SYSTEM CONTROL DIAGRAMS
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FOREWORD

NORSOK (The competitive standing of the Norwegian offshore sector) is the industry initiative to add value, reduce cost and lead time and eliminate unnecessary activities in offshore field developments and operations.

The NORSOK standards are developed by the Norwegian petroleum industry as a part of the NORSOK initiative and supported by OLF (The Norwegian Oil Industry Association) and TBL (Federation of Norwegian Manufacturing Industries). NORSOK standards are administered and issued by NTS (Norwegian Technology Standards Institution).

The purpose of NORSOK standards is to contribute to meet the NORSOK goals, e.g. to develop standards that ensure adequate safety, value adding and cost effectiveness and thus are used in existing and future petroleum industry developments.

The NORSOK standards make extensive references to international standards. Where relevant, the contents of a NORSOK standard will be used to provide input to the international standardisation process. Subject to implementation into international standards, the NORSOK standard will be withdrawn.

Section 4.4 is informative.
Annexes A and B are normative.
Annexes C and D are informative.

INTRODUCTION

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 computerised systems and 3D modeling provide efficient tools for specifying and handling of physical equipment in a standardised 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 behavior. However, the P&IDs provide limited facilities for documentation of the overall functionality as well as operational aspects of the plant.

It’s the control system engineer’s task to design the control system so as to fulfil the process functionality required to achieve product specifications as well as the requirements imposed by the overall operating & 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 imagination of plant behavior 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 can not 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 System Control Diagram (SCD).

Work is ongoing on SCD Application Guidelines (Informative) and SCD Readers Manual (Informative), and will be included in later revisions of this standard.
1 SCOPE
This standard is intended to cover functional as well as drawing related requirements for use of System Control Diagrams.

The standard will also establish a general framework for implementation of the SCD Approach in terms of Project Execution Guidelines and Application Guidelines. The Project Execution Guidelines defines a strategy for project execution and is intended for project responsible engineers. The Application Guidelines provides a basis for application design and is intended for application engineers responsible for developing SCDs.

The Readers Manual will contain a simplified introduction for engineers and operators using SCDs for verification and documentation of control functionality.

The Functional Standard as well as the Drawing Standard shall be considered normative, while the other documents are informative only.

2 NORMATIVE REFERENCES
The following standards include provisions, which, through reference in this text, constitute provisions of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet or exceed the requirements of the standards referenced below.

NORSOK I-002 Safety and Automation Systems (SAS)
NORSOK L-003 Piping details
NORSOK Z-004 CAD Symbol Libraries
IEC 61131-1 Programmable controllers - Part 1: General information
IEC 61131-3 Programmable controllers - Part 3: Programming languages
ISO 3511 (all parts) Process measurement control functions and instrumentation - Symbolic representation
NS 1710 Technical drawings – Drawing symbols for piping systems
NS 1438 Process measurement control functions and instrumentation – Symbolic representation – Part 1: Basic requirements

3 DEFINITIONS AND ABBREVIATIONS
3.1 General definitions
Normative references Shall mean normative (a requirement) in the application of NORSOK Standards.
Informative references Shall mean informative in the application of NORSOK Standards.
Shall  Shall is an absolute requirement to be followed strictly in order to conform to the standard. Shall requirements shall preferably be used in all NORSOK standards. Non-compliance to shall-requirements shall be subject to acceptance by the client.

Should Should is a recommendation. Alternative solutions having the same functionality and quality are acceptable to the client.

May  May indicates a course of action that is permissible within the limits of the standard (a permission).

Can  Can-statements are conditional and indicates a possibility open to the user of the standard.

### 3.2  Function definitions
All definitions are based on positive logic; defined state is true when logical equal to '1'.

<table>
<thead>
<tr>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm</td>
<td>Discrete change of state resulting in an audio/visual annunciation requiring operator acknowledges.</td>
</tr>
</tbody>
</table>
| Alarm categories    | The following categories are defined, not reflecting priority or criticality of the alarm:  
  **Action alarm**: Alarm feature including blocking facilities intended for automatic safeguarding actions in order to protect equipment, environment or human beings. (Ref. figure in A 3.2.1)  
  **Warning alarm**: Alarm without blocking facilities intended for abnormal conditions enabling operator intervention in order to prevent further escalation. (Ref. figure in A 3.2.2)  
  **Fault alarm**: Alarm associated to fault or failure in the instrument and/or control device. (Ref. figure in A 3.2.3) |
<p>| Alarm filtering     | Alarms determined by additional processing to be less important, irrelevant or otherwise unnecessary are not presented to the operator, but can be accessed upon request. |
| Alarm hysteresis    | The degree of normalisation required to reset an active alarm state, measured from the alarm activation limit. Normally expressed in terms of a fraction (%) of the operating range. |
| Alarm suppression   | Disable alarm annunciation as well as any associated automatic actions. |
| Blocking            | Disable 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 disables functions. (Ref. Figure in A 3.4) |
| Commands            | Manipulation affecting the mode of the function template. |</p>
<table>
<thead>
<tr>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The following commands are defined:</strong></td>
<td><strong>Set:</strong> Memory variable set to true state on being true.</td>
</tr>
<tr>
<td><strong>Reset:</strong> Memory variable reset to false state on being true. Reset shall have priority over set.</td>
<td><strong>Force:</strong> Action overruling any other signal while being true. The mode is reset to its original state when signal is no longer true.</td>
</tr>
<tr>
<td><strong>Lock:</strong> Action overruling any other signal while being true. The new mode is maintained when lock signal is no longer true.</td>
<td><strong>Control option Pre-defined properties of the function template defined during the configuration of the system reflecting the specific control requirements.</strong></td>
</tr>
<tr>
<td><strong>Deviation warning</strong></td>
<td>State calculated in a modulating controller by subtracting the measured value from the set point value. A warning will be announced if deviation is outside working area.</td>
</tr>
<tr>
<td><strong>Disabled mode</strong></td>
<td>Function not available for external control commands</td>
</tr>
<tr>
<td><strong>Dynamic information</strong></td>
<td>Information displayed on the VDUs reflecting the state of the process or system. The following dynamic information elements are defined:</td>
</tr>
<tr>
<td><strong>Alarm:</strong> Discrete change of data resulting in an audio / visual annunciation in the control room, requiring operator acknowledgement as well as input to alarm list.</td>
<td><strong>Event:</strong> Discrete change of state resulting in a displayed status in the control room as well as input to the event list.</td>
</tr>
<tr>
<td><strong>Status:</strong> Binary state.</td>
<td><strong>Indication:</strong> Continuos display of information.</td>
</tr>
<tr>
<td><strong>Enabled mode</strong></td>
<td>Function available for external/remote control commands.</td>
</tr>
<tr>
<td><strong>Flow element</strong></td>
<td>Device used to control/ shut down or manipulates a flow of fluid or electric energy, ex. Valve, pump. Where the flow device only has two positions, it is referred to as a binary flow device ex. Motor - on/ off, valve - Open/Close.</td>
</tr>
<tr>
<td><strong>High position:</strong> No flow restriction</td>
<td><strong>Low position:</strong> No flow</td>
</tr>
<tr>
<td><strong>Function template</strong></td>
<td>Function assembly detailed requirements for operation and control.</td>
</tr>
<tr>
<td><strong>Limit switch</strong></td>
<td>Device connected to the actuator or valve providing a positive signal when the valve reaches a pre-established position.</td>
</tr>
<tr>
<td>Definition</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor Control Center (electrical protection relay assembly)</td>
</tr>
<tr>
<td>Mode</td>
<td>State of operation selected by the operator or resulting from an external event</td>
</tr>
<tr>
<td></td>
<td>The following operation modes are defined:</td>
</tr>
<tr>
<td></td>
<td><strong>Auto:</strong> Operation of process objects automatically performed by the control logic. (Ref. figure in A 3.4)</td>
</tr>
<tr>
<td></td>
<td><strong>Outside:</strong> Flow element operated from a field device. I.e. local panel. (Ref. figure in A 3.4)</td>
</tr>
<tr>
<td></td>
<td><strong>Manual:</strong> Flow element manually controlled by the operator from the CCR. (Ref. figure in A 3.4)</td>
</tr>
<tr>
<td></td>
<td><strong>Duty/Standby:</strong> Intended for automatic supervision of flow element operating in parallel to increase the system availability. One flow</td>
</tr>
<tr>
<td></td>
<td>element will be assigned duty (priority 1) and will thus normally be in operation. The other is assigned standby (priority 2) and will</td>
</tr>
<tr>
<td></td>
<td>automatically be put in operation if duty fails. All flow elements will have to be selected auto to obtain automatic duty/standby function.</td>
</tr>
<tr>
<td></td>
<td>(Ref. figure in A 3.4)</td>
</tr>
<tr>
<td></td>
<td><strong>Blocked:</strong> Alarm status signals from process variable limit checking are blocked within the function, giving annunciation, but not</td>
</tr>
<tr>
<td></td>
<td>allowing all related automatic safeguarding actions. Associated safeguarding function disabled. Related alarm annunciation not disabled</td>
</tr>
<tr>
<td></td>
<td>(i.e. no external signal outputs are blocked). (Ref. figure in A 3.4)</td>
</tr>
<tr>
<td></td>
<td><strong>Suppress:</strong> Disable alarm annunciation as well as related safeguarding actions. (Ref. figure in A 3.4)</td>
</tr>
<tr>
<td></td>
<td><strong>Internal set point mode:</strong> Sub- mode to auto mode used for PID controllers. The set point to be entered by the operator.</td>
</tr>
<tr>
<td></td>
<td><strong>External set point mode:</strong> Sub- mode to auto mode used for PID controllers. The set point to be entered from external functions in the</td>
</tr>
<tr>
<td></td>
<td>control logic. Typically use in cascading PID controllers.</td>
</tr>
<tr>
<td></td>
<td><strong>Track:</strong> To follow another signal. I.e. “set-point” tracking etc.</td>
</tr>
<tr>
<td></td>
<td><strong>Safeguarding:</strong> Flow device is in safe state. The term safe is related to the protection of equipment, environment and human beings.</td>
</tr>
<tr>
<td></td>
<td>(Ref. Figure in A 3.4)</td>
</tr>
<tr>
<td></td>
<td><strong>Disabled:</strong> Function not available for external control commands. Safeguarding commands will not be affected in</td>
</tr>
<tr>
<td>Definition</td>
<td>Explanation</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Override</td>
<td>Override function intended to set the output signal to predefined state, independent of changes in logic states. Normally used in connection with mimic/matrix panels for test purpose.</td>
</tr>
</tbody>
</table>
| Position     | **Actual position:** The feedback-position of a flow element, independent of the state of the control output.  
                **Confirmed position:** Compared actual position and control output. True if no mismatch and false if there are a mismatch. (Ref. Figure in A 3.4) |
| Process      | A sequence of chemical, physical, or biological activities for the conversion, transport, or storage of material or energy. |
| Shutdown     | Signal to set an element to safeguarding mode. (Ref. figure in A 3.4)                           |
| Shutdown level | Signal latch included in the common signal path between a group of initiators and a group of flow elements. |

### 3.3 Abbreviations

- **API**  
  American Petroleum Institute  
- **C&E**  
  Cause & Effect  
- **CCR**  
  Central Control Room  
- **ESD**  
  Emergency Shutdown System  
- **F&G**  
  Fire & Gas  
- **HIPPS**  
  High Integrity Pressure Protection System  
- **HMI**  
  Human Machine Interface  
- **HVAC**  
  Heating, Ventilation and Air Condition  
- **MCC**  
  Motor Control Center  
- **NPD**  
  Norwegian Petroleum Directorate  
- **P&ID**  
  Piping & Instrument Diagram  
- **PCS**  
  Process Control System  
- **PSD**  
  Process Shutdown System  
- **SAS**  
  Safety and Automation System  
- **SCD**  
  System Control Diagram  
- **VDU**  
  Visual Display Unit
4 THE 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 & 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.

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. The approach encourage 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.

4.2 Framework

The SCD standard represents an open standard in terms of operation & 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.

The standard 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 optimised 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 standard.

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,
sequencing, global safeguarding functions as well as fire & gas functions are less suitable for the SCD representation as such. Please refer to the figure below.

![Figure 1, SCD Framework](image)

Typical applications proven suitable for the SCD representation are the following:

- Control of process and utility systems
- Process Shutdown applications
- Package Control
- HVAC

A cause & effect representation will typically be used for fire & gas and emergency shutdown systems. Cause & effects 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.

Sequence logic should be specified according to IEC 61131-3. The graphical language - Sequential Function Chart (SCF) should be used.

### 4.3 Life Cycle Concept

The SCD standard is intended to cover the complete life cycle of a process plant.

The System Control Diagram, where used, will form the single source of documentation for the Safety and Automation System control and shutdown strategies for all life cycle phases.

- Engineering
- Implementation
- Commissioning
- Operations
- Modifications

The objectives will be different within each phase. Annex C will provide an introductory overview of what the SCD Approach implies for the different life cycle phases. However, it is important to
emphasise that this standard is only intended to provide an overview of the standard as well as an initial starting point for inexperienced users.

### 4.4 Basic Design (Informative)

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

Please refer to the figure below for an introductory overview.

![Diagram of Basic Design Process]

**Figure 2, Basic Design**

### 4.4.1 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 & 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.
4.4.2 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.
4.4.3 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 are developed on two levels.

Object Typical
SCD Applications

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 listed below.

Verify the completeness of the function templates.
Reduce the number of typical solutions.
Improve the quality of the SCD Development.
Standardised solutions.
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.

### 4.4.4 Application Design

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

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.
Figure 7, Application Design

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

- Establish process schematic and identify all control objects.
- Define applicable function templates.
- Develop basic interlocking strategies based on an overall interlocking hierarchy/philosophy.
- Develop automatic control strategies. (e.g. package start/stop, duty/standby, sequencing)
- Develop alarm strategies including automatic suppression of secondary alarms.
ANNEX A - SCD FUNCTION STANDARD (NORMATIVE)

A.1 Introduction
This annex contains a collection of definitions, explanations and descriptions of function templates, the main bricks for the SCD approach. It holds the legend of functional templates and their terminal names. Templates are normally implemented in the various control systems, employing special developed “Function Blocks” or by combining other properties built in the control system. This annex shall be considered to be normative. It is permitted to reject terminals or introduce additional terminals on the templates to meet special requirements. However, the terminals that are included shall have the same functionality as described in this annex.

A.2 Terminal codes

A.2.1 Syntax

A.2.1.1 Standard
The general syntax for standard terminals is:

( ) = Has to be used
[ ] = Optional

A.2.2 Overview
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 template contains necessary monitoring functions to ensure that the most frequent faults regarding to the field object are detected and reported. Each signal interconnecting two functions uses terminal codes for identification. 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).

<table>
<thead>
<tr>
<th>Letter</th>
<th>1.Character</th>
<th>Succeeding characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Action</td>
<td>Auto mode</td>
</tr>
<tr>
<td></td>
<td>Alarm</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Binary status</td>
<td>Blocked mode</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>Confirmed</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>Disabled transition mode</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>Enabled status</td>
</tr>
<tr>
<td>F</td>
<td>Force command</td>
<td>Fault / Failed</td>
</tr>
<tr>
<td>G</td>
<td></td>
<td>Position</td>
</tr>
<tr>
<td>Letter</td>
<td>1.Character</td>
<td>Succeeding characters</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>H</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Internal set point mode</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>Not used</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Not used</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Lock command Low</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Manual mode</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Not used</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Outside mode</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Priority allocation</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Reset command Reference signal</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Set command Safeguarding mode</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>Track mode</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>suppressed mode</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>Variance / Deviation</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>Warning alarm Warning alarm</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>External input External set-point mode. <strong>Note:</strong> Together with B as 1.st character - X= external</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Normal function output Not used</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>Not used</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Number</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>User defined (to be shown on SCDs)</td>
<td></td>
</tr>
<tr>
<td>&amp;</td>
<td>Parameters (User &amp; system dependent - not to be shown on SCDs)</td>
<td></td>
</tr>
</tbody>
</table>

Only positive logic shall be used. This implies that a defined state of terminal is true when it is logical equal to ' 1 '.

**A.2.3 Signal types (1.Character)**

**A.2.3.1 Inputs**

\[ X = \text{External function Input} \]

**A.2.3.2 Commands**

\[ S = \text{Set} \]
\[ R = \text{Reset} \]
\[ F = \text{Force} \]
\[ L = \text{Lock} \]
A.2.3.3 Outputs

Y = Normal function output (Related to main function of element)
A = Action Alarm
W = Warning alarm
B = Binary status

A.2.3.4 Special characters

% = User defined (To be shown on SCDs)
& = Parameters (User & system dependent, not shown on SCDs)

A.2.4 Explanatory code (Succeeding characters)

A.2.4.1 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 = External Set point mode

A.2.4.2 Signal Identifiers

C = Confirmed
E = Enabled status
F = Fault/Failed
G = Position
Q = Quantity
R = Reference
W = Warning
X = External

A.2.4.3 Sub functions

H = High
HH = High High
L = Low
LL = Low Low
V = Variance / deviation

A.2.5 Terminal description for function templates

Index of normative terminal codes used in this annex. New terminal codes shall be created to section 2.2.
<table>
<thead>
<tr>
<th>Terminal Code</th>
<th>Signal Type</th>
<th>Terminal Name</th>
<th>Supplementary description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHH</td>
<td>binary output</td>
<td>Action alarm High-High</td>
<td>True, when X-value &gt;AHH limit</td>
</tr>
<tr>
<td>ALL</td>
<td>binary output</td>
<td>Action alarm Low-Low</td>
<td>True, when X-value &lt;ALL limit</td>
</tr>
<tr>
<td>BA</td>
<td>binary output</td>
<td>Status auto/man. mode</td>
<td>True: auto, false: manual</td>
</tr>
<tr>
<td>BB</td>
<td>binary output</td>
<td>Status blocked mode</td>
<td>The function is in blocked mode (no action output). I.e. all safeguarding signals are blocked</td>
</tr>
<tr>
<td>BBHH</td>
<td>binary output</td>
<td>Action alarm High-High is blocked</td>
<td></td>
</tr>
<tr>
<td>BBLL</td>
<td>binary output</td>
<td>Action alarm Low-Low is blocked</td>
<td></td>
</tr>
<tr>
<td>BCH</td>
<td>binary output</td>
<td>Output position high confirmed</td>
<td>Output Y compared to feedback position high from MCC or limit switch and validated as true</td>
</tr>
<tr>
<td>BCL</td>
<td>binary output</td>
<td>Output position low confirmed</td>
<td>Output Y compared to feedback position Low from MCC or limit switch and validated as true</td>
</tr>
<tr>
<td>BG</td>
<td>analogue output</td>
<td>Binary status of position</td>
<td>Position of the valve-for use in downstream logic</td>
</tr>
<tr>
<td>BHH</td>
<td>binary output</td>
<td>Status alarm High-High</td>
<td>Status alarm annunciation (HH) without blocking logic</td>
</tr>
<tr>
<td>BLL</td>
<td>binary output</td>
<td>Status alarm Low-Low</td>
<td>Status alarm annunciation (LL) without blocking logic</td>
</tr>
<tr>
<td>BO</td>
<td>binary output</td>
<td>Status outside mode</td>
<td>The control function is in outside mode</td>
</tr>
<tr>
<td>BP1</td>
<td>integer output</td>
<td>Status priority 1</td>
<td></td>
</tr>
<tr>
<td>BP1F</td>
<td>binary output</td>
<td>Priority 1 faulty</td>
<td>Start Priority 2 (For Standby logic)</td>
</tr>
<tr>
<td>BP2</td>
<td>integer output</td>
<td>Status priority 2</td>
<td></td>
</tr>
<tr>
<td>BP2F</td>
<td>binary output</td>
<td>Priority 2 faulty</td>
<td>Start Priority 3 (For Standby logic)</td>
</tr>
<tr>
<td>BS</td>
<td>binary output</td>
<td>Status safeguarding mode</td>
<td>A shutdown signal of the process function is true</td>
</tr>
<tr>
<td>BT</td>
<td>binary output</td>
<td>Status tracking mode</td>
<td>In tracking mode as long as signal is true. Ex. Set point tracking.</td>
</tr>
<tr>
<td>Terminal Code</td>
<td>Signal Type</td>
<td>Terminal Name</td>
<td>Supplementary description</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------</td>
<td>------------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>BU</td>
<td>binary output</td>
<td>Status suppressed mode</td>
<td>Process output function is suppressed. No action output and no alarm annunciation.</td>
</tr>
<tr>
<td>BX</td>
<td>binary output</td>
<td>Status external mode</td>
<td>True: extern and false: intern or image of input.</td>
</tr>
<tr>
<td>BXH</td>
<td>binary output</td>
<td>Binary status High</td>
<td>True, when X-value &gt; High limit. No Alarm annunciation, event only</td>
</tr>
<tr>
<td>BXHH</td>
<td>binary output</td>
<td>Binary status High-High</td>
<td>True, when X-value &gt; High-High limit No Alarm annunciation, event only</td>
</tr>
<tr>
<td>BXL</td>
<td>binary output</td>
<td>Binary status Low</td>
<td>True, when X-value &lt; Low limit No Alarm annunciation, event only</td>
</tr>
<tr>
<td>BXLL</td>
<td>binary output</td>
<td>Binary status Low-Low</td>
<td>True, when X-value &lt; Low-Low limit No Alarm annunciation, event only</td>
</tr>
<tr>
<td>FB</td>
<td>binary input</td>
<td>Force blocked mode</td>
<td>Logic input: alarm action is blocked as long as input signal is true.</td>
</tr>
<tr>
<td>FBHH</td>
<td>binary input</td>
<td>Force blocked mode for alarm High-High</td>
<td>Logic input: alarm HH action is blocked as long as input signal is true.</td>
</tr>
<tr>
<td>FBLL</td>
<td>binary input</td>
<td>Force blocked mode for alarm Low-Low.</td>
<td>Logic input: alarm LL action is blocked as long as input signal is true.</td>
</tr>
<tr>
<td>FDH</td>
<td>binary input</td>
<td>Force disable transition high.</td>
<td>Permissive to start when false and prevents element to be started when true.</td>
</tr>
<tr>
<td>FDL</td>
<td>binary input</td>
<td>Force disable transition low.</td>
<td>Prevents element to be stopped.</td>
</tr>
<tr>
<td>FQ</td>
<td>binary input</td>
<td>Force totalizing</td>
<td></td>
</tr>
<tr>
<td>FSH</td>
<td>binary input</td>
<td>Force safeguarding high</td>
<td><strong>Shutdown</strong> – 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.</td>
</tr>
<tr>
<td>FSL</td>
<td>binary input</td>
<td>Force safeguarding low</td>
<td><strong>Shutdown</strong> – 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.</td>
</tr>
<tr>
<td>FT</td>
<td>binary input</td>
<td>Force track mode</td>
<td>Track signal: XT-value</td>
</tr>
<tr>
<td>FU</td>
<td>binary input</td>
<td>Force suppression mode.</td>
<td>Logic input: alarm action and alarm annunciation is suppressed as long as input signal is true.</td>
</tr>
<tr>
<td>FUHH</td>
<td>binary input</td>
<td>Force suppression mode for alarm High-High.</td>
<td>Logic input: alarm HH action and annunciation is suppressed as long as input signal is true.</td>
</tr>
<tr>
<td>Terminal Code</td>
<td>Signal Type</td>
<td>Terminal Name</td>
<td>Supplementary description</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------</td>
<td>---------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>FULL</td>
<td>binary input</td>
<td>Force suppression mode for alarm Low-Low.</td>
<td>Logic input: alarm LL action and annunciation is suppressed as long as input true.</td>
</tr>
<tr>
<td>FUWH</td>
<td>binary input</td>
<td>Force suppression mode for alarm WH</td>
<td>Logic input: alarm WH action and annunciation is suppressed as long as input true.</td>
</tr>
<tr>
<td>FUWL</td>
<td>binary input</td>
<td>Force suppression mode for alarm WL</td>
<td>Logic input: alarm WL action and annunciation is suppressed as long as input true.</td>
</tr>
<tr>
<td>LA</td>
<td>binary input</td>
<td>Lock auto mode.</td>
<td>Locks the control function to auto mode, overruling the operator. After signal disappears, template keeps in auto mode.</td>
</tr>
<tr>
<td>LI</td>
<td>binary input</td>
<td>Lock internal set point mode.</td>
<td>Locks the logic to internal mode, overruling the operator. After signal disappears the logic keeps in internal set point operation mode.</td>
</tr>
<tr>
<td>LM</td>
<td>binary input</td>
<td>Lock manual mode.</td>
<td>Locks the logic to manual mode, overruling the operator. After signal disappears the logic keeps in manual mode.</td>
</tr>
<tr>
<td>LO</td>
<td>binary input</td>
<td>Lock outside operation mode.</td>
<td>Locks the logic to outside system operation mode, overruling the operator. After signal disappears the logic keeps in outside system operation mode.</td>
</tr>
<tr>
<td>LSH</td>
<td>binary input</td>
<td>Lock safeguarding high.</td>
<td><strong>Shutdown</strong> - signal overrules operator inputs (locking the template to manual mode with Y-output to high -open valve-). Input is subject to blocking .</td>
</tr>
<tr>
<td>LSL</td>
<td>binary input</td>
<td>Lock safeguarding low.</td>
<td><strong>Shutdown</strong> - signal overrules operator inputs (locking the template to manual mode with Y-output to low -stop motor-). Input is subject to blocking.</td>
</tr>
<tr>
<td>LX</td>
<td>binary input</td>
<td>Lock external set point mode.</td>
<td>Locks the logic function to external mode, overruling the operator. After signal disappears template keeps in external set point operation mode.</td>
</tr>
<tr>
<td>PFCT</td>
<td>Float point value</td>
<td>Factor used for calculation of flow</td>
<td></td>
</tr>
<tr>
<td>PKF</td>
<td>Float point value</td>
<td>K-factor used for calculations of flow.</td>
<td>Defines the pressure drop across the orifice plates.</td>
</tr>
<tr>
<td>Terminal Code</td>
<td>Signal Type</td>
<td>Terminal Name</td>
<td>Supplementary description</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------</td>
<td>-------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>PMOD</td>
<td>Integer value</td>
<td>Define formula to be used for flow calc.</td>
<td></td>
</tr>
<tr>
<td>RX</td>
<td>binary input</td>
<td>Reset latched output</td>
<td></td>
</tr>
<tr>
<td>RXQ</td>
<td>binary input</td>
<td>Reset external totalizer</td>
<td>Logic signal to reset</td>
</tr>
<tr>
<td>SP1</td>
<td>binary input</td>
<td>Set priority 1</td>
<td>Set duty (prio.1) mode</td>
</tr>
<tr>
<td>SP2</td>
<td>binary input</td>
<td>Set priority 2</td>
<td>Set standby (prio.2) mode</td>
</tr>
<tr>
<td>WH</td>
<td>binary output</td>
<td>Warning alarm – High.</td>
<td>True, when X-value &gt;WH limit</td>
</tr>
<tr>
<td>WL</td>
<td>binary output</td>
<td>Warning alarm – Low</td>
<td>True, when X-value &lt;WL limit</td>
</tr>
<tr>
<td>WV</td>
<td>binary output</td>
<td>Warning deviation</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>DI / AI</td>
<td>External function input</td>
<td>Binary or analogue input signal from process</td>
</tr>
<tr>
<td>X1-X4</td>
<td>DI / AI</td>
<td>External function input 1 to 4</td>
<td>Binary or analogue input signal from process</td>
</tr>
<tr>
<td>XE</td>
<td>binary input</td>
<td>Function externally enabled</td>
<td>Electrical available used for electr. Equipment only</td>
</tr>
<tr>
<td>XEQ</td>
<td>binary input</td>
<td>External enable totalizing</td>
<td>Input to logic enable/disable totalizing</td>
</tr>
<tr>
<td>XF</td>
<td>binary input</td>
<td>External fault</td>
<td>Loop failure-i.e. input card broken.</td>
</tr>
<tr>
<td>XG</td>
<td>analogue input</td>
<td>Position read as measured value</td>
<td>Position read as measured value Logical deviations.</td>
</tr>
<tr>
<td>XGH</td>
<td>binary input</td>
<td>Position high feedback</td>
<td>Signal from MCC (running) or limit switch high.</td>
</tr>
<tr>
<td>XGL</td>
<td>binary input</td>
<td>Position low feedback</td>
<td>Signal from MCC (stopped) or limit switch low.</td>
</tr>
<tr>
<td>XOH</td>
<td>binary input (pulsed)</td>
<td>External outside set high</td>
<td>From process to control element. I.e. valve/ damper- in outside mode. Set high signal (positive edge) to open valve.</td>
</tr>
<tr>
<td>XOL</td>
<td>binary input (pulsed)</td>
<td>External outside set low</td>
<td>From process to control element. I.e. valve/ damper in outside mode. Set low signal (positive edge) to close valve.</td>
</tr>
<tr>
<td>XH</td>
<td>binary input</td>
<td>External set high</td>
<td>From process to control element. I.e. valve/ damper- in auto mode. Set high signal (open valve) only</td>
</tr>
<tr>
<td>XL</td>
<td>binary input</td>
<td>External set low</td>
<td>From process to control element. I.e. valve/ damper in auto mode. Set low signal (close valve) only</td>
</tr>
<tr>
<td>Terminal Code</td>
<td>Signal Type</td>
<td>Terminal Name</td>
<td>Supplementary description</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------</td>
<td>--------------------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>XP1H</td>
<td>binary input (pulsed)</td>
<td>External priority 1 set high.</td>
<td>From logic or process to control element. I.e. motor- first priority in auto mode. Set high signal (start motor) only</td>
</tr>
<tr>
<td>XP1L</td>
<td>binary input (pulsed)</td>
<td>External priority 1 set low</td>
<td>From logic or process to control element. I.e. motor- first priority in auto mode. Set low signal (stop motor) only</td>
</tr>
<tr>
<td>XP2H</td>
<td>binary input (pulsed)</td>
<td>External priority 2 set high.</td>
<td>From logic or process to control element. I.e. motor- second priority in auto mode. Set high signal (start motor) only</td>
</tr>
<tr>
<td>XP2L</td>
<td>binary input (pulsed)</td>
<td>External priority set 1 low</td>
<td>From logic or process to control element. I.e. motor- second priority in auto mode. Set low signal (stop motor) only</td>
</tr>
<tr>
<td>XR</td>
<td>analogue input</td>
<td>External set point value</td>
<td>Used in external – auto – mode</td>
</tr>
<tr>
<td>XT</td>
<td>analogue input</td>
<td>Tracking value</td>
<td>Used in tracking mode</td>
</tr>
<tr>
<td>Y</td>
<td>binary output</td>
<td>Normal function output</td>
<td>Output status, which can be used in downstream logic</td>
</tr>
<tr>
<td>YF</td>
<td>binary output</td>
<td>Output function failed.</td>
<td>For use in downstream logic</td>
</tr>
<tr>
<td>YH</td>
<td>binary output (pulsed)</td>
<td>Pulsed normal function output high.</td>
<td>Output pulse to start big motors, which are operated with pulsed start/stop signals</td>
</tr>
<tr>
<td>YL</td>
<td>binary output (pulsed)</td>
<td>Pulsed normal function output low.</td>
<td>Output pulse to stop big motors, which are operated with pulsed start/stop signals</td>
</tr>
<tr>
<td>YR</td>
<td>analogue output</td>
<td>Reference set point value</td>
<td>Set point to slave controller</td>
</tr>
<tr>
<td>YX</td>
<td>analogue output</td>
<td>Measured value output</td>
<td></td>
</tr>
</tbody>
</table>
A.3 Block schematic representation of functions

A.3.1 Notation

Operator input from CCR
Annunciation in CCR
Logic functions

A.3.2 The notation of “Block and suppress” related to alarm function.

A.3.2.1 Action Alarm

A.3.2.2 Warning Alarm
A.3.2.3 Fault Alarm

Fault detection logic

Logic function: "Suppress"

YF (Function Failed)

XF (Suppressed)

A.3.3 The notation of event functions

A.3.3.1 Event

Limits

Limit Check

BXHH/ BXH/ BXL/ BXLL
A.3.4 Auto/Manual/Outside selector logic principals

Note 1: Applicable for SBE and SBV
Note 2: Only applicable for SBE
Note 3: Ref. figure A for motors (SBE)
Duty / Standby selector logic principals for motors

A.3.5 Override
A.4 Function templates

A.4.1 Introduction

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 or device with its related instrumentation for either measuring process variables or manipulating the state of the process. All function templates in this specification are thus 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 can be represented by one symbol with its in- and out-puts to process, operator station and other logic. The interconnections between the function templates shall be recognisable 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 (process engineers, operators, etc.) and more instrumentation related users (instrument engineers, automation engineers, etc.).

The SCDs are a precise specification for the control system application and should be available on a magnetic medium. To generate the control system from the SCDs reduce possible errors, manually interpreting verbal specifications into control applications in software. An automatically generation of the control system to a certain degree (from an ideal point of view - 100%) will improve the efficiency and reduce the cost dramatically.

Additionally the SCDs can serve as a fault finding and debugging tool. The unified way of configuring with function templates, which are clearly defined before start of application configuration assures consistency in operation, alarm handling and indication of variables on the operator stations over the whole plant. All alarm handling features shall reside within the function templates. It shall have a function oriented approach towards the operator. The operator interface shall contribute to enable the operator to operate the process with a minimum number of shutdowns and hazardous situations and further achieve an increased optimisation of the process.

A.4.2 Function template name convention

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

The name syntax should be:

<Primary function> [ by means of <Control type> ] of <Device>
Example:

```
S B _
```

<table>
<thead>
<tr>
<th>Letter</th>
<th>1. Character (Primary function)</th>
<th>2. Character (Control Type)</th>
<th>Succeeding characters (Device (optional use if required))</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>Analogue (Automatic Function)</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>Binary (Automatic Function)</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Continuos Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>Electrically motor / heaters</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Sequencing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Latching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Totalize</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Switching Control</td>
<td>Step (Automatic Function)</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td></td>
<td></td>
<td>Valve / dampers</td>
</tr>
<tr>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>Mathematical functions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td></td>
<td></td>
<td>User defined</td>
</tr>
</tbody>
</table>
A.4.2.1 Primary function

S - Switching Control
C - Continuous Control
L - Latching
K - Sequencing
Y - Mathematical functions
Q - Totalize
M - Monitoring

A.4.2.2 Control Type

A - Analogue (Automatic Function)
B - Binary (Automatic Function)
S - Step (Automatic Function)

A.4.2.3 Device (optional use if required):

E - Electrically motor / heaters (MCC)
V - Valve / dampers
# - User defined

A.4.2.4 Legend for naming function templates used in this annex.

<table>
<thead>
<tr>
<th>Primary Function</th>
<th>Control Type</th>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>B</td>
<td>E</td>
<td>Switching control by means of a binary control action of El. power Devices.</td>
</tr>
<tr>
<td>C</td>
<td>B</td>
<td></td>
<td>Continuous control by means of a binary control action of El. power Devices.</td>
</tr>
<tr>
<td>S</td>
<td>B</td>
<td>V</td>
<td>Switching control by means of a binary control action of H/P power Devices (e.g. Valves)</td>
</tr>
<tr>
<td>C</td>
<td>A</td>
<td></td>
<td>Continuous control by means analogue control action</td>
</tr>
<tr>
<td>C</td>
<td>S</td>
<td></td>
<td>Continuous control by means step control action</td>
</tr>
<tr>
<td>M</td>
<td>A</td>
<td></td>
<td>Monitoring of Analogue Process Value</td>
</tr>
<tr>
<td>M</td>
<td>B</td>
<td></td>
<td>Monitoring of Binary Process Value</td>
</tr>
<tr>
<td>Q</td>
<td>A</td>
<td></td>
<td>Totallizing of Analogue Process Value</td>
</tr>
<tr>
<td>Y</td>
<td>A</td>
<td></td>
<td>Calculation of Analogue Process Value</td>
</tr>
<tr>
<td>L</td>
<td>B</td>
<td></td>
<td>Latching of Binary signal. I.e. PSD level block</td>
</tr>
</tbody>
</table>
A.4.3 Process variable Monitoring and Display

A.4.3.1 MB - Monitoring of Binary (Digital) Process Variables

A.4.3.1.1 Purpose
Function template intended for automatic monitoring ( alarming), display and storage of binary process variable.

A.4.3.1.2 Requirements
The template includes alarm suppression and blocking functions. Additionally there shall be the possibility to adjust to input signals "Normal energised/Normal de energised" via a parameter. The type of annunciation as well as the alarm priority assigned shall be incorporated according to system vendor standards.

A.4.3.1.3 Function Template Schematic

<table>
<thead>
<tr>
<th>Inputs</th>
<th>MB</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal function input</td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>External fault</td>
<td>XF</td>
<td>YF</td>
</tr>
<tr>
<td>Reset latched output</td>
<td>RX</td>
<td></td>
</tr>
<tr>
<td>Operator Station:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocking on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blocking off</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suppression on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suppression off</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logic:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force block mode</td>
<td>FB</td>
<td>BB</td>
</tr>
<tr>
<td>Force suppression mode</td>
<td>FU</td>
<td>BU</td>
</tr>
<tr>
<td></td>
<td>BX</td>
<td></td>
</tr>
</tbody>
</table>

Parameters:
Reference to vendor documentation
A.4.3.2 MA - Monitoring of Analogue Process Variables.

A.4.3.2.1 Purpose
Function template for calculation, display (indication), automatic monitoring ( alarming) and storage of process variable or control variable. The template comprises handling of field instrument and signaling faults.

A.4.3.2.2 Requirements
The template includes suppress and blocking functions. Suppression from operator station includes all alarm and fault outputs, whilst by logic it is possible to suppress individual alarm outputs. Faults cannot be suppressed by logic input. All limit checking and alarm annunciation resides within the template.
The parameter-values for the warning levels shall be adjustable from the operator-station. Hysteresis will be defined in % of maximum range and common for all limits given by parameter inputs. Additional status outputs shall be provided for limit checking without alarm annunciation (Event-handling).
Features for square-root extraction with a factor multiplied (measurements of flow by means of an orifice plate) and features for smoothing (low pass filtering) of the analogue input signal are not included. These shall be realised in auxiliary function template and only be used where applicable.
A separate function template (QA) will handle totalizing. Trending will be defined on HMI level.
### A.4.3.2.3 Function Template Schematic

<table>
<thead>
<tr>
<th>Inputs</th>
<th>MA</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal function input</td>
<td>X</td>
<td>Y Normal Function output</td>
</tr>
<tr>
<td>External fault</td>
<td>XF</td>
<td>YF Function failed</td>
</tr>
</tbody>
</table>

**Operator Station:**

- Block HH on
- Block HH of
- Block LL on
- Block LL off
- Suppression on
- Suppression off

**Logic:**

- Force block alarm HH FBHH AHH Action alarm HH
- Force block alarm LL FBLL BHH Status alarm HH
- Force suppress alarm HH FUHH WH Warning alarm High
- Force suppress alarm WH FUWH WL Warning alarm Low
- Force suppress alarm WL FUWL ALL Action alarm LL
- Force suppress alarm LL FULL BLL Status alarm LL

**Parameters:**

Reference to vendor documentation
A.4.4 Flow element Monitoring and Binary Control

A.4.4.1 SBE - Controls of Motors (Electrical Equipment)

A.4.4.1.1 Purpose

Function template for binary (on/off) control of a measured process variable by means of changing flow of medium (electricity, heat or fluid).

The function template shall be applied for all binary control of flow elements such as motors, pumps, heaters, fans etc.

A.4.4.1.2 Requirements – Control options

The function template can be configured to operate with several modes according to the type of application. These modes are fixed during run-time, but selected when structuring the control logic and thus called control options. The configured mode of the flow element is defining the principles of operation and is not depending on the actual state of the process the flow element is serving.

The control options allow for operation in both manual mode and auto mode. These operational modes are sub-modes to the selected configured option and may further be changed during run-time.

The control options can be defined by a parameter within the template or for some automation systems also defined as different template within a family of SBE - template. The following control options shall be made available:

Option 1: Outside Automation System Controlled (CCR indication only)

Flow element (motor) is locally controlled. Status will generally be indicated based on feedback signal (running -position high-) from the MCC. If the actual control output to the flow element is wired through the automation system based on inputs from a outside (local) control function, but no operator control is allowed due to operational reasons, this option shall be used. The flow element will not be operable from the HMI system. This shall be reflected by the indication on the operator stations.

Option 2: Manual Operation only (from HMI in CCR)

Flow element is manually switched to high or low flow (On/Off) by the operator in the CCR. The flow element will additionally be subject to safeguarding (shutdown) or interlock functions overruling the operator input. These are acting through the SMB template by means of the input terminals on the function template.
Option 3: Manual Operation + Automatic Control

The flow element is automatically operated by means of external input commands. External used in this context means that the binary control signal is generated outside the loop, in software or hardware. This configuration allows for operation in both manual and automatic mode. When switched to automatic by the operator the external inputs (X-terminals) will maneuver the flow element. When switched to manual mode, the last output position will be maintained until operator's input (i.e. when it was running it keeps running).

To use minimum amount of terminals a stand-alone SBE function template is always considered to be in priority 1 (default value). The function template allows for automatic operation by means of control inputs (XP1H/XP1L-pulsed inputs- used as set priority 1 to High / set priority 1 to Low, Y output will be following if in auto and priority 1).

Option 4: Duty/Standby operation

Intended for automatic supervision of flow machines operating in parallel to increase the system availability. The operator shall be able to select priority function. One flow machine will be assigned duty (priority 1) and will thus normally be in operation. The other one is assigned standby (priority 2) and will automatically be put in operation if duty fails. Both flow machines will have to be selected auto to obtain automatic duty/standby function. Duty generates start command to standby if:
- Duty in auto mode and running and priority 1 and
  - (Fails to operate (YF = true) or
  - (Safeguarding mode and not blocked) or
  - (Not enabled (XE = false) and not suppressed)

Standby starts if:
- Standby in auto mode and not running and
  - Priority 2 selected and
  - Transition to high not disabled (Start permission)

Automatic duty/standby function will be obtained by system vendor standards and is thus not further specified. This function should however preferable reside within the function template.

A.4.4.1.3 General requirements:

Disable transition facilities shall be provided within the function template to prevent manual and automatic binary control. Suppressing and blocking possibilities shall also be include. Coincidence status on requested safeguarding actions when blocking / suppression is true shall be implemented. The symbols used on VDUs shall always show true position / status of the motor.
### A.4.4.1.4 Function Template Schematic

#### Inputs

<table>
<thead>
<tr>
<th>Input Description</th>
<th>SBE</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pos. High feedback (MCC)</td>
<td>XGH</td>
<td>Y</td>
</tr>
<tr>
<td>External fault</td>
<td>XF</td>
<td>YF</td>
</tr>
<tr>
<td>Function externally enabled (MCC)</td>
<td>XE</td>
<td>YH</td>
</tr>
<tr>
<td>External priority 1 Set High</td>
<td>XP1H</td>
<td>YL</td>
</tr>
<tr>
<td>External priority 1 Set Low</td>
<td>XP1L</td>
<td>BCH</td>
</tr>
<tr>
<td>External priority 2 Set High</td>
<td>XP2H</td>
<td>BCL</td>
</tr>
<tr>
<td>External priority 2 Set Low</td>
<td>XP2L</td>
<td></td>
</tr>
<tr>
<td>External outside set High</td>
<td>XOH</td>
<td></td>
</tr>
<tr>
<td>External outside set Low</td>
<td>XOL</td>
<td></td>
</tr>
</tbody>
</table>

#### Operator Station:

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Auto mode</td>
<td>Fault annunciation</td>
</tr>
<tr>
<td>Select Man. mode</td>
<td>Status ON/OFF</td>
</tr>
<tr>
<td>Select outside</td>
<td>Auto / manual / Outside</td>
</tr>
<tr>
<td>Select On (high)</td>
<td>Status Blocked</td>
</tr>
<tr>
<td>Select off (low)</td>
<td>Status Suppressed</td>
</tr>
<tr>
<td>Blocking on</td>
<td>Status Disabled</td>
</tr>
<tr>
<td>Blocking off</td>
<td>Status Safeguard</td>
</tr>
<tr>
<td>Suppression on</td>
<td>Coincidence state</td>
</tr>
<tr>
<td>Suppression off</td>
<td>Adaptation</td>
</tr>
</tbody>
</table>

#### Logic:

<table>
<thead>
<tr>
<th>Logic Description</th>
<th>SBE</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lock safeguarding Low</td>
<td>LSL</td>
<td>BA</td>
</tr>
<tr>
<td>Force Safeguarding Low</td>
<td>FSL</td>
<td>BO</td>
</tr>
<tr>
<td>Force Disable transition High</td>
<td>FDH</td>
<td>BP1</td>
</tr>
<tr>
<td>Force Disable transition Low</td>
<td>FDL</td>
<td>BP2</td>
</tr>
<tr>
<td>Force suppression mode</td>
<td>FU</td>
<td>BS</td>
</tr>
<tr>
<td>Force block mode</td>
<td>FB</td>
<td>BB</td>
</tr>
<tr>
<td>Lock Auto mode</td>
<td>LA</td>
<td>BU</td>
</tr>
<tr>
<td>Lock Manual mode</td>
<td>LM</td>
<td>BP1F</td>
</tr>
<tr>
<td>Lock Outside operation mode</td>
<td>LO</td>
<td>BP2F</td>
</tr>
<tr>
<td>Set priority 1 – Duty</td>
<td>SP1</td>
<td></td>
</tr>
<tr>
<td>Set priority 2 – Standby</td>
<td>SP2</td>
<td></td>
</tr>
</tbody>
</table>

Parameters: Reference to vendor documentation
A.4.4.2 SBV - Control of Valves (Pneumatic/Hydraulic Equipment)

A.4.4.2.1 Purpose

Function template for binary (on/off) control of a flow element by means of changing flow of
medium (heat or fluid). The function template will be applied for binary control (open/close flow elements) such as
valves, dampers etc.

A.4.4.2.2 Requirements - Control options

The function template can be configured to operate with several options according to the type of
application. These options are fixed during run-time, but selected when structuring the control
logic and thus called control options. The configured option of the flow element is defining the
principles of operation and is not depending on the actual state of the process the flow element is
serving.

The configured option allows for operation in both manual mode and auto mode. These
operational modes are sub-modes to the selected configured mode and may further be changed
during run-time.

The control options can be defined by a parameter within the template or for some automation
systems also defined as different template within a family of SBV-template. The following modes
shall be made available:

Option 1: Outside Automation System Controlled (CCR indication only)

Flow element (valve) is locally controlled. Status will generally be indicated based on feedback
from limit-switches ("No limit-switches" feedback configuration mode 1, cannot be applied in this
case!). See next page.

If the actual control output to the flow element is wired through the automation system based on
inputs from a outside (local) control function, but no operator control is allowed due to operational
reasons, this option shall also be used. The flow element will not be operable from the VDUs. This
shall be reflected in the indication on the operator stations.

Option 2: Manual Operation only (from VDU in CCR)

The operator in CCR manually switches flow element to high or low flow (Open/Close). The flow
element will additionally be subject to safeguarding (shutdown) or interlock functions overruling
operators input. These are acting through the SBV template by means of the input terminals on the
function template.

The flow element is automatically operated by means of external input commands. External used in this context means that the binary control signal is generated outside the function template, in software or hardware. This configuration allows for operation in both manual and automatic mode. When switched to automatic by the operator the external inputs (X-terminals) will maneuver the flow element. When switched to manual mode, the last output position will be latched until operators input (i.e. when it was running, it keeps running). The function template allows for automatic operation by means of control inputs (XH/XL-pulsed inputs- used as set to High / set to Low, Y output will be following if in auto mode)

Duty/standby configurations for valves are not used. But there is another configuration mode for the SBV-function template, which is the feedback limit-switch constellation. A parameter shall define the four possible constellations:

Feedback option 1: No limit-switches

The position of the element (valve/damper) is derived from the output of the function template and shown on the operator station. (for this mode the confirmed outputs are not relevant)

Feedback option 2: Position high limit-switch feedback only

The position of the element (valve/damper) is taken from the high limit switch only (i.e. if not open, it is assumed to be closed)

Feedback option 3: Position low limit-switch feedback only

As in 2, relying on the low switch (i.e. if not closed, it is assumed to be open)

Feedback option 4: Position high and low limit switches feedback

The position of the element is calculated out of the position of both limit switches. End positions as well as “moving” status can be shown on the operator stations.

A.4.4.2.3 General Requirements

Feedback from the valve/damper is monitored according to the feedback limit-switch constellation and compared to the output state (Y) of the element.
If mismatch is detected, a fault alarm shall be generated. An additional alarm delay function has to be incorporated to allow for a certain delay in change of state. Disable transition facilities shall be provided within the function template to prevent manual and automatic binary control. Suppressing and blocking possibilities shall be also implemented into the template. Coincidence status on requested safeguarding actions when blocking / suppression is true shall be implemented. The symbols used on VDUs shall always show true position / status of the valve.
### A.4.4.2.4 Function Template Schematic

<table>
<thead>
<tr>
<th>Inputs</th>
<th>SBV</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position High feedback</td>
<td>XGH</td>
<td>Position High feedback</td>
</tr>
<tr>
<td>Position Low feedback</td>
<td>XGL</td>
<td>Position Low feedback</td>
</tr>
<tr>
<td>External fault</td>
<td>XF</td>
<td>External fault</td>
</tr>
<tr>
<td>External set high</td>
<td>XH</td>
<td>External set high</td>
</tr>
<tr>
<td>External set low</td>
<td>XL</td>
<td>External set low</td>
</tr>
<tr>
<td>External outside set high</td>
<td>XOH</td>
<td>External outside set</td>
</tr>
<tr>
<td>External outside set low</td>
<td>XOL</td>
<td>Operator Station:</td>
</tr>
<tr>
<td>Operator Station:</td>
<td></td>
<td>Select Auto mode</td>
</tr>
<tr>
<td>Select Auto mode</td>
<td></td>
<td>Select Man. mode</td>
</tr>
<tr>
<td>Select outside</td>
<td></td>
<td>Select outside</td>
</tr>
<tr>
<td>Select Open (high)</td>
<td></td>
<td>Select Open (high)</td>
</tr>
<tr>
<td>Select Closed (low)</td>
<td></td>
<td>Select Closed (low)</td>
</tr>
<tr>
<td>Blocking on</td>
<td></td>
<td>Blocking on</td>
</tr>
<tr>
<td>Blocking off</td>
<td></td>
<td>Blocking off</td>
</tr>
<tr>
<td>Suppression on</td>
<td></td>
<td>Suppression on</td>
</tr>
<tr>
<td>Suppression off</td>
<td></td>
<td>Suppression off</td>
</tr>
<tr>
<td>Logic:</td>
<td></td>
<td>Logic:</td>
</tr>
<tr>
<td>Lock Safeguarding H</td>
<td>LSH</td>
<td>Lock Safeguarding H</td>
</tr>
<tr>
<td>Lock safeguarding L</td>
<td>LSL</td>
<td>Lock safeguarding L</td>
</tr>
<tr>
<td>Force Safeguarding H</td>
<td>FSH</td>
<td>Force Safeguarding H</td>
</tr>
<tr>
<td>Force Safeguarding L</td>
<td>FSL</td>
<td>Force Safeguarding L</td>
</tr>
<tr>
<td>Force Disable transition H</td>
<td>FDH</td>
<td>Force Disable transition H</td>
</tr>
<tr>
<td>Force Disable transition L</td>
<td>FDL</td>
<td>Force Disable transition L</td>
</tr>
<tr>
<td>Force suppress mode</td>
<td>FU</td>
<td>Force suppress mode</td>
</tr>
<tr>
<td>Force block mode</td>
<td>FB</td>
<td>Force block mode</td>
</tr>
<tr>
<td>Lock Auto mode</td>
<td>LA</td>
<td>Lock Auto mode</td>
</tr>
<tr>
<td>Lock Manual mode</td>
<td>LM</td>
<td>Lock Manual mode</td>
</tr>
<tr>
<td>Lock Outside operation mode</td>
<td>LO</td>
<td>Lock Outside operation mode</td>
</tr>
<tr>
<td>Parameters: Reference to vendor documentation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Normal function output
- Alarm Function failed
- Output Position High Confirmed
- Output Position Low Confirmed
- Fault annunciation
- Status Open/Closed
- Auto / manual / Outside
- Status Blocked
- Status Suppressed
- Status Disabled
- Status Safeguard
- Coincidence state
A.4.4.3 CB - Binary Control (Analogue Input - Binary Output)

A.4.4.3.1 Purpose

Function template for binary (on/off) control of a measured analogue process variable by means of changing flow of medium (electricity, heat or fluid). The function template shall be applied for all binary control of flow elements such as motors, pumps, heaters, fans etc.

A.4.4.3.2 Requirements - Control options

The function template can be configured to operate with several options according to the type of application. These options are fixed during run-time, but selected when structuring the control logic and thus called control options. The configured option of the flow element is defining the principles of operation and is not depending on the actual state of the process the flow element is serving. The control options allow for operation in both manual mode and auto mode. These operational modes are sub-modes to the selected configured mode and may further be changed during run-time. The control options can be defined by a parameter within the template or for some automation systems also defined as different template within a family of CB - template. The following control options shall be made available:

Option 1: Manual Operation only (from VDU in CCR)

Flow element is manually switched to high or low flow by the operator. The flow element will additionally be subject to safeguarding (shutdown) or interlock functions overruling the operator input. These are acting through the CB - template by means of the input terminals on the function template.

Option 2: Manual Operation + Automatic Control

The flow element is automatically operated by means of external input commands. External used in this context means that the analogue value is read and checked against the parameterised limit value. If the input value is higher than the high limit value, the output is set to one. There is a hysteresis defined, which prevents flickering output setting when the input value decreases beneath the limit. It is valid vice versa for the low limit. When switched to automatic by the operator the external inputs (X-terminals) will maneuver the flow element. When switched to manual mode, the last output position will be latched until operators input (i.e. when high, it will keep output high).

A.4.4.3.3 General Requirements

Disable transition facilities shall be provided within the function template to prevent manual and automatic binary control. Suppressing and blocking possibilities including coincidence status generation shall be also implemented.
### A.4.4.3.4 Function Template Schematic

<table>
<thead>
<tr>
<th>Inputs</th>
<th>CB</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Function input</td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Position High feedback</td>
<td>XGH</td>
<td>YF</td>
</tr>
<tr>
<td>Position Low feedback</td>
<td>XGL</td>
<td>BCH</td>
</tr>
<tr>
<td>External fault</td>
<td>XF</td>
<td>BCL</td>
</tr>
<tr>
<td>Function externally</td>
<td>XE</td>
<td></td>
</tr>
<tr>
<td>Enabled (MCC)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Inputs**
- Normal Function input: X, Y
- Position High feedback: XGH, YF
- Position Low feedback: XGL, BCH
- External fault: XF, BCL
- Function externally: XE
- Enabled (MCC)

**Logic:**
- Lock Safeguarding: LSH, BA
- Lock safeguarding: LSL, BS
- Force Safeguarding: FSH, BB
- Force Safeguarding: FSL, BU
- Force Disable transition: FDH, BXH
- Force Disable transition: FDL, BXL
- Force suppression mode: FU, WH
- Force blocked mode: FB, WL
- Lock Auto mode: LA
- Lock Manual mode: LM

**Operator Station:**
- Select Auto mode
- Select Man. mode
- Select On (high)
- Select off (low)
- Blocking on
- Blocking off
- Suppression on
- Suppression off

**Logic:**
- Fault annunciation
- Status ON/OFF
- Auto / manual
- Status Blocked
- Status Suppressed
- Status Disabled
- Status Safeguard
- Coincidence state

**Parameters:**
Reference to vendor documentation
A.4.5 Modulating control

A.4.5.1 CA - Modulating Control (PID Controller)

A.4.5.1.1 Purpose

Function template for modulating control. Vendor standard PID controller template shall be used. The following features shall be provided. If not included, building a macro containing these additional features to the vendor standards shall be included.

A.4.5.1.2 Requirements

The controller can be operated in either manual, automatic internal or external mode. The operational modes appear eligible on the operator station. The controller can be forced to different modes by logic inputs.

Signal conditioning such as square-root extraction and smoothing (low pass filter) of analogue signal shall not be included into this template. These functions shall be used if applicable only and thus be realised in auxiliary function template. The CA template generates a fault alarm (monitoring of the analogue variable, feedback supervision), a coincidence alarm and a deviation warning. The deviation is calculated by subtracting the measured value from the set point. It is monitored and a warning will be enunciated on the operator station, if the deviation is outside working area.

Controller output

Function output will normally be within the range of 0-100 %. However, other output ranges may be applied for cascading via parameters. The controller can be switched to output tracking mode by input FT. The output value Y will then be clamped to the input XT, output tracking value.

Set point

The set point shall be either internal or external. Another controller or other values generate external set point (XR) is used when operated in cascade mode and the set point. External may additionally be used for automatic setting of set point for automatic restart purposes. The operator gives internal set point.

The internal set point shall be clamped to the measured value in manual mode to assure a bumpless transfer from manual to automatic mode (set point tracking whilst in manual mode). The last set point used in auto mode is stored and displayed as a reference set point. The reference set point is shown on the operator station only and may be changed in manual mode by operating the set point value.

When switched to auto by the operator, the operator can manually adjust the set point to accomplish a bumbles transfer to the decided reference set point. When forced to auto by external logic, the set point shall automatically by step-by-step changed back to the original reference set point, if the measured process value has changed. The rise of the ramp is defined by an input parameter.

External/internal set point mode appears eligible on the operator station. The controller can be locked to external mode as well as to internal mode.
Other required features

A possibility to differ in between direct acting (increasing control deviation to give an increasing output) and indirect acting (increasing measured value to give an decreasing output) has to be provided. Fail-to-open and fail-to-closed functions are to be obtained.

It shall further be possible to adjust the PID controller parameters such that the controller acts either as a P controller, as a PI controller or with a PID algorithm. The controller parameters shall be indicated on the operator station and easily be changeable. If operable from operator station, they ought to be keyword protected. A feedback from the controller valve position low (XGL) can be monitored and compared with the Output State. If mismatch is detected, a fault alarm shall be generated.

However, to allow for a certain delay in change of state a parameter must be applied to adjust delay time. The function template shall also provide blocking and suppression facilities with the necessary additional features (coincidence status).
### A.4.5.1.3 Function Template Schematic

#### Inputs

<table>
<thead>
<tr>
<th>Normal function input</th>
<th>X</th>
<th>Y</th>
<th>Normal function output</th>
</tr>
</thead>
<tbody>
<tr>
<td>External fault</td>
<td>XF</td>
<td>YF</td>
<td>Function failed</td>
</tr>
<tr>
<td>External Set point value</td>
<td>XR</td>
<td>YR</td>
<td>Reference Set point value</td>
</tr>
<tr>
<td>Tracking value</td>
<td>XT</td>
<td>YX</td>
<td>Measured value output (X)</td>
</tr>
<tr>
<td>Position low feedback</td>
<td>XGL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Operator Station:**
- Select Auto mode: Alarm/Fault Annunciation
- Select Man. mode: Status Low- Closed
- Select Internal: Auto / manual
- Select External: Internal / External
- Set Setpoint: Status Blocked
- Set Output: Status Suppressed
- Blocking on: Status Track mode
- Blocking off: Status Safeguard
- Suppression on: Coincidence state
- Suppression off:

**Logic:**
- Lock Safeguarding H: LSH
- Lock safeguarding L: LSL
- Force Safeguarding H: FSH
- Force Safeguarding L: FSL
- Force Track mode: FT
- Force suppression mode: FU
- Force blocked mode: FB
- Lock Auto mode: LA
- Lock Manual mode: LM
- Lock External set-point mode: LX
- Lock Internal set-point mode: LI

- Lock Safeguarding: W/ Warning Deviation
- Lock safeguarding L: BA Status Auto/Man mode
- Force Safeguarding H: BX Status External/Internal mode
- Force Safeguarding L: BS Status Safeguarding mode
- Force Track mode: BB Status Blocked mode
- Force suppression mode: BU Status suppressed mode
- Force blocked mode: BT Status Tracking mode
- Lock Auto mode: WH Warning Alarm High
- Lock Manual mode: WL Warning Alarm Low

**Parameters:**
Reference to vendor documentation
A.4.5.2 CS - Step Control Template

A.4.5.2.1 Purpose
Function template for typical control and monitoring of choke valves. The choke valves are operated by either pulsed or steady output signals. One output for opening and one for closing the valve.

A.4.5.2.2 Requirements
The function template can be operated in either manual, auto mode. In manual mode the operator can maneuver the valve step by step to either open or closed position. Alternatively the operator can enter a set point for position (internal mode) and switch to auto mode. The valve will then automatically travel to set point position. Finally the function template can be operated in external mode, utilising the input terminal XR for external set point. Disable transition facilities shall be provided within the function template to prevent manual and automatic sequencing binary control, as well as automatic closed loop (modulating) control actions.
Maximum allowed deviation between set point and position feedback is given by parameter input. If outside limits, a warning shall be generated. Position feedback from flow element (XGL) will be compared with the position read (XG < 1 %) and initiate a function failed alarm if mismatch is detected. Function failed alarm (fault alarm) shall be announced on the operator station. Function failed status shall further be made available on the output terminal YF.

The following actions will be taken:

- Generate fault alarm and set output YF
- Switch to manual mode if in auto mode
- Position retained
- Externally generated faults may be connected to the template. These will only be enunciated.
- Safeguarding, blocking and inhibiting functions shall be incorporated into the template as for SBE, SB and CA.
### A.4.5.2.3 Function Template Schematic

<table>
<thead>
<tr>
<th>Inputs</th>
<th>CS</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position Read as measured value</td>
<td>XG</td>
<td>YH</td>
</tr>
<tr>
<td>External fault</td>
<td>XF</td>
<td>YL</td>
</tr>
<tr>
<td>External Set point value</td>
<td>XR</td>
<td>YF</td>
</tr>
<tr>
<td>Position low feedback</td>
<td>XGL</td>
<td>BCL</td>
</tr>
<tr>
<td>Position status of position</td>
<td></td>
<td>BG</td>
</tr>
</tbody>
</table>

**Operator Station:**
- Select Auto mode: Alarm/Fault Annunciation
- Select Man. mode: Status Low- Closed
- Select Internal: Auto / manual
- Select External: Internal / External
- Set Step Open: Status Blocked
- Set Step Close: Status Suppressed
- Set Step point: Status Safeguard
- Blocking on: Status Moving
- Blocking off: Coincidence state
- Suppression on: 
- Suppression off: 

**Logic:**
- Lock safeguarding: L
- Force Disable transition: H
- Force suppression mode: FU
- Force blocked mode: FB
- Lock Auto mode: LA
- Lock Manual mode: LM
- Lock External set point mode: LX
- Lock Internal set point mode: LI
- LSL
- W  V: Warning Deviation
- BA: Status Auto/Man mode
- BX: Status External/Internal mode
- BS: Status Safeguarding mode
- BB: Status Blocked mode
- BU: Status suppressed mode

Parameters: Reference to vendor documentation
A.4.6 Co-ordination Function Template

A.4.6.1 QA - Totalizer Template

A.4.6.1.1 Purpose
Function template for accumulation of process values based on time intervals.

A.4.6.1.2 Requirements
A scale factor is determined by comparison of engineering units for function input and outputs, and shall be routed into the template via an input parameter.
Overflow of counter shall result in function failed (YF).
The automatic monitoring comprises limit checking on HH action alarms as well as H warnings and a status high without any alarm/warning annunciation.

Totalizing on/off

The totalizing function can be started and stopped by the operator. The totalizing can be enabled and disabled from logic by means of the input XEQ. If disabled or stopped the output value will be frozen until started again and XEQ is set. When input FQ is set from logic, the totalizer is forced to count unless X (Analogue variable) lower than 0, XEQ = false, or external fault is set (XF = 1).
The totalizer can be reset by the operator as well as from logic input, but only as long as the function template is enabled.
A.4.6.1.3 Function Template Schematic

<table>
<thead>
<tr>
<th>Inputs</th>
<th>QA</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal function input</td>
<td>X</td>
<td>Y1 Previous total</td>
</tr>
<tr>
<td>External fault</td>
<td>XF</td>
<td>Y2 Current total</td>
</tr>
<tr>
<td>External enabling totalizing</td>
<td>XEQ</td>
<td>YF Function failed</td>
</tr>
<tr>
<td>Reset external totalizing</td>
<td>RXQ</td>
<td></td>
</tr>
</tbody>
</table>

Operator Station:
- Set Totalizer on
- Set Totalizer off
- Reset Totalizer
- Block HH on
- Block HH off
- Suppression on
- Suppression off

Logic:
- Force Totalizing FQ AHH Action alarm HH
- Force block mode alarm HH FBHH BHH Status alarm HH
- Force suppression mode alarm HH FUHH WH Warning alarm H
- Force suppression mode alarm WH FUWH BBHH Action alarm HH is blocked

Parameters: Reference to vendor documentation
A.4.6.2 YA - Process Input Calculation Template

A.4.6.2.1 Purpose
Function template for execution of simple signal as well as control variable processing.

A.4.6.2.2 Requirements
The template shall comprise the following features:

- Ratio calculation
  The ratio between two analogue values is calculated and multiplied with a constant parameter.

  Algorithm:
  
  \[
  \text{If (X2 = 0) then} \\
  \quad \text{YF} := 1 \quad ; \text{Divide by zero.} \\
  \text{else} \\
  \quad \text{Y} := \frac{\text{X1}}{\text{X2}} \times \text{PFCT} \quad ; \text{Calculate ratio.}
  \]

- Flow calculation based on density
  Actual volumetric flow (m³/h) of gas or liquid is calculated based on density.

  Algorithm:
  
  \[
  \text{Y} = \text{PFCT} \times \sqrt{\frac{\text{X1}}{\text{X2}}}
  \]

  Where:
  
  \[
  \begin{align*}
  \text{PFCT} & = \text{Measuring constant given by the pressure} \\
  \text{X1} & = \text{Diff. pressure transmitter signal (Bar).} \\
  \text{X2} & = \text{Density transmitter signal (kg/m³).}
  \end{align*}
  \]
• Flow calculation based on pressure (Bara) and temperature
Actual volumetric flow (m\(^3\)/h) of gas or liquid is calculated based on temperature and absolute pressure.

Algorithm:
\[
Y = PFCT \times \sqrt{\left(\frac{X1 \times (X3+273.15)}{X2+1.01325}\right) \times MW}
\]

Where:
- \(PFCT\) = Measuring constant given by the pressure drop across the actual orifice plate.
- \(X1\) = Diff. pressure transmitter signal (Bar).
- \(X3\) = Temperature (Celsius).
- \(X2\) = Pressure (Barg).
- \(MW\) = molweight entered by operator.

Note: Temperature is converted to Kelvin and pressure is converted to Bara within the block. Input to be given in degrees.

• Flow calculation based on pressure, temperature and density
Standardised flow (Sm\(^3\)/h) of gas or liquid is calculated based on temperature, pressure and density.

Algorithm:
\[
Y = PFCT \times \sqrt{\left(\frac{X1}{X2}\right) \times \frac{(X3+1.01325)}{(X4+273.15)}}
\]

Where:
- \(PFCT\) = Measuring constant given by the pressure drop across the actual orifice plate.
- \(X1\) = Diff. pressure transmitter signal (Bar).
- \(X2\) = Density transmitter signal (kg/m\(^3\)).
- \(X3\) = Pressure transmitter signal (Barg).
- \(X4\) = Temperature transmitter signal (Cels)
Flow calculation based on pressure and temperature
Standardised flow (Sm³/h) of gas or liquid is calculated based on temperature and pressure.

Algorithm:
When more than one calculation are based on the same pressure and temperature, these calculations can be done with help of one common compensation block. To obtain this feature, parameterize PKF=0.

\[ Y = PFCT \times \sqrt{\frac{(X2+1.01325)}{(X3+273.15) \times MW}} \]

Where:
- **PFCT** = Factor compensating for design temperature and design pressure of the orifice plate
- **X2** = Pressure transmitter signal (barg)
- **X3** = Temperature transmitter signal (cels)
- **MW** = Molweight entered by operator.

When only one calculation is based on the temperature and pressure; parameterize PKF > 0.

\[ Y_A = PKF \times \sqrt{X1} \]
\[ Y_B = PFCT \times \sqrt{\frac{(X2+1.01325)}{(X3+273.15) \times MW}} \]
\[ Y = Y_A \times Y_B \]

Where:
- **PKF** = Measuring constant given by the pressure drop across the actual orifice plate.
- **X1** = Diff. pressure transmitter signal (Bar).
- **PFCT** = Factor compensating for design temperature and design pressure of the orifice plate.
- **X2** = Pressure transmitter signal (barg)
- **X3** = Temperature transmitter signal (cels)
- **MW** = Molweight entered by operator.
Iterative flow calculation based on temperature and density. Standardised flow \((\text{Sm}^3/\text{h})\) of gas or liquid is calculated iterative based on temperature and density.  

Algorithm: \[ Y = PFCT \times C \times \sqrt{\frac{X_1}{X_2}} \]

Where:
- \(PFCT\) = Factor compensating for design temperature and design pressure of the orifice plate 
- \(C\) = \(e\)

With:
- \(dT = TEMP - 15\)
- \(a = \frac{613.9723}{DS}\)
- \(DS = \frac{X_2}{C}\)
- \(X_1 = \text{Diff. pressure transmitter signal (bar)}\)
- \(X_2 = \text{Density transmitter signal (kg/m}^3\)\)

The calculation is done iterative. When calculation limits:

\[ |DS - (DS_{\text{old value}})| < 0.05 \]

and

\[ |C - (C_{\text{old value}})| < 10^{-5} \]

The different constellations shall be preferably achieved during implementation in configuration modes. The formulas shall be defined according to specific project requirements. The way of calculation and selection of configuration mode is dependent on the automation system used.
### A.4.6.2.3 Function Template Schematic

#### Inputs

<table>
<thead>
<tr>
<th></th>
<th>YA</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>Y</td>
</tr>
<tr>
<td>X2</td>
<td>YF</td>
</tr>
<tr>
<td>X3</td>
<td></td>
</tr>
<tr>
<td>X4</td>
<td></td>
</tr>
</tbody>
</table>

#### Outputs

- Normal function output
- Alarm - Function failed

#### Operator Station:
- Molecular weight input

#### Parameters:
- Factor used for calculation: PFCT
- K-factor used for calculation: PKF
- Define formula for Calculation: PMOD

#### Parameters:
- Reference to vendor documentation
A.4.7 Process Shutdown templates

A.4.7.1 LB – PSD shutdown level template

A.4.7.1.1 General

Function template for safeguarding shutdown functions requiring latching. One LB function template shall be used per shutdown level. The shutdown levels form an overview over the whole shutdown system. They are build up in a hierarchy of levels. The LB will be the interface to the HMI and also supervise the shutdown performance per level. All cause and effect elements will have the possibility to interface the LB.

A.4.7.1.2 Normal function input (Primary Safeguarding)

If the automatic Safeguarding actions (input X) initiated by single cause results in a release of several succeeding levels, the primary shutdown level is the first shutdown released. The Primary Safeguarding will be latched and will thus require a reset interaction by the operator.

A.4.7.1.3 External Safeguarding

An External Safeguarding (input XS) is a shutdown released from a higher shutdown level. External Safeguarding may be chained to form a timed sequence or logic condition of succeeding shutdown actions. External Safeguarding will not be latched and will thus not require a separate reset interaction by the operator.

A.4.7.1.4 Blocking

The function template shall provide the possibility to block all inputs from other shutdown levels as well as to all other shutdown levels from the operator station. Using two independent operations should do this. These blocking facilities shall not affect the process inputs/outputs. Blocking of Primary Safeguard may be shown on the LB. Blocking on effect elements is shown on the LB.

A.4.7.1.5 Monitoring

When a shutdown is performed correctly, only the shutdown level status (from LB) should be reported and logged in additional to the alarm coming from the shutdown initiator (Primary Safeguard). However, if not all defined shutdown actions are performed due to equipment failure or blocked mode on shutdown actions, separate level associated alarms for coincidence and fault should be generated.
A.4.7.1.6  Function Template Schematic

<table>
<thead>
<tr>
<th>Inputs</th>
<th>LB</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal function input</td>
<td>X</td>
<td>Normal function output</td>
</tr>
<tr>
<td>External safeguarding</td>
<td>XS</td>
<td>Output external</td>
</tr>
<tr>
<td>Reset safeguarding</td>
<td>RX</td>
<td></td>
</tr>
</tbody>
</table>

Operator Station:
- Set safeguard
- Reset safeguard
- Blocking on XS
- Blocking off XS
- Blocking on YX
- Blocking off YX

Parameters:
- Shutdown level

Reference to vendor documentation
A.4.8 Auxiliary Function Template

A.4.8.1 Required Auxiliary Function Template

Dependent on the design it has shown to be helpful and sensible to have special function template for the ESD and F&G systems. These templates shall include all necessary interfaces to the mimic/matrix of the ESD system, but shall basically be based on the standard template as previously outlined.

There shall be card-monitoring possibilities provided, which shall be implemented using the built in standards of the automation system.

For the sub sea functions there may also be an extra set of function template, which incorporate the special sub sea control system interfaces.
A.4.9 Sequence logic

Sequence logic should be specified according to IEC 61131-3. The graphical language - Sequential Function Chart (SCF) should be utilised. Sequence oriented tasks should be formulated using steps and transitions. The steps represent actions (to SCD functions) and transition conditions that must be fulfilled before moving to the next step.

Features of the Sequential Function Chart shall include:
- Formulation of steps and conditions for SCD
- Parallel sequences and alternative sequence selection (priority can be specified).
- Feedback paths allowable.

The sequence logic may be specified in SCD drawing or a separate document. There shall be implemented references between SCD functions and sequence logic.
ANNEX B - SCD DRAWING STANDARD (NORMATIVE)

B.1 Introduction

The SCD is in general a simplified version of the P&ID’s where all the piping details have been excluded and where functional templates and their logical connections have been included. A consequence of this is that the process is presented on a considerable fewer sheets. This gives a better overview of the process.

It is recommended to design the layout of the SCD independently and in parallel to the P&ID.

The information on the SCD is in general divided in four categories:

- Equipment
- Measuring Instruments
- Functions
- Flow paths

The symbols used to present the equipment are mainly based on ISO3511 and NS1710. In addition some new symbols are introduced in the standard to reflect the extended information provided by the SCDs.

B.2 Content of scd’s

B.2.1 Equipment

B.2.1.1 Plant Equipment

Plant equipment is defined as equipment used to process, transport or store process fluids: gas, liquids or solids. Such equipment includes:

- Tanks, pressurized vessels, columns
- Flow machines: fans, pumps, compressors, ejectors, turbines, conveyors and weight feeders
- Mixers
- Heat exchangers
- Filters
- Hydrocyclones, reactors or other special process equipment
- Complex or non-electrical drives.

Construction details or internals may be shown only where essential for the understanding of associated instruments and control. The equipment should be tagged.

B.2.1.2 Electrical Equipment

Electrical equipment shall, as a general rule be included on the SCD’s. A symbol with references to the electrical system shall always be used as interface between system function and electrical actuators. All process inline electrical equipment shall be included on the SCD. Electrical equipment normally included on the SCD’s are:
• Electrical heaters
• Electrical-chemical equipment
• Generators
• Motors with extensive instrumentation

Examples of equipment, which normally will not be shown on the SCD’s are:

• Electrical motors directly connected to mechanical equipment forming an entity (for examples standard motor/pump configuration)
• Local emergency push buttons when these are provided as a standard feature.

Individual electrical consumers may require additional features associated with the electrical switchboard or starter circuitry. Additional electrical equipment may be inserted between the switchboard reference symbol and the consumer. The same reference symbol shall be used to give references to such.

Typical additional equipment is:

• Transformers (normally only included if instrumentation is involved)
• Frequency converters (normally involves control)

**B.2.1.3 Valves**

Valves shall be included on the SCD’s according to the list below:

• Remotely controlled valves with actuator (incl. On/off valves and control valves)
• Local self-actuated control valves or valves controlled from local controllers
• Pressure safety valves
• Check valves and flow restriction orifices where essential for understanding system operation

**B.2.2 Measuring Instruments**

All measuring instruments with input to the control system, or to local controllers shall be shown on the SCD.

Instruments connected to dedicated control systems with separate operator station shall be included where essential for understanding the system.

**B.2.2.1 Functions**

**B.2.2.2 Control Functions**

The SCD shall include all Control functions and their interrelation. Interrelation in form of exchange of status’s, measuring variables, interlocking and suppression. Both functions controlled by the SAS and in any package-supplied control system shall be identified to give a total understanding for the operation. These functions are represented with different symbols as specified later in this annex.

All control functions including locally mounted controllers shall be shown. For locally mounted controllers may tag number however be omitted
B.2.2.3 Shutdown Functions

All shutdown functions within PCS and PSD shall be implemented on the SCDs. Shutdown functions within the PCS and non-latched shutdown functions within PSD shall be implemented as logical connections between the relevant output and inputs on the applicable control function blocks. Latched shutdown functions within PSD shall be implemented as logical connections between the relevant output and the shutdown function template, ref. SCD - Functional standard. Shutdown functions from the external systems like HIPPS, F&G and ESD shall be identified by the triangle reference symbol which gives references to the external system and logical connected to the relevant output and inputs on the applicable control function blocks.

B.2.3 Flow paths

B.2.3.1 Process Flow

Flow paths (including recycle lines) which are required for understanding of system operation for normal operation, start-up and shutdown shall be included.

B.2.3.2 Signals

The following signals shall be shown on the SCD:

- signals between functions blocks and field instruments/flow elements
- signals interconnecting function templates
- signals between electrical equipment and function templates
- Signals between local control panels and function templates
- signals from/to shutdown reference triangles
- signals from/to sequence reference flags

The signal path shown on the SCD’s shall in general only reflect the functional relations.

Signal lines may only be omitted if it is described in the SCD-legend or in a typical.

B.2.4 Information not shown on the SCD’s

- Minor flow paths as pipes and ducts not essential for understanding of the system
- Pipes with valves etc. for maintenance purpose
- Pipe tagging
- Local instruments without connection to any control function
- Fire and gas detection and fire fighting equipment (but may however be shown on special printouts suited for these purposes)
- General utility functions as heat-tracing etc.

B.2.4.1 Black Box representation

To ease the readability of the SCD’s the following recommendation shall be adhered to:

- Functions, which are not required for the general understanding of the process/system interactions, may be omitted or described in a short text with reference to a lower level SCD where the function may be fully shown. An example is the mechanical part of a compressor.
- Pure logic functions of some complexity may on the SCD be shown as a black box including textual description of the function. Details of the internals may be included on a more detailed level SCD.
B.2.5 Parallel Equipment

Where parallel, identical, complex equipment shall be shown, only one set may be fully drawn. The other sets may be shown as boxes with reference to the fully drawn set. Interdependency between parallel functions, may be indicated by showing the interconnected function templates with terminal codes inside the box. Where required to ease the understanding, connections may be drawn inside the borders of the box. An example is presentation of wells.

B.3 Layout

B.3.1 Layout

Proper layout of the SCD’s is a key factor to obtain readability. Experience shows that the SCD’s have a tendency to include information to an extend which makes the readability suffer. Only general guidelines are introduced in this section.

B.3.2 The extent of information on SCD’s

Primarily the process shall be divided in functional standalone sections on each SCD. Natural process splits shall be considered to minimise the number of interfaces. As a guideline for readability of the SCD the number of objects may be used. The process may be sectionalised to provide a maximum number of objects requiring function templates (transmitters, valves, motors, etc.). The maximum number should be 30-40 if the functions are dominated of control, 50-60 if the functions are dominates of monitoring.

B.3.3 Location of information on the SCD’s

Different type of information has to be allocated:

- References to associated SCD’s should be located on the outermost right or left areas
- Shutdown applications shall be located on the upper section of the SCD sheet.
- The process and associated function templates shall be located in the remaining part

B.3.4 Direction of flow

The main flow should normally be from left to right in the diagram. This statement is applicable for both process flow and for flow of information. However, control signal may by nature be contrary to this and violations of the statement will occur.

B.3.5 Page connectors

References to and from succeeding and preceding SCD sheets shall be included both for process flow and signals. The references represent the connecting links and all transfer of process medium or signals between SCD’s shall be supported by the page connector symbol.

Page connector symbols may include both the process and the signal flow. The direction of flow for the two types may be reversed. Such cases should be limited to include signals having a direct and significant influence on the flow. An example would be a signal for stop or trip of a pump upstream the process section shown on the SCD where the signals originate.
B.4 Symbols

The symbols used on the SCD shall in general adhere to the symbols used on the P&ID's, ref. ISO 3511. However, modifications and additions to both the symbols itself and the range of symbols defined in the P&ID legend are required to reflect the extended information provided by the SCD's. To enable use of extended functions the following SCD symbols are introduced:

- Function templates
- Logic and arithmetic functions
- Signal Lines
- Instruments
- Reference symbols

B.4.1 Function Template symbol

Function template shall be used for all tagged functions related to instrumentation and control.

<table>
<thead>
<tr>
<th>System in SAS</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCS - C</td>
<td></td>
</tr>
<tr>
<td>PSD - P</td>
<td></td>
</tr>
<tr>
<td>ESD - E</td>
<td></td>
</tr>
<tr>
<td>HIPPS - H</td>
<td></td>
</tr>
</tbody>
</table>

The left-hand three rows column is dedicated for:

- Typical (internal control option/variant for specific template)
- System and Unit in SAS
- Function Template (Annex A)

The text field is dedicated for additional information to the reader of the SCD.

The symbol represents the complete control function covered by the function template, ref. SCD Function Standard. The control function can be completely integrated in SAS (as shown in above example) or can be integrated in stand-alone packages.

The symbol shall be altered to show the degree of integration:

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
</tbody>
</table>

I     Control function and HMI fully integrated in the main control system.
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Control function and HMI fully integrated in the main control system.</td>
</tr>
<tr>
<td>II.</td>
<td>HMI function integrated in the main control system. Outside control function not shown separately</td>
</tr>
<tr>
<td>III.</td>
<td>Outside control function. Interface to the main control system shown separately if applicable. Symbol I should then be used.</td>
</tr>
</tbody>
</table>
### B.4.2 Symbols for logic and arithmetic functions

As a general rule, positive logic shall be used on the SCDs.

Symbols for arithmetic and logic functions are unique for the SCD method. The symbols for combination of multiple input signals can be shown differencing between software and hardware realisation:

<table>
<thead>
<tr>
<th></th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Logic &quot;OR&quot; (A or B = C)</td>
</tr>
<tr>
<td>&amp;</td>
<td>Logic &quot;AND&quot; (A and B = C)</td>
</tr>
<tr>
<td>H</td>
<td>High Selector (C = the higher of A and B)</td>
</tr>
<tr>
<td>L</td>
<td>Low Selector (C = the lower of A and B)</td>
</tr>
<tr>
<td>&gt;</td>
<td>Comparator High (C = 1 when B &gt; A, otherwise C = 0)</td>
</tr>
<tr>
<td>&lt;</td>
<td>Comparator Low (C = 1 when B &lt; A, otherwise C = 0)</td>
</tr>
<tr>
<td>+</td>
<td>Arithmetic Plus (A + B = C)</td>
</tr>
<tr>
<td>-</td>
<td>Arithmetic Minus (A - B = C)</td>
</tr>
<tr>
<td>*</td>
<td>Arithmetic Multiply (A * B = C)</td>
</tr>
<tr>
<td>/</td>
<td>Arithmetic Division (A / B = C)</td>
</tr>
<tr>
<td>M</td>
<td>Memory element (S=set, R=reset)</td>
</tr>
<tr>
<td>I</td>
<td>Inverter ( NOT A = C)</td>
</tr>
<tr>
<td>S</td>
<td>Split of signal</td>
</tr>
<tr>
<td>#</td>
<td>Optional</td>
</tr>
</tbody>
</table>
By use of “Optional” the formula should be written at the output signal line.

To avoid ambiguities regarding hardware/software interpretation and system unit allocation of signals the following rules shall be strictly adhered to:

- Signals from field devices shall always be routed directly to a function template.
- A hardware signal split is defined to be a field device and such an exception, where a field device is connected to a field device.

In special cases output from a hardware signal split can be routed to a local instrument.
The logic elements for single signal operation are defined in the table below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Logic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter</td>
<td>![Symbol for Inverter]</td>
<td>![Logic for Inverter]</td>
</tr>
<tr>
<td>Timer (delay on rising edge)</td>
<td>![Symbol for Timer (rising edge)]</td>
<td>![Logic for Timer (rising edge)]</td>
</tr>
<tr>
<td>Timer (delay on falling edge)</td>
<td>![Symbol for Timer (falling edge)]</td>
<td>![Logic for Timer (falling edge)]</td>
</tr>
<tr>
<td>Pulse generator (pos. pulse on false - true)</td>
<td>![Symbol for Pulse generator (false - true)]</td>
<td>![Logic for Pulse generator (false - true)]</td>
</tr>
<tr>
<td>Pulse generator (pos. pulse on true - false)</td>
<td>![Symbol for Pulse generator (true - false)]</td>
<td>![Logic for Pulse generator (true - false)]</td>
</tr>
</tbody>
</table>

All symbols shall maintain the orientation of the symbol regardless of the relative signal line orientation.

**B.4.3 Parameter Labels**

To implement process parameters, numbers and logical operands the symbol shown below should be used.
B.4.4 Signal line

The general symbol for signal line is

Arrow shall be included to indicate the direction of information flow. Whenever multiple usage of a signal is required, the signal split symbol shall be used. Signal lines for electrical signal/power, hydraulic signal/power, pneumatic signal power and digital communication link shall be identical to symbols defined in the P&ID legend.

B.4.5 Instruments

The instruments shall be drawn with small circles without tag identification on SCD where the instrument tag may be derived from the associated function template. This is a deviation from ISP3511. The reason for the deviation is that the same information is shown in the function template.

No tag number shall be provided at this point unless where the process variable cannot be derived from the function code shown in the function template. The identification letters dedicated for the measured variable shall in that case be given adjacent to the instrument symbol.

B.4.6 Mechanical equipment

The symbols for the equipment shall be identical to symbols defined in the P&ID legend. Only the basic symbol shall be used. Auxiliary equipment not required to fulfill the intention of the SCD shall be omitted.

B.4.7 Valves

B.4.7.1 On/Off Valves

The on/off valves shall be drawn as a simple valve. The actuator shall be drawn with a small circle without tag identification letters. This is a deviation from ISO 3511. The reason for the deviation is that the same information is shown in the function template.
B.4.7.2 Modulating control valves

B.4.7.3 Limitswitches
For indication of limitswitches shall GSL and GSH be used. GSL indicates a limitswitch for closed position. GSH indicate a limitswitch for open position. GSL should be located downstream the valve. GSH upstream the valve.
**B.4.7.4 Fail Safe**

Fail Safe should be shown on the SCD according to the figure below.

![Fail Safe Diagram](image)

- Fail Close
- Fail Open
- Failed Locked

**B.4.7.5 Normal Open / Normal Close**

Normal Open / Normal Close may be shown on the SCD. If shown it shall be shown according to the figure below.

![Normal Open/Close Diagram](image)

- Normal Open
- Normal Close
B.4.8 Electrical equipment

For electrical devices, the SCD shall provide references to the electrical equipment which hold signal interface to the control system.
B.4.9 Reference Symbols

B.4.9.1 Page Connectors

Page Connectors to and from succeeding and preceding SCD sheets shall be included both for process and signal flow lines. The page connectors represent the connecting links and all transfer of process medium or signals between SCD’s shall be supported by the reference symbol.

Drawing reference for process connections

\[
\text{SCD-number} \quad \rightarrow \quad \text{SCD-number}
\]

Drawing reference for instrument signals

The description shall give a unique reference

\[
\text{SCD-number} \quad \rightarrow \quad \text{SCD-number}
\]

B.4.9.2 ESD/HIPPS/Blowdown/F&G Reference Triangle

References to and from the ESD, HIPPS, Blowdown and Fire & Gas shall be included on the SCD. The ESD, HIPPS, Blowdown and Fire & Gas can, but will normally not be included on the SCD’s.

\[
\text{Level} \quad \text{E} \quad \text{E - ESD Action} \quad \text{H - HIPPS} \quad \text{B - Blowdown Action} \quad \text{F - Fire & Gas Action}
\]

\[
\text{Level} \quad \text{E} \quad \text{E - ESD Input} \quad \text{H - HIPPS} \quad \text{B - Blowdown Input} \quad \text{F - Fire & Gas Input}
\]
**B.5 Tagging**

All function templates on SCD shall be tagged.

The tag shall identify the function of the template and shall have a sequence number.

The project standards for tagging shall be used. Such standard will normally be in accordance with generally accepted standards like NS 1438 / ISO 3511.

The same tag identification shall be used for identical functions on P&ID, SCD and HMI.

In cases were the equipment shall be tagged e.g. tagging of electrical equipment should object tagging be used.

**B.6 Terminal codes**

Each function template has defined input and output signals. Input denoted with X is acting on the output Y and/or on operator presentation. The blocks contain necessary monitoring functions to ensure that the most frequent faults regarding to the field object are detected and reported.

Each signal interconnecting two functions, use terminal codes for identification.

The most frequent used terminal codes are shown in the table below. For complete overview of terminal codes ref. annex A; Functional Standard.
The inputs shall be located to the left of the function template.
The outputs shall be located to the right of the function template.
The feedback signals shall be located at the bottom of the function template.
The control function interlocks and the alarm suppressions should be located at the top of the function template.
The mode selection should be located at the bottom of the function template.
ANNEX C - PROJECT EXECUTION GUIDELINES (INFORMATIVE)

C.1 Engineering

C.1.1 Objectives

The SCD Approach represents an overall methodology in order to achieve the following main objectives during the engineering phase:

- Improved quality
- Improved standardisation
- Improved safety
- Improved productivity
- Improved process understanding

C.1.1.1 Quality

Operation & control requirements are defined by a single document forming the basis for verification activities as well as implementation and testing.

- Verification of control strategies defined by other disciplines. (process, mechanical, HVAC etc.)
- Verification of control strategies defined by package suppliers.
- Verification of control system implementation. (Factory Acceptance Test)
- Validate operation & control strategies with client/operations.
- Third-party verifications related authority requirements.

C.1.1.2 Standardisation

Improved standardisation will be accomplished on a control system level as well as on an application level.

Control system level:

- Common functionality in terms of function templates.
- Common documentation, independent of control system supplier.
- Common terminology used for identical control functions, independent of control system supplier.

Application level:

- Common control strategies for all systems.
- Common control strategies for packages.

C.1.1.3 Safety

Process safeguarding functions are shown in connection with process control functions defining the requirements for independent process safeguarding functions in addition to the process control functions

Process related emergency shutdown functions are also shown in connection with the process safeguarding and control functions enabling an enhanced understanding of the plant safety requirements.
C.1.1.4 Productivity

The previous objectives will obviously result in an improvement of the productivity.

- Improved standardisation resulting in simpler implementation.
- Improved quality resulting in less changes during design, test and commissioning of the control system.

Efficient communication between all parties will improve the productivity for the control engineers.

The functions are defined in an unambiguous manner making the internal disciplines work more efficient as additional documents and meetings can be reduced.

Improved communication with third parties regarding operation & control. The SCDs forms the basis for interface discussions. Design changes may be documented by SCD mark-ups, e.g. attached to minutes of meetings.

The amount of interchangeable documents and subsequently the number of dependencies between the involved parties can be reduced.

- Common document for design, test, commissioning and operation.
- Common document for all disciplines.
- Common document for all package suppliers.

The SCD Approach will enable the control engineer to develop the operation & control requirements in parallel with the process design and will thus support concurrent engineering.

Field proven solutions may also be copied from previous projects independent of control system supplier.

The SCD Development can be split in two main activities.

- Basic Design
- Application Design

The Basic Design will normally only be applicable for a first time implementation of the SCD standard or in order to facilitate new operational requirements.

The Application Design contains the development of the actual SCDs within a specific project.
C.2 Implementation

C.2.1 Objectives

The following main objectives can be defined for the implementation phase:

- Unambiguous input to implementation
- Improved standardisation
- Improved productivity

C.2.1.1 Unambiguous input

Unambiguous definition of functional requirements is of vital importance for the implementation phase. Discussions related interpretation of functional requirements as well as possible re-work is avoided.

The information, which is not relevant for the control system, has been removed making the implementation effort simpler.

A structured design based on standard templates and basic logic functions may be directly translated into application logic providing a simple link between functional requirements and the actual implementation.

C.2.1.2 Standardisation

A well defined and widely recognized standard will provide a basis for development of corresponding supplier standards.

The need to develop project specific typical (function blocks) will be significantly reduced. Function blocks based on a general standard may thus be used independent of specific project requirements.

Applications may further be re-used from one project to another.

C.2.1.3 Productivity

The previous objectives will also impact the productivity.

- Unambiguous input to the implementation providing a basis for efficient programming as well as reduced probability for modifications.
- Improved standardisation resulting in extensive reuse of proven solutions.

A well defined basis for programming will also require less use of system specialists for application programming. The programming effort will mainly consist of translating functional templates and connectivity, rather than software development as such.

However, the ultimate objective in order to improve the overall productivity is to facilitate automatic configuration of the safety and automation system, based on SCDs, eliminating manual programming.
C.2.2 Documentation

The initial implementation of the SCD standard should be based on a joint effort between the involved parties in order to achieve an optimized use of supplier standard functionality to accomplish the project control strategy.

The implementation model is defined by the Basic Function Design.

The high-level supplier documentation should provide a bridge to the SCDs in order to enable non-system experts understanding supplier documentation.

![Diagram of SCD Design Documentation and Supplier High-Level Documentation](image)

**Figure 8, SAS Supplier Interface**

Even if a one-to-one mapping of templates should be the ultimate target, a one-to-many strategy should be adopted if required. System constraints in terms of logic restrictions, CPU load, parameters etc. may call for an optimisation. A one-to-many approach implies that one specific template results in variants depending on control options or parameter selections. The number of variants should be kept to an absolute minimum. The functionality implemented should also be kept within the range of the original template.

C.2.3 Verification

The SCDs should form the basis for the verification activities.

Internal application tests as well as Factory Acceptance Test, should be based on SCDs.

C.3 Commissioning

C.3.1 Objectives

The System Control Diagrams will be used throughout the commissioning phase. The SCDs handed over to commissioning must reflect as “programmed status”. The use of SCDs can be related to the following activities:

- Commissioning procedures
- Commissioning runs
C.3.1.1 Commissioning procedures

The SCDs forms the basis for the commissioning procedures related the Safety and Automation System.

The procedures should cover activities not already covered by the SCDs. The SCDs will thus be included as a part of the commissioning documentation as such.

The SCDs will typically provide the following information to be covered by the procedures.

- Blocking of Interlocks during commissioning.
- Suppression of alarms.

C.3.1.2 Commissioning runs

The SCDs must be kept updated throughout the commissioning phase.

Commissioning of the Safety and Automation System will mainly be based on the SCDs.

The SCDs will thus be a “live” document subject to yellow-lining, mark-ups, comments etc.

C.4 Operation

The development of the System Control Diagram as such was initiated in order to provide a functional description of the logic contained in the Safety and Automation System for operational personnel, not familiar with the supplier logic standard.

C.4.1 Objectives

The main objectives by using SCDs in the operational phase can be related to the following:

- Safety analysis
- Production control
- Modifications

C.4.1.1 Safety Analysis

The SCDs defines process safeguarding functions in connection with the process control strategies. Effects of critical process conditions may thus be evaluated by means of the SCDs. “What if” scenarios as well as post event analysis may be carried out.

Process effects related safeguarding systems documented by means of cause & effects may also be evaluated.

Effects resulting from faulty instrumentation or a manual blocking of a safeguarding function will be documented and may be encountered for by means of the SCDs.

The SCDs should form the basis for approval of workpermits affecting the Safety and Automation System.
C.4.1.2 Production Control

The SCD representation is closely allied to the operator interface displayed on the VDUs in the control room. The SCDs will thus provide an unambiguous documentation of the SAS functionality for the operators with an apparent relationship to the actual operator interface.

The daily use of the SCDs in the control center will be related to “trouble-shooting”. The SCDs will enable the operator to resolve operational problems without involving additional system specialists.

Most control systems provide e.g. well defined information on mode of operation for a selected control object. However, if the control object is interlocked by an external cause, the source of the interlock is often not properly documented.

By providing the operators with enhanced possibilities to resolve operational problems, the requirements for reduced manning will be met.

C.5 Modifications

The SCDs will also be used in connection with modifications to the Safety and Automation System. The methodology applicable for modifications during the operational phase will be similar to the engineering methodology for application design, implementation and verification.

- Multidiscipline design.
- Input to implementation.
- Basis for verification and testing.
ANNEX D – SCD LEGEND (NORMATIVE)

Function Block Symbols

Standard SAS control function:
Function fully implemented with standard SAS function template for logic as well as HMI.

Non – Standard control function:
Logic control function implemented as non – SAS software, but with a standard SAS HMI.

Local control function:
Logic control function implemented as non – SAS software and with no SAS HMI.

FT: SAS function template name
ID: SAS unit identification
Operator info: Identification of the controlled object (valve, motor, heater) as it appears to the operator (on VDU alarm lists etc.) or other convenient operator info.

Function template terminals

Control function interlocks
Alarm suppression
Mode selection

Extension of function block symbols if more terminal points are required.
Reference symbols

**DRAWING REFERENCE FOR PROCESS CONNECTION**

**DRAWING REFERENCE FOR INSTRUMENT SIGNALS**

R = Unique signal reference identifying the signal connection

The DESCRIPTION field shall contain a unique signal reference.

- Signal to global function
- Function identifier
- Signal to global function

Ref: Reference to shutdown level.

Equipment symbols

- **Block valve**
- **Control valve**
- **Manual valve (generic symbol)**
- **Valve normally closed**
- **Valve normally open**
- **Valve to close on loss of signal (FC)**
- **Valve to open on loss of signal (FO)**
Valve to be locked on loss of signal (FL)

Valve to maintain position on loss of signal (FI)

Transmitter

Safety relief element

Low (GSL) and High (GSH) limit switch indicator

Power (text field)
Object tag (power)
Object tag (controlled equipment)

Instrument signals

General signal, e.g. logic software signal within a node or hardwired signal from transmitter to SAS. Can also be used for bus signals and serial lines.

Data communication link, i.e. bus or serial line. The signal line reflects the logic end points of the signal, and not the actual bus topology.

Constant values

Constant values used as parameters to logical/arithmetic elements (e.g. timers, pulses). To be shown as a signal into the actual element.

Value of parameter, e.g. 25

Unit of parameter, e.g. deg. C
Logic and arithmetic symbols

- **Hardware function**
- **Software function**
- **Software split of signal**

**Logic OR**
Output true if A OR B true.

**Logic AND**
Output true if A AND B true.

**Inverter**

**Pulse**, i.e. positive pulse upon transition from 0 to 1 (10 S = duration of pulse)

**Pulse**, i.e. positive pulse upon transition from 1 to 0.

**Time delay**, i.e. delayed transition from 0 to 1 (10 S = delay time).

**Time delay**, i.e. delayed transition from 1 to 0.

**Binary memory element**. Input signal latched on positive pulse input.

**High signal selector**. The output signal is set equal the highest of input signals A and B.

**Low signal selector**. The output signal is set equal the lowest of input signals A and B.

**Comparator high**
Output = true if B greater than A.
Comparator low
Output = true if B less than A.

Arithmetic plus.
Output = A + B

Arithmetic minus
Output = B – A

Arithmetic multiply.
Output = B * A.

Arithmetic division.
Output = B / A

Optional