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3.1.33
"output" track mode
normal function output follows another external signal

3.1.34
outside mode
flow element operated from a external device, i.e. local panel

3.1.35
process
sequence of chemical, physical, or biological activities for the conversion, transport, or storage of material or energy

3.1.36
position
state of flow element resulting from an external event

Note 1 to entry: The following positions are defined:

Actual position: see definition
Confirmed position: see definition

3.1.37
safeguarding mode
flow device is in safe state

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

3.1.38
safeguarding failure
safeguarding action not confirmed

3.1.39
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 flow elements.

3.1.40
"setpoint" tracking
setpoint tracks normal function input (measured value), in manual mode

3.1.41
shall
expression in the content of a document conveying objectively verifiable criteria to be fulfilled and from which no deviation is permitted if compliance with the document is to be claimed

Note 1 to entry: Requirements are expressed using the verbal forms specified in ISO/IEC Directives, Part 2:2016, 7.2, Table 3.

3.1.42
should
expression in the content of a document conveying a suggested possible choice or course of action deemed to be particularly suitable without necessarily mentioning or excluding others d

Note 1 to entry: Recommendations are expressed using the verbal forms specified in ISO/IEC Directives, Part 2:2016, 7.3, Table 4.

Note 2 to entry: In the negative form, a recommendation is the expression that a suggested possible choice or course of action is not preferred but it is not prohibited.

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3.1.43
shutdown
signal to set an element to safeguarding mode

3.1.44
shutdown level
signal latch included in the common signal path between a group of initiators and a group of flow elements

3.1.45
status
binary state

3.1.46
suppression
disable alarm annunciation as well as any associated automatic actions

Note 1 to entry: For input objects like MA and MB templates suppression disables state alarm annunciation as well as actions.

Note 2 to entry: For output objects like CA, CS, SB, SBE and SBV templates suppression disables fault alarm annunciation and feedback failure monitoring. External output is however maintained.

Note 3 to entry: Alarm suppression according to YA-711 is not covered by this PAS. Suppression according to this PAS is the sum of YA-711's alarm filtering and blocking/inhibit). Suppression according to YA-711 is often called "hiding" in environments that use the NORSOK definition of suppression.

3.1.47
warning alarm
alarm not associated with any automatic action

Note 1 to entry: A warning alarm may be used as a precursor to an action alarm.

3.2 Abbreviated terms

BPCS	basic process control system
C&E	cause and effect
CCR	central control room
CPU	central processing unit
D&ID	duct and instrument diagram
EFB	elementary function block
ESD	emergency shutdown system
F&G	fire and gas
FAT	factory acceptance test
H/P	hydraulic/pneumatic
HIPPS	high integrity pressure protection system
HMI	human machine interface
HVAC	heating, ventilation and air condition
I/O	input/output (signals, cards, etc)
MCC	motor control center
NDE	normally deenergised
NE	normally energised
OS	operator station
PSA	Petroleum Safety Authority
P&ID	piping and instrument diagram

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PCS	process control system
PFD	process flow diagram
PID	proportional integral derivative (controller)
PSD	process shutdown system
SAS	safety and automation system
SCD	system control diagram
SD	shutdown
SFC	sequential function chart
SIF	safety instrumented function
SIL	safety integrity level
SIS	safety instrumented system
UPS	uninterruptable power supply
USD	unit shutdown
VDU	visual display unit

4 The system control diagram (SCD) approach

4.1 Conceptual definition

The SCD concept returns to the basis of the P&ID, the process schematic. Information not required for the design of the control system is removed. The SCD shall focus on representing systems and functional relationships, not individual physical equipment.

The SCD combines all functional design requirements into a common unambiguous document and represents a top-down approach to the design of the system.

The process schematic includes a simplified representation of process lines and equipment. Instrumentation and control objects are represented by simplified symbols only.

The automation functions are represented by a limited number of high-level function templates. Each template represents a specific control philosophy selected for a class of objects. The control philosophy is defined/limited by a general range of attributes made available for the specific application. The application level is defined by using the applicable attributes.

Complex control and interlocking strategies are developed by inter-connecting templates. Additional logic and arithmetic functions may be used.

A functional description of the process objectives should follow the SCD.

The SCD function templates are vendor independent, thus a set of SCDs may serve as a functional SAS specification, even before the system vendor is selected. The vendor on his side has an unambiguous basis for system bid and eventually implementation. Functional monitoring and control solutions may be reused from one plant development to the other, even if different control systems are used to implement the functions.

Because the SCDs can be developed in parallel with the P&IDs, introduction of the SCD approach facilitate a parallel development of both the physical and functional relationships visualised on dedicated documents. This approach encourages team work between different disciplines during the process development phases and the traditional artificial split between the development of physical and functional relationships may be eliminated. Thus enhanced overall quality is achievable.

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4.2 Framework

This PAS represents an open standard in terms of operation and control philosophy. The standard is based on a basic core made up by function elements and terminology. The function elements are further combined into functional templates. These templates represent a level of standardisation intended for the system application design. Templates may be adapted and combined differently in order to represent various control strategies.

This PAS is neither based on nor limited to any specific control system. A reduced number of attributes may thus be implemented in order to accomplish an optimized implementation for a specific control system. However, suppliers should consider an initial effort in order to implement the complete range of attributes for the templates defined within this PAS.

The SCD approach has been developed with a view to industrial processes controlled by state-of-the-art process control systems, but as it provides a general process oriented approach for development of the documents, no field of application are explicitly excluded.

However, global safeguarding functions as well as fire and gas functions are less suitable for the SCD representation as such, see Figure 1.

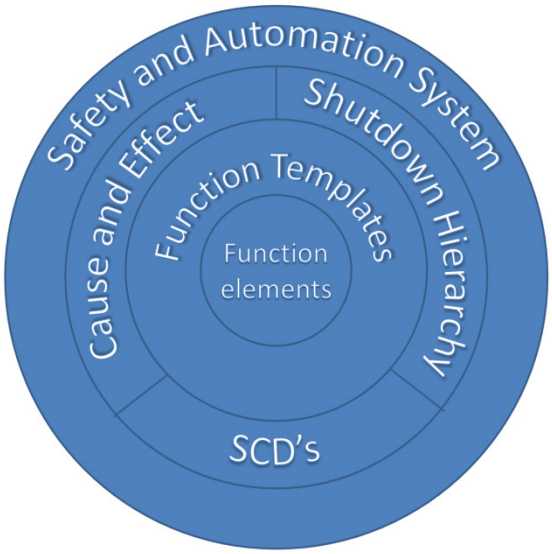

Figure 1 – SCD framework

Typical applications proven suitable for the SCD representation are as follows:

- control of process and utility systems;
- process shutdown applications;
- package control;
- HVAC.

A shutdown hierarchy should be made to provide a complementary overview of ESD and PSD levels.

A C&E representation will typically be used for F&G and ESD. C&Es may additionally be used for high level PSD levels in order to provide a complementary overview. However, the SCD should be defined master to ensure system consistency.

4.3 Life cycle concept

This PAS is intended to cover the complete life cycle of a process plant.

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The SCD will form the single source of documentation for the SAS control and shutdown functions for all life cycle phases as follows:

- engineering;
- implementation;
- commissioning;
- operations;
- modifications.

The objectives will be different within each phase. Annex C provides an introductory overview of what the SCD approach implies for the different life cycle phases.

Annex C is only intended to provide an overview of this PAS as well as an initial starting point for inexperienced users.

4.4 Basic design (informative)

4.4.1 General

The basic system design is closely related to the overall engineering strategy for the SAS system focusing on the following main design activities:

- basic system design;
- basic function design;
- basic application design.

See Figure 2 for an introductory overview.

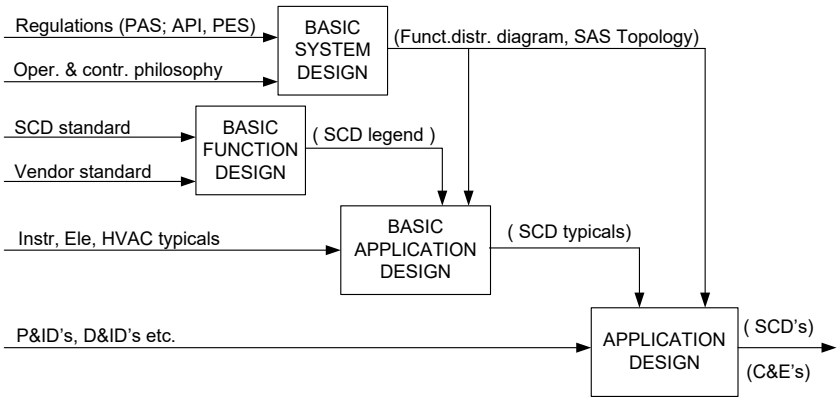

Figure 2 – Basic design

4.4.2 Basic system design

The basic system design is a general control system design activity, but is closely allied to the SCD functional template development. Based on authority regulations as well as company operational and control philosophies the actual system distribution is developed. The system distribution defines the interface between the different types of field components and the control system in terms of sub-system connection, see Figure 3.

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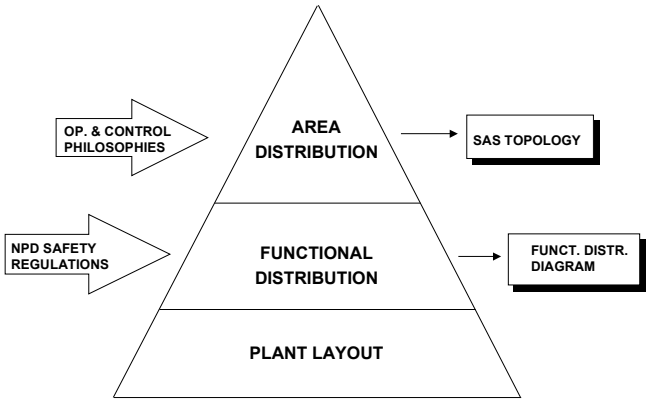

Figure 3 – Basic system design

4.4.3 Basic function design

The basic function design should be based on a joint effort between the involved parties in order to achieve an optimized use of the supplier standard functionality. Each functional element should be referred to the corresponding supplier standard functions and combined into an optimal set of templates. It is important that the resulting templates are consistent with the general standard, see Figure 4.

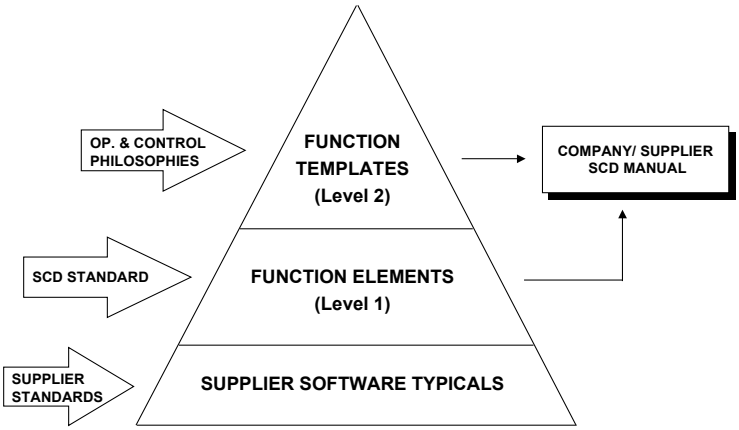

Figure 4 – Basic function design

4.4.4 Basic application design

The basic application design focuses on developing typical solutions that will form the basis for the development of the actual SCDs. The typical is developed on the following two levels:

- object typical;
- SCD applications.

See Figure 5.

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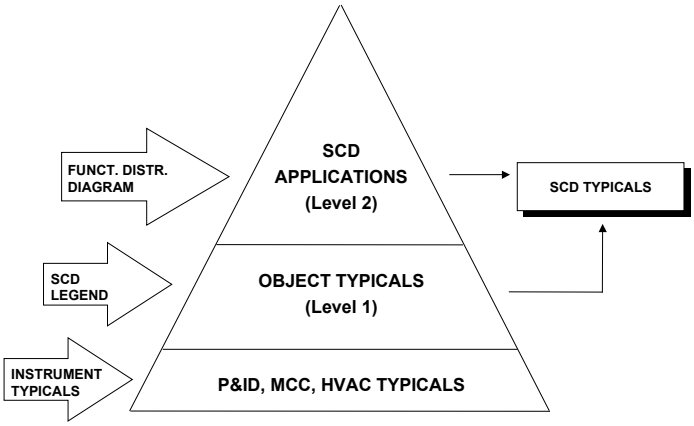

Figure 5 – Basic application design, application typical

The purpose of the object typical is to reflect a typical signal interface for a specific control object as well as the functional operator interface. The main objectives are as follows:

- verify the completeness of the function templates;
- reduce the number of typical solutions;
- improve the quality of the SCD development;
- standardised solutions.

See Figure 6.

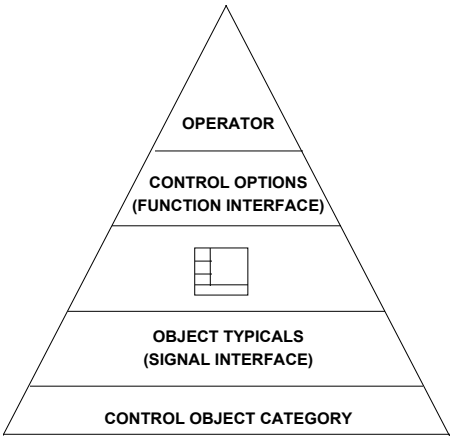

Figure 6 – Object typical

The purpose of the application typical is to reflect comprehensive application in order to reduce the number of different solutions as well as verify the completeness of the object typical.

4.4.5 Application design

The SCDs should be jointly developed by the system disciplines, driven by user requirements, not by technology/discipline organisation.

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The SCDs should as far as possible be developed in parallel with the P&IDs. The application design may be represented by means of a traditional water fall model, see Figure 7.

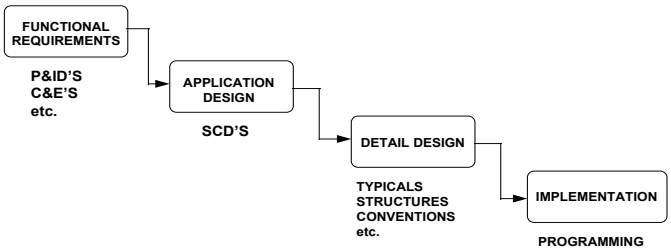

Figure 7 – Object typical

Development of SCDs are made up of the following main steps:

1) establish process schematic and identify all control objects;
2) describe the process and control objectives;
3) define applicable function templates;
4) develop basic interlocking strategies based on an overall interlocking hierarchy/philosophy;
5) develop automatic control strategies, e.g. package start/stop, duty/standby, sequencing;
6) develop alarm strategies including automatic suppression of secondary alarms.

4.5 Alarm management

The templates defined in this PAS do contain some alarm management functionality as they through the definition of the concept of suppress prevent the alarm from being initiated.

Any project may select to separate the actual alarm from the action if they have separate additional functionality for alarm management. Even so they should maintain the function of suppress defined herein.

In this PAS alarms are divided in the classic categories action, warning and fault alarms, see 3.1. The new alarm management guides EEMUA 191, NAMUR NA102 and ANSI/ISA-18.2 all recommend that alarms should be prioritised. A priority-setting of an alarm should be possible to do independently of the alarm category. This PAS does not contain any recommendations for priorities of the different alarms.

It is not defined with this PAS any symbolic or notification to reflect the priority of each alarm. It is important to maintain the readability of the document and therefore is it not recommended to show these details on the SCD diagram. But if the project finds it beneficial to do so this PAS will not prevent it. In any case it is recommend to add such information on a separate and dedicated layer.

The term "alarm" is generally used throughout this specification of functionality in this PAS. This shall be understood as statuses that will be available for generating alarms if required by the alarm philosophy of the actual plant.

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Annex A
(normative)

System control diagram (SCD) function standard

A.1 Overview

A.1.1 General

This annex contains a collection of definitions, explanations and descriptions of function templates, the main building components for the SCD approach. It defines the functional templates and their terminal names.

In this PAS the defined logic functionality, with input terminals (receiving actions from other functions) and output terminals (initiating actions towards other functions) is called function templates. A template is brought in to use as a function block when a copy of the template is inserted into to the SAS software configuration as a tagged object and given parameter values and logical connections.

A.1.2 Compliance

There is no certification procedures defined for this PAS. It is up to each individual project to define whether it complies or not. There may be many reasons to not limit the function template or diagram produced to the content defined herein. It is permitted to reject terminals or introduce additional terminals on the templates to meet special requirements. However, the terminals that are included from this annex shall have the same functionality as described. This allows for SAS suppliers to include for additional functionality specific to their system.

It is strongly recommended that the function templates are tested thoroughly upon completion and prior to use in any project. It is assumed that the tests will follow SAS suppliers well defined test and quality control procedure.

A.1.3 Positive logic

Only positive logic shall be used. This implies that a defined state of terminal is true when it is logical equal to "1", e.g. are as follows:

- for terminal ALL on MA "1" means value lower than the limit;
- for terminal Y on SBV "1" means open command;
- for terminal LSL on SBE "1" means function template set to safeguarding low state.

The positive logic shall always be applied for function terminals i.e. there shall be no parameters to invert the signals inside the functions which negate the terminal meaning.

An exception is made for input X on MB where an inverter is added to make it possible to adapt to normally energised or non-energised input signal.

A.1.4 Execution sequence of logic

The SCDs do not specify the sequence of execution. This must be defined during implementation in SAS system.

A.1.5 Functions used in SIF

Safety application development should comply with IEC 61508/Norsk olje og gass 070.

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For these applications the function template development has to obtain SIL approval. The different vendors will have different implementations. This PAS does not define the SIL specific requirements to the implementation.

For safety functions documented by SCD the NORSOK function templates shall be used.

OLF 070 specifies that any blocking and suppress shall be removed when required by a common operation, to ensure SIL requirement is met. This functionality will not be shown on SCDs.

A.1.6 HMI presentation

For each function template there are listed a set of elements under the heading operator station in the function template schematic. This shall be regarded as a minimum requirement to the HMI symbol/faceplate for that specific function template. How this information is structured between the function template and the HMI is not the scope of this PAS.

When the term "alarm" is used in the description of the function it is meant as the possibility to generate an alarm on the actual information. It will be up to each plant alarm philosophy to define what to alarm to the operator.

A.2 Terminal codes

A.2.1 General

Each function has defined input and output signals. Input denoted with X is acting on the output Y and/or on operator presentation as described by the main function tag.

The general syntax for terminals code is as follows: NNNN (max 4 characters).

The codes are established from the following table. If numbers are used in the code, it shall always be considered to be a modifier to the proceeding letter (letter + number = one code).

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Table A.1 – Terminal codes identification letters

Letter	1.Character	Succeeding characters
A	Action alarm	Auto mode
B	Binary status	Blocked mode
C		Confirmed
D		Disabled transition mode
E		Enabled status
F	Force command	Fault/Failed/Forward
G		Position
H		High
I		Internal set point mode
J		Not used
K		Not used
L	Lock command	Low
M		Manual mode
N		Hold
O		Outside mode
P	Parameter	Reserved as start letter for parameter naming if required.
Q		Quantity
R	Reset command	Reference signal
S	Set command	Safeguarding mode
T		Track mode
U		Suppressed mode
V		Variance/Deviation
W	Warning alarm	Warning alarm
X	External input	Multifunction see terminal description.
Y	Normal function output	Not used
Z		Not used

A.2.2 Signal types (1.Character)

A.2.2.1 Inputs

X = normal function input (related to main function of template)

A.2.2.2 Commands

S = set

R = reset

F = force

L = lock

A.2.2.3 Outputs

Y = normal function output (related to main function of element)

A = action alarm

W = warning alarm

B = binary status

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A.2.2.4 Special characters

= User defined (to be shown on SCDs). Could be used as 1st letter on a pin not in accordance with this PAS.

NOTE Some SAS systems may not support this special character.

A.2.3 Explanatory code (succeeding characters)

A.2.3.1 Modes

A = auto mode

B = blocked mode

D = disabled transition mode

I = internal set point mode

M = manual mode

O = outside mode (locally – field – operated)

S = safeguarding mode

T = track mode

U = suppressed mode

X = multifunction see terminal description external set

A.2.3.2 Signal identifiers

C = confirmed

E = enabled status

F = Fault/Failed

G = position

Q = quantity

R = reference

S = safeguarding

W = warning

X = external

A.2.3.3 Sub functions

H = high

HH = high high

L = low

LL = low low

V = variance/deviation

A.2.4 Terminal description for function templates

Index of normative terminal codes used in this annex are described in Table A.2. New terminal codes shall be created according to A.2.2.

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Table A.2 – Terminal codes

Terminal code	Signal type	Terminal name	Supplementary description
AHH	binary output	Action alarm high-high	True, when X-value >AHH limit.
ALL	binary output	Action alarm low-low	True, when X-value <ALL limit.
BA	binary output	Status auto/man. mode	True: auto, false: manual.
BB	binary output	Status blocked mode	The function is in blocked mode (no action output). I.e. all safeguarding signals are blocked.
BBHH	binary output	Action alarm high-high is blocked	True if FBHH or OS blocking is active.
BBLL	binary output	Action alarm low-low is blocked	True if FBLL or OS blocking is active.
BCH	binary output	Output position high confirmed	Output Y compared to feedback position high from MCC or limit switch and validated as true.
BCL	binary output	Output position low confirmed	Output Y compared to feedback position low from MCC or limit switch and validated as true.
BCQ	Analogue output	Number of SBEs running	The amount of confirmed running SBE units.
BE	Binary output	Status enable mode	BE = 1 if XE = 1
BGT	binary output	Status test mode	Status breaker in test position
BH	binary output	Output high confirmed	BH = 1 if sequence is running, BH = 1 also when sequence in hold.
BHH	binary output	Status alarm high-high	Status Alarm annunciation (HH) unaffected by blocking
BLL	binary output	Status alarm low-low	Status Alarm annunciation (LL) unaffected by blocking
BL	binary output	Status sequence ended	BL = 1 if the sequence is completed normally (see functional description)
BN	binary output	Status hold	BN = 1 if sequence is held by operator
BO	binary output	Status outside mode	The control function is in outside mode
BS	binary output	Status safeguarding mode	A safeguarding signal of the process function is true
BT	binary output	Status tracking mode	In tracking mode as long as signal is true. Ex. Set point tracking.
BU	binary output	Status suppressed mode	True if the template is in suppressed mode (any process output function is suppressed).
BX	binary output	Status external mode or function input	True: external, false: internal or image of input.
BXH	binary output	Status event high	True, when X-value > Event high limit. No alarm annunciation, event only.
BXHH	binary output	Status event high-high	True, when X-value > Event high-high limit. No alarm annunciation, event only.
BXL	binary output	Status event low	True, when X-value < Event low limit. No alarm annunciation, event only.
BXLL	binary output	Status event low-low	True, when X-value < Event low-low limit. No alarm annunciation, event only.
FB	binary input	Force blocked mode	Logic input: alarm action is blocked as long as input signal is true.
FBHH	binary input	Force blocked for alarm high-high	Logic input: AHH action is blocked as long as input signal is true.
FBLL	binary input	Force blocked for alarm low-low.	Logic input: ALL action is blocked as long as input signal is true.
FDH	binary input	Force disable transition high.	Prevents element to be started / opened / connected when true. Subject to blocking.

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Terminal code	Signal type	Terminal name	Supplementary description
FDL	binary input	Force disable transition low.	Prevents element to be stopped / closed / disconnected when true. Subject to blocking.
FN	binary input	Force hold	FN = 1 will temporarily hold the sequence in the current step.
FQ	binary input	Force totalizing	Totalizing as long as true.
FSH	binary input	Force safeguarding high	Safeguarding – Signal overrules operator inputs (forcing the template Y-output high). After signal returns to normal, template will react to actual terminal status again. Signal is subject to blocking. If in Manual mode the output remains high after signal returns to normal.
FSL	binary input	Force safeguarding low	Safeguarding – Signal overrules operator inputs (forcing the template Y-output low). After signal returns to normal, template will react to actual terminal status again. Signal is subject to blocking. If in Manual mode the output remains low after signal returns to normal.
FT	binary input	Force track mode	Track signal: XT-value
FU	binary input	Force suppression mode.	For input objects the alarm action and alarm annunciation is suppressed. For output objects the feedback will be neglected and hence alarm annunciation suppressed.
FUHH	binary input	Force suppression mode for alarm high-high.	Logic input: alarm HH action and annunciation is suppressed as long as input true.
FULL	binary input	Force suppression mode for alarm low-low.	Logic input: alarm LL action and annunciation is suppressed as long as input true.
FUWH	binary input	Force suppression mode for alarm WH	Logic input: alarm WH annunciation is suppressed as long as input true.
FUWL	binary input	Force suppression mode for alarm WL	Logic input: alarm WL annunciation is suppressed as long as input true.
LA	binary input	Lock auto mode.	Locks the control function to auto mode, overruling the operator. After signal disappears, template keeps in auto mode.
LI	binary input	Lock internal set point mode.	Locks the control function to internal mode, overruling the operator. After signal disappears the logic keeps in internal set point operation mode.
LM	binary input	Lock manual mode.	Locks the control function to manual mode, overruling the operator. After signal disappears the logic keeps in manual mode.
LO	binary input	Lock outside operation mode.	Locks the control function to outside system operation mode, overruling the operator. After signal disappears the logic keeps in manual mode.
LSH	binary input	Lock safeguarding high.	Safeguarding – signal overrules operator inputs (locking the template to manual mode with Y-output to high -open valve-). Input is subject to blocking. After signals disappear the template remains in manual mode and the output high.
LSL	binary input	Lock safeguarding low.	Safeguarding – signal overrules operator inputs (locking the template to manual mode with Y-output to low -stop motor-). Input is subject to blocking. After signals disappear the template remains in manual mode and the output low.
LX	binary input	Lock external set point mode.	Locks the logic function to external mode, overruling the operator. After signal disappears template keeps in external set point operation mode.

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Terminal code	Signal type	Terminal name	Supplementary description
RX	binary input	Reset logic function	Reset latched logic output or safeguarding.
RXQ	binary input	Reset external totalizer	Logic signal to reset.
WH	binary output	Warning alarm – high	True, when X-value >WH limit. This output should not be used for downstream logic. Subject to suppression.
WL	binary output	Warning alarm – low	True, when X-value <WL limit. This output should not be used for downstream logic. Subject to suppression.
WV	binary output	Warning deviation	
X	binary/analogue input	External function input	Binary or analogue input signal from process or logic.
X1-X4	binary/analogue input	External function input 1 to 4	Binary or analogue input signal from process or logic.
X4H	binary input	Call for minimum 4	If = 1, then at least 4 SBE shall run.
X3H	binary input	Call for minimum 3	If = 1, then at least 3 SBE shall run.
X2H	binary input	Call for minimum 2	If = 1, then at least 2 SBE shall run.
X1H	binary input	Call for minimum 1	If = 1, then at least 1 SBE shall run.
X3L	binary input	Call for maximum 3	If = 1, then a maximum of 3 SBE shall run.
X2L	binary input	Call for maximum 2	If = 1, then a maximum of 2 SBE shall run.
X1L	binary input	Call for maximum 1	If = 1, then a maximum of 1 SBE shall run.
XAHH	binary input	External alarm HH	Subsystem input: alarm HH is set as long as this signal is true.
XALL	binary input	External alarm LL	Subsystem input: alarm LL is set as long as this signal is true.
XE	binary input	Function externally enabled	Electrical available used for electr. equipm. only.
XEQ	binary input	External enable totalizing	Input to logic enable/disable totalizing.
XF	binary input	External fault	Fault status received from template external source. Loop failure, i.e. input card broken.
XFF	analogue input	Feed forward	Signal representing a disturbance which is converted into a corrective action to minimize deviations of controlled variable. The feed forward function is only active when the controller is in auto mode.
XFX	binary input	Link fault	There is a communication link fault.
XG	analogue input	Position read as measured value	Position read as measured value.
XGH	binary input	Position high feedback	Signal from MCC (running) or limit switch high.
XGL	binary input	Position low feedback	Signal from MCC (stopped) or limit switch low.
XGX	binary input	Breaker test position	Breaker truck in test position.
XGZ	binary input	External earthed	Breaker is earthed and connect command shall not be performed.
XH	binary input	External set high	From logic or process to control template, i.e. valve/ damper in auto mode. Set high signal (open valve) only.
XWH	binary input	External warning alarm WH	Subsystem input: warning alarm WH is set as long as this signal is true.
XWL	binary input	External warning alarm WL	Subsystem input: warning alarm WL is set as long as this signal is true.
XL	binary input	External set low	From logic or process to control template. , i.e. valve/ damper in auto mode. Set low signal (close valve) only.

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Terminal code	Signal type	Terminal name	Supplementary description
XOH	binary input (positive edge)	External outside set high	From process to control template, i. i.e. valve/damper in outside mode. Set high signal (positive edge) to open valve.
XOL	binary input (positive edge)	External outside set low	From process to control template, i.e. valve/damper in outside mode. Set low signal (positive edge) to close valve.
XP	binary input	Rotate priority.	Signal goes high will execute the rotate priority function.
XQ	Analogue input	Number of requested SBE's to run	In auto. The amount of requested running SBE units. Value.
XQHH	analogue input	Limit value of XHH	Subsystem input: the value in engineering units of the HH limit used by the subsystem.
XQH	analogue input	Limit value of XWH	Subsystem input: the value in engineering units of the WH limit used by the subsystem.
XQL	analogue input	Limit value of XWL	Subsystem input: the value in engineering units of the WL limit used by the subsystem.
XQLL	analogue input	Limit value of XLL	Subsystem input: the value in engineering units of the LL limit used by the subsystem.
XR	analogue input	External set point value	Used in external – auto – mode.
XS	binary input	External safeguarding	Safeguarding signal from other shutdown level.
XT	binary output	Tracking value	Used in tracking mode.
Y (Y1,Y2)	analogue/ binary output	Normal function output	Output value / status that can be used in downstream logic
YF	binary output	Function failed.	YF = 1 if XF = 1 or if an internal error has been detected by the template.
YH	binary output pulsed	Pulsed normal function output high	Pulse open/start command. YH = 1 (one pulse).
YL	binary output pulsed	Pulsed normal function output low	Pulse close/stop command. YL = 1 (one pulse).
YG	analogue output	Output of valve position	Position of the valve-for use in downstream logic.
YQ	Analogue output	Number of requested SBE's to run	The current amount of requested running SBE units.
YR	analogue output	Reference set point value.	Actual setpoint for use in downstream logic.
YX	analogue/binary output	Function output	Binary or analogue output signal from function template.

A.3 SCD control function template behaviour

For a complementary specification and better visualization of the control function behaviour, see Annex F.

A.4 Function templates

A.4.1 General

Function templates shall contain all necessary functions concerning an object with its interfaces towards the process, other function templates or logic and operator station. An object is considered to be a physical instrument, an equipment with its measurements or a control function

All function templates in this specification are related to one object (one function symbol on the SCD). It is a requirement for a function template that it covers a complete function that

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can be represented by one symbol with its in- and out-puts to process, operator station and other logic. The templates shall be presented in any "logic view", printed or electronically as one single symbol. The interconnections between the function templates shall be recognizable within the automation system. Thus, a function template can be said to represent an object as defined above, on the SCD.

The SCDs represent a graphical documentation of the application software. The SCDs are the interface for process related users (e.g. process engineers, operators, etc.) and more instrumentation related users, e.g. instrument engineers, automation engineers, etc.

The SCDs are a precise specification for the control system application and should be available on an electronic format allowing extraction of its detailed data for function blocks, connections etc. These data extracted from the SCDs, could be used to automatically generate the initial part of the control system configuration, in order to improve the quality and efficiency related to the control system configuration work.

Additionally the SCDs can serve as a fault finding and debugging tool. The unified way of configuring with function templates assures consistency in operation, alarm handling and indication of variables on the operator stations over the whole plant. The SCDs shall have a function oriented approach towards the operator.

A.4.2 Function template name convention

A.4.2.1 General

Function templates shall be given a name (abbreviation) compound by minimum two-characters, identifying the main function of the software item.

The name syntax should be: < Primary function> [by means of < Control type>] of < Device>

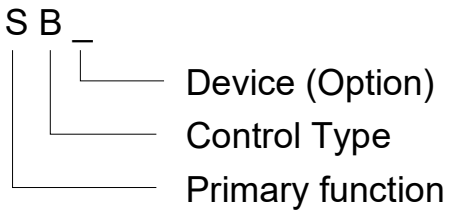

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Table A.3 – Function template letter identification

Letter	1.Character (Primary function)	2.Character (Control type)	Succeeding characters (Device (optional use, if required))
A		Analogue (function)	
B		Binary (function)	Breaker
C	Continuous control		Coordination
D			
E			Electrically motor/heaters
F			
G			
H	Hand		
I			
J			
K	Sequencing		
L	Latching		
M	Monitoring		
N			
O	Output		
P			
Q	Totalize		
R			
S	Switching control	Step (automatic function)	Serial communicated
T			
U			
V			Valve/dampers
W			
X			
Y			
Z			
#	Optional [1)]		

[1)] Identifies supplier/project specific function which is not in accordance with this PAS.

A.4.2.2 Primary function

C – continuous control

H – hand

K – sequencing

L – latching

M – monitoring

O – output

S – switching control

Q – totalize

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A.4.2.3 Control type

A – analogue (automatic function)

B – binary (automatic function)

S – step (automatic function)

A.4.2.4 Device (optional use, if required)

B – Breaker

C – coordination

E – electrically motor/heaters (MCC)

S – Serial communication

V – valve/dampers

A.4.2.5 Special character

– this character is optional to use. It is recommended to use it to identify that the function is not in accordance with this PAS. It shall be shown on SCDs as 1.letter in template identification code.

NOTE Some SAS systems may not support this special character.

A.4.2.6 List of function templates

Table A.4 – List of function templates described in this annex

Primary function	Control type	Device	Description
C	A		Continuous control by means analogue control action.
C	S		Continuous control by means step control action.
H	A		Hand entering of an analogue value
H	B		Hand entering of a binary value
K	B		Sequence (K) control by means of collecting binary statuses
L	B		Latching of Binary signal, i.e. PSD level block.
M	A		Monitoring of analogue process value.
M	A	S	Monitoring of analogue process value and serial communicated alarm limits
M	B		Monitoring of binary process value.
O	A		Output of analogue signal
Q	A		Totalizing (quantum) of analogue process value.
S	B		Switching control be means of binary signal for shutdown.
S	B	B	Breaker control by means of binary control action of an electrical breaker
S	B	C	Switching control by means of a binary action and coordination control of multiple electrical power devices
S	B	E	Switching control by means of a binary control action of electrical power devices.
S	B	V	Switching control by means of a binary control action of H/P power devices, e.g. valves.

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A.4.2.7 Template description

The templates descriptions included in this annex will have following chapters:

A.x.x	XX – Annex A function template paragraph number
A.x.x.1	Intended use
A.x.x.2	Technical description
A.x.x.2.1	Functional template schematic
A.x.x.2.2	I/O terminals
A.x.x.2.3	Template parameters with default values
A.x.x.3	Functional description
A.x.x.3.1	General
A.x.x.3.2	Operation modes
A.x.x.3.3	Control requirements
A.x.x.3.4	Safeguarding
A.x.x.3.5	Error handling

A.4.2.8 Function template schematic – content

A.x.x.2.1 "Functional template schematic" contains a schematic illustration of the template with input and output terminals respectively on left and right side of the square symbolising the template.

The terminals are listed under following headings:

Inputs/Outputs: The terminals listed under these headings are normally those used to connect in from and out to field instrumentation and to other function templates. (logic).

Operator stations: Here the information is listed without terminals, because they will not be connected on the SCD diagram. How this information is communicated to the HMI is not defined by this PAS. The information is regarded as required by the operator to be able to operate the object in a safe manner.

Logic:

	AA		
Inputs			Outputs
Aaaaa aaaaa aaaaa	AAA	AAA	Aaaaa aaaaa aaaaa
Aaaaa aaaaa aaaaa	AAA	AAA	Aaaaa aaaaa aaaaa
Aaaaa aaaaa aaaaa	AAA	AAA	Aaaaa aaaaa aaaaa
Aaaaa aaaaa aaaaa			Aaaaa aaaaa aaaaa
Aaaaa aaaaa aaaaa			Aaaaa aaaaa aaaaa
Aaaaa aaaaa aaaaa			Aaaaa aaaaa aaaaa
Operator station:			Operator station:
Aaaaa aaaaa aaaaa	AAA	AAA	Aaaaa aaaaa aaaaa
Aaaaa aaaaa aaaaa	AAA	AAA	Aaaaa aaaaa aaaaa
Aaaaa aaaaa aaaaa	AAA	AAA	Aaaaa aaaaa aaaaa

Figure A.1 – Typical function template schematic

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A.4.3 CA – PID controller

A.4.3.1 Intended use

The CA function template shall be used for continuous control, i.e. proportional, integral and derivative control (PID control).

A.4.3.2 Technical description

A.4.3.2.1 Function template schematic

Inputs	CA		Outputs
Normal function input	X	Y	Normal function output
External fault	XF	YF	Function failed
External setpoint value	XR	YR	Reference setpoint value
External tracking value	XT	YX	Measured value output
Position low feedback	XGL	BCL	Output position low confirmed
Position high feedback	XGH	BCH	Output position high confirmed
Feed forward	XFF	BS	Status safeguarding
Lock safeguarding high	LSH	BB	Status blocked
Lock safeguarding low	LSL	BU	Status suppressed
Force safeguarding high	FSH	BA	Status auto/man
Force safeguarding low	FSL	BX	Status external/internal
Force tracking	FT	BT	Status tracking
Force blocking	FB	WV	Deviation warning[2)]
Force suppression	FU	WH	Warning alarm H[2)]
Lock auto	LA	WL	Warning alarm L[2)]
Lock manual	LM		
Lock external setpoint	LX		
Lock internal setpoint	LI		
Operator station:			Operator station:
Auto/Manual			Alarms and faults
Internal/External			Closed
Internal setpoint			Auto/Manual
Set output value			Internal/External
Blocking on/off			Tracking
Suppression on/off			Blocked
			Suppressed
			Safeguarding
			Conflict

[2)] Shall not be used for downstream logic, see 3.1.

Figure A.2 – CA function template schematic

A.4.3.2.2 I/O terminals

Input terminals

Terminal code	Signal type	Terminal name	Supplementary description
X	Analogue input	Normal function input	Analogue input signal representing the process value to be controlled.
XF	Binary input	External fault	Fault indication from outside the template.
XR	Analogue input	External setpoint value	The external setpoint value to be used when the controller is in auto and external mode, e.g. the setpoint used if this controller is part of a cascade control.

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Terminal code	Signal type	Terminal name	Supplementary description
XT	Analogue input	External tracking value	The output value Y equals the input value XT, when the controller is in auto and tracking mode.
XGL	Binary input	Position low feedback	Signal from limit switch low (optional). XGL = 1 is closed flow element. Enabling the closed limit switch shall be defined by a parameter.
XGH	Binary input	Position high feedback	Signal from limit switch high (optional). XGH = 1 is open flow element. Enabling the open limit switch shall be defined by a parameter.
XFF	Analogue input	Feed forward	Signal representing a disturbance which is converted into a corrective action to minimize deviations of controlled variable. The feed forward function is only active when the controller is in auto mode.
LSH	Binary input	Lock safeguarding high.	Safeguarding – LSH = 1. Overrules operator possibility to set Auto/Manual mode. Locks template in manual mode, and Y goes to highest output value regardless of failure state. Input is subject to blocking. When signal goes low, the template remains in manual mode and Y remains unchanged.
LSL	Binary input	Lock safeguarding low.	Safeguarding – LSL = 1 Overrules operator possibility to set Auto/Manual mode. Locks template to manual mode and Y to lowest output value regardless of failure state. Input is subject to blocking. When signal goes low, the template remains in manual mode and Y remains unchanged.
FSH	Binary input	Force safeguarding high	Safeguarding – FSH = 1. Sets Y to highest output value regardless of failure state. When signal is reset, the template will react to actual terminal statuses again if in auto mode. In manual mode, the output (Y) remains unchanged after signal returns to normal. Signal is subject to blocking.
FSL	Binary input	Force safeguarding low	Safeguarding – FSL = 1. Sets Y to lowest output value regardless of failure state. When signal is reset, the template will react to actual terminal statuses again if in auto mode. In manual mode, the output (Y) remains unchanged after signal returns to normal. Signal is subject to blocking.
FT	Binary input	Force tracking	The object is forced to tracking mode when FT = 1, and the Y output starts tracking the XT input if in auto mode.
FB	Binary input	Force blocking	FB = 1. Safeguarding actions LSH, LSL, FSH and FSL will be blocked.
FU	Binary input	Force suppression	Alarm annunciation is suppressed, WH,WL,WV, YF = 0 and statuses XF, XGL and XGH are neglected as long as FU = 1.
LA	Binary input	Lock Auto	LA = 1. Locks the template in auto mode. When LA is reset, the template remains in auto mode.
LM	Binary input	Lock Manual	LM = 1. Locks the template in manual mode. When LM is reset, the template remains in manual mode. LM has higher priority than LA.
LX	Binary input	Lock external setpoint	Locks the control function template to use external setpoint, overruling the operator. When LX is reset, the object remains in external mode.
LI	Binary input	Lock internal setpoint	Locks the control function template to use internal setpoint, overruling the operator. When LI is reset, the object remains in internal mode. LI has higher priority than LX.

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Output terminals

Terminal code	Signal type	Terminal name	Supplementary description
Y	Analogue output	Normal function output	Control signal to flow element. Y is normally 0 % to 100 %, e.g. for a valve, 0 % is fully closed and 100 % is fully opened, independent of the valve's fail open/close setting.
YF	Binary output	Function failed	YF = 1 if external or function fault. See error handling.
YR	Analogue output	Reference setpoint value	Actual setpoint being used.
YX	Analogue output	Measured value output	The controller measurement value. The YX is normally equal to X, except if the signal is faulty. If the signal is faulty, YX is set to a predefined value.
WV	Binary output	Deviation alarm (warning)	The absolute difference between the measured value X and the used setpoint is above a predefined limit for a predefined time. The deviation warning is enabled only when the controller is in auto internal or auto external. WV is disabled by alarm suppression.
BCL	Binary output	Output position low confirmed	If the closed limit switch is enabled, the output Y is compared to the low limit switch feedback and validated as true (BCL = 1) if Y within "limit confirmed state closed" and XGL = 1. If the closed limit switch is disabled, BCL = 1 when Y is within "limit confirmed state closed".
BCH	Binary output	Output position high confirmed	If the open limit switch is enabled, the output Y is compared to the high limit switch feedback and validated as true (BCH = 1) if Y within "limit confirmed state opened" and XGH = 1. If the open limit switch is disabled, BCH = 1 when Y is within "limit confirmed state opened".
BS	Binary output	Status safeguarding	BS = 1 if any safeguarding input is active.
BB	Binary output	Status blocked	BB = 1 when the template is blocked from operator station or FB = 1.
BU	Binary output	Status suppressed	BU = 1 when suppressed from operator station or FU = 1.
BA	Binary output	Status auto/man	BA = 1 when auto mode is set from operator station or LA = 1.
BX	Binary output	Status internal / external	BX = 1 when set in external mode from operator station or LX = 1.
BT	Binary output	Status tracking	BT = 1 when FT = 1 and in auto mode.
WH	Binary output	Warning alarm H	True, when X[3)]-value >WH limit. Subjected to suppression. Should not be used for downstream logic.
WL	Binary output	Warning alarm L	True, when X[3)]-value <WL limit. Subjected to suppression. Should not be used for downstream logic.

[3)] The X value used for comparison with the alarm limit shall be given in measurement unit (%, barg, bara, Kg/h, mm, etc)

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A.4.3.2.3 Template parameters with default values

Parameters

Parameter code	Signal type	Parameter name	Supplementary description	Default
1)	Enum	Position feedback configuration	0: No feedback 1: Only XGL 2. Only XGH 3. Both XGL and XGH	
1)	Analogue	Deviation limit	Deviation alarm limit between the measured value X and the used setpoint YR.	5 %
1)	Analogue	Time delay deviation alarm	Delay of deviation alarm between X and YR.	5 s
1)	Analogue	Limit confirmed state closed	When XGL is configured, XGL is used for closed state monitoring. When no closed limit switch is configured: Closed state is calculated by comparing to the operating range. The % value is calculated in relation to the full range, e.g. if the full range is 0 % to 100 % and the confirmed limit state is set to 2 %, confirmed closed limit is 2 % or less.	2 %
1)	Analogue	Limit confirmed state opened	When XGH is configured, XGH is used for open state monitoring. When no limit switch is configured: Open state is calculated by comparing to the operating range. The % value is calculated in relation to the full range, e.g. if the full range is 0 % to 100 % and the confirmed limit open state is set to 98 %, confirmed open limit is 98 % or higher.	98 %
1)	Analogue	WH limit	Alarm limit for WH	-
1)	Analogue	WL limit	Alarm limit for WL	-
1)	Analogue	Time delay warning alarms	Delay before alarm is raised after limit has been reached.	0
1)	Analogue	Hysteresis value	The hysteresis should be defined in % of display range. The hysteresis shall only affect the return of alarms and events, not initiation. Common for all limits.	2 %
1)	Analogue	Minimum range input	Minimum range value in. (Display range)	-
1)	Analogue	Maximum range input	Maximum range value in. (Display range)	-
1)	Analogue	Minimum setpoint range	Minimum allowed setpoint value. This value is greater or equal to minimum range in.	-
1)	Analogue	Maximum setpoint range	Maximum allowed setpoint value. This value is less or equal to maximum range in.	-
1)	Analogue	Minimum range output	Minimum range value out.	0
1)	Analogue	Maximum range output	Maximum range value out.	100
1)	Analogue	Minimum operating range	Minimum allowed output value. This value is greater or equal to minimum range out.	0
1)	Analogue	Max. operating range	Maximum allowed output value. This value is less or equal to maximum range out.	100
1)	Binary input	Limitation by operating range in Manual mode	0 = No limit for manual. 1 = Manual output limited by operating range.	
1)	Analogue	Ext-P	Proportional parameter in PID algorithm from external source.	-

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Parameter code	Signal type	Parameter name	Supplementary description	Default
1)	Analogue	Ext-I	Integral time in PID algorithm from external source.	-
1)	Analogue	Ext-D	Derivate time in PID algorithm from external source.	-
1)	Binary	Enable ext PID parameters	0 = use internal parameters 1 = use external parameters	0
1)	Analogue	P	Proportional parameter in PID algorithm.	1.0
1)	Analogue	I	Integral time in PID algorithm.	0 s
1)	Analogue	D	Derivate time in PID algorithm.	0 s
1)	Analogue	KFF	Proportional parameter in feed forward algorithm.	0.0
1)	Binary	Control direction	0: The controller is direct acting, i.e. increased input compared to setpoint shall cause increased output. 1: The controller is reverse acting, i.e. increased input compared to setpoint shall cause decreased output.	1
1)	Analogue	Ramp setpoint up/down	Ramp time when switching between different modes, e.g. manual to auto internal. Engineering units/sec (value 0 disables function)	0
1)	Analogue	Ramp output up/down	Ramp time when switching between different modes, e.g. into output tracking. %/s (value 0 disables function)	0
1)	Binary	Fault options	For external fault, output Y options 0: Freeze (to manual and keep last value) 1: Output Y is set to substitute value.	0
1)	Binary	Restart options	0: Enter manual mode and substitute value 1: Enter auto mode	0
1)	Analogue	Substitute value	If substitute value option is selected for external fault or restart, the output Y is set to defined substitute value.	0
1)	Binary	X outside range	Reaction if X outside range see error handling 0: Function disabled 1: Function enabled	0
1)	Analogue	Travel time	Time value defining full travelling time in sec.	10 s
1) Parameter code to be defined if used on a terminal. It shall then start with the letter P.				

A.4.3.3 Functional description

A.4.3.3.1 General

The CA function template shall be used for continuous control of e.g control valves, variable speed drive motors and thyristor heaters.

The function template may act e.g. as a P,PI,PD or PID controller.

The controller can be operated in either manual or auto mode. In manual mode the PID algorithm is not active and the output is set manually from the template. In auto mode the PID algorithm is active. The setpoint used in the PID algorithm is either the internal or external setpoint, depending on the internal/external setting of the template.

The controller can be switched to output tracking mode by input FT. The output value Y will then be clamped to the input XT.

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The feed forward function may be incorporated according to system vendor standards, but shall as a minimum include a proportional factor that is multiplied with the feed forward signal and added to the output signal.

The controller shall be parameterised as either direct or reverse acting.

All limit checking and alarm annunciation resides within the template.

The template includes safeguarding, together with suppress and blocking functions.

See Figure F.19 for complementary function behaviour description of the CA template.

A.4.3.3.2 Operation modes

Modes functions

Function	Description
Auto	In auto mode the CA template calculates the control signal using the PID control algorithm. The setpoint used in this calculation may be either internal or external. The auto mode may be set by the operator or by logic. It shall be possible to enable auto mode even if the template is in force safeguarding mode (FSL,FSH) or in fault state (YF = 1). Auto mode does not necessarily indicate that the control algorithm is running, if e.g. the template is in force safeguarding mode, tracking mode or in a fault state. The auto mode works in combination with internal, external and tracking mode. When in auto mode, the BA output is set.
Manual	In manual mode the output control signal (Y) is set by the operator, unless forced by safeguarding. The PID control algorithm is disabled.
Internal	Internal mode has only effect in auto mode. The PID control algorithm uses the value set by the operator as setpoint. The internal mode shall be possible to enable when the template is in manual/auto mode, safeguarding mode or in a fault state.
External	External mode has only effect in auto mode. The PID control algorithm uses the value from XR as setpoint. The external mode shall be possible to enable when the template is in manual/auto mode, safeguarding mode or in a fault state.
Tracking	Tracking mode has only effect in auto mode. The controller output Y is equal to the XT input. Switching in and out of tracking should be bumpless. The tracking mode shall be possible to set at any time.
Feed forward	The feed forward function shall as a minimum include a proportional factor that is multiplied with the feed forward signal (XFF) and added to the output value.
Block	Blocking disables safeguarding mode (LSH/LSL/ FSH/FSL).
Suppression	Suppresses YF, WV, WH and WL, and sets these outputs to 0. Position feedback XGL and XGH are disregarded, and the control template will use output Y to calculate closed and/or open position.

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A.4.3.3.3 Control requirements

Control functions

Function	Description
Set point	Setpoint definition: Operator setpoint: value available for operator manipulation Stored setpoint: operator setpoint stored in specific mode changes (defined below) External setpoint: value equal to XR Actual setpoint: value used by PID algorithm (one of the above) The operator setpoint is: In auto mode: set by operator In manual mode: equal to X (setpoint tracking) Set to stored setpoint when switching from manual to auto internal by logic (LA). Set to stored setpoint when switching from auto external to auto internal by logic (LI). The last setpoint used is stored and displayed as the stored setpoint when: – switching from auto internal to manual, – switching from auto internal to auto external. – switching from auto internal to tracking mode. The actual setpoint is: In manual mode: equal to X In auto internal mode: equal to operator setpoint In auto external mode: equal to XR In tracking mode: not affected Actual setpoint transitions are subject to bumpless transfer.
Algorithm	The flow element (e.g. valve, VSD motor, etc.) is operated by an analogue output signal. Possibility for direct or reverse control action. There shall be anti-windup protection. Controller deviation dead band shall be available. Remote setting of K, Td and Ti parameters shall be possible.
Bumpless	There shall be bumpless switching of actual setpoint between operation modes. There shall be bumpless transfer of operator setpoint changes. The setpoint shall be clamped to the measured value in manual mode to assure a bumpless transfer from manual to automatic mode (the setpoint tracks the measured value while the controller is in manual mode). When the controller is forced to auto by logic, the setpoint shall automatically be ramped back to the stored setpoint value. When the controller is switched to auto by the operator, the operator can manually adjust the set point and ramp it back to the stored setpoint value to accomplish a bumpless transfer to that value.
Cascade	There shall be a synchronization functionality between master and slave controllers to secure controlled interaction. This function is not shown on the SCD.
Restart	After restart of the controller node, the function template will be set to a predefined state selected by "Restart options" parameter.

A.4.3.3.4 Safeguarding

Safeguarding functions

Function	Description
Lock	Set the output to safeguarding position and sets the function template to manual mode
Force	Set the output to safeguarding position, but the mode of function template is not changed
Conflict	True if any safeguarding action is requested when the template is in blocked state. It shall be possible to generate an alarm on this event. If any safeguarding action is enabled and the object is blocked

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A.4.3.3.5 Error handling

Error functions

Function	Description
External fault	XF = 1[4]: Shall be possible to generate alarm and set YF = 1. The template will enter manual mode. The output Y will be either substitute value or freeze value (depending on parameter).
Function fault	Feedbacks XGL and XGH can be monitored and compared with the output value. If a mismatch is detected, it shall be possible to generate an alarm and set YF = 1. When Y > "Limit confirmed state % closed" and XGL = 1 delayed by a predefined "travel time". When Y < "Limit confirmed state % open" and XGH = 1 delayed by a predefined "travel time". It shall be possible to disable this function.
Setpoint limits	High and low setpoint limits shall be available. Manual input, which exceeds these limits, shall not be used. The operator shall retype a value. Where it is not desirable to allow switching a controller to external setpoint with setpoint outside these limits, it shall be possible to generate an alarm and prevent the controller to be set in external modus. External input, which exceeds these limits, clamp to threshold value. Shall be possible to generate an alarm.
Warning deviation	WV = 1. Shall have the possibility to generate warning when measured value passes defined deviation alarm parameter.
X outside range[4]	Shall be possible to generate alarm and set YF = 1. The template will enter manual mode. The output Y will be either substitute value or freeze value (depending on parameter). It shall be possible to disable this function.
[4] Signal quality may be transferred as system internal information.	

A.4.4 CS – Step control

A.4.4.1 Intended use

The CS function template shall be used for control and monitoring of position controlled valves. The valves are operated by either pulsed or steady output signals. One output for opening and one for closing the valve.

For subsea choke valves it is expected to be requirement for adaption.

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A.4.4.2 Technical description

A.4.4.2.1 Functional block schematic

Inputs	CS		Outputs
Position reading	XG	YH	Normal function output high
External fault	XF	YL	Normal function output low
External setpoint value	XR	YF	Function failed
Position low feedback	XGL	YG	Output valve position
Lock safeguarding low	LSL	WV	Warning deviation
Force disable transition high	FDH	BCL	Output position low confirmed
Force blocking	FB	BS	Status safeguarding
Force suppression	FU	BB	Status blocked
Lock auto	LA	BU	Status suppressed
Lock manual	LM	BA	Status Auto/Man
Lock external setpoint	LX	BX	Status external/internal
Lock internal setpoint	LI		
			Operator station
Operator station			Alarms and faults
Auto/Manual			Open/Closed
Internal/External			Auto/Manual
Step open			Internal/External
Step close			Blocked
Setpoint			Suppressed
Blocking on/off			Safeguarding
Suppression on/off			Moving transition high
			Moving transition low
			Conflict

Figure A.3 – CS function template schematic

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