



Exploration & Production

GENERAL SPECIFICATION

INSTRUMENTATION

GS INS 161

PID standard function

00	11/03	First issue
Rev.	Date	Notes



Contents

1. Scope	3
2. Reference documents.....	3
3. General description of functions	4
3.1 List of main functions	4
3.2 Functional scheme.....	5
4. Interfaces description	6
5. Detailed description of functions	7
5.1 CASCADE / AUTO / MANUAL mode	7
5.2 Output value handling	7
5.3 Process shutdown.....	8
5.4 Maintenance inhibit of associated measurement.....	8
5.5 Analogue output fault status.....	8
5.6 Measurement fault	8
5.7 Specific features when interlocked with RAI standard	8
5.8 Status of automatic switching to MANUAL mode	8
5.9 PID_MR / PID_SR Option : Cascaded controllers (Master/Slave).	9
5.10 PID_RD Option : PID controller with redundant valves.....	10
5.11 PID_SPR Option : split range PID controller	12
5.12 PID_ON/OFF Option : PID controller with flip/flop analogue output.....	14
5.13 PID_1DC Option : PID controller with a digital output.....	15
6. Standard tuning parameters and variables.....	16
7. Representation and animation description (HMI).....	16
7.1 Events and values to be recorded.....	16
7.2 Alarms handling	17
7.3 Control display	17
7.4 Miscellaneous	20

1. Scope

The purpose of this document is to define the Standard Function of PID controller.

In order to assist in understanding, the document should be read in conjunction with **GS INS 150**, Design Methods for System Configuration Standard Functions.

This Standard Function shall be used in conjunction with the AI standard and potentially with the RAI (Redundant analogue inputs) and GCF (Pressure and temperature compensated flow) Standard Functions as well.

The analogue output is part of this Standard Function.

The following options are available :

- PID : **Standard functions**
- PID_MR/PID_SR : Cascaded controllers (Master/Slave)
- PID_RD : PID controller with redundant valves
- PID_SPR : Split range PID controller
- PID_ON/OFF : PID controller with flip/flop analogue output
- PID_1DC : PID controller with digital output

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
Not applicable	

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

**Codes**

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

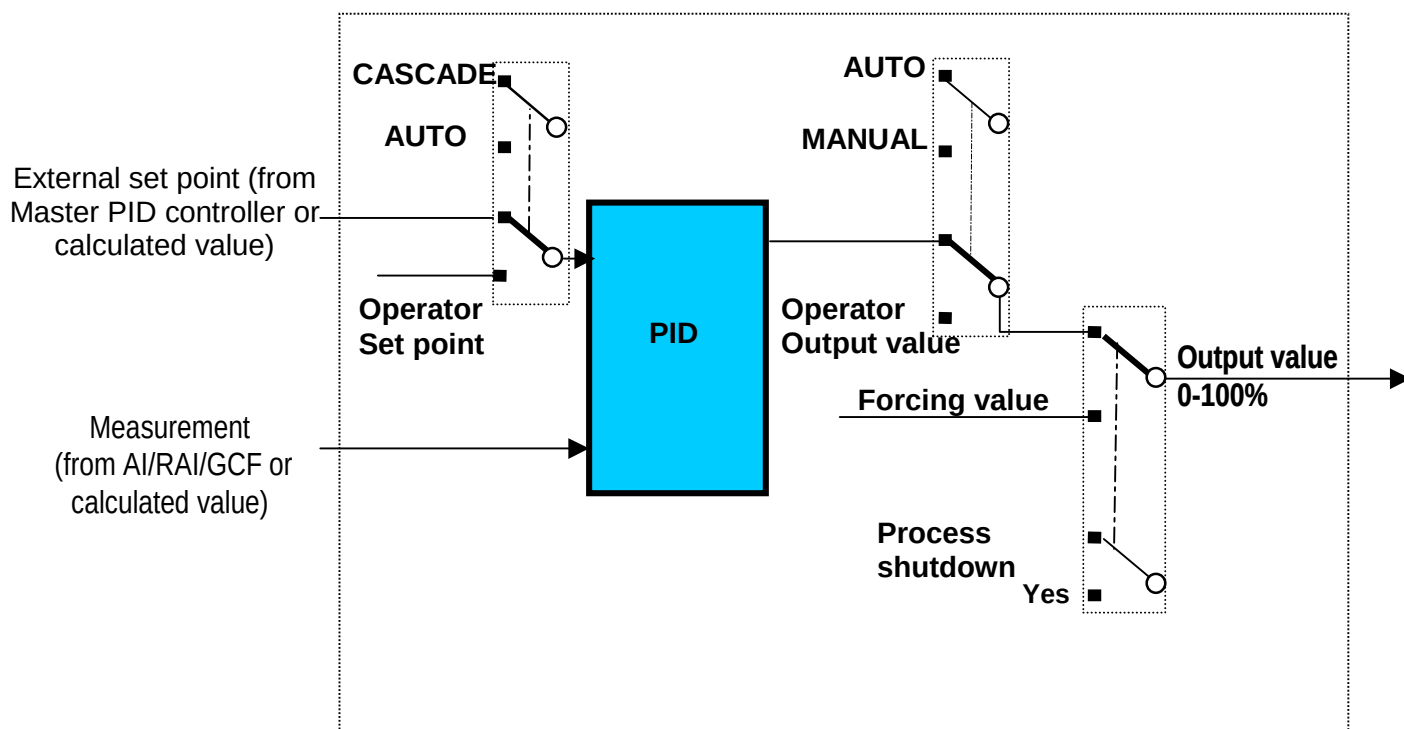
Reference	Title
GS INS 150	Design Method for System Configuration Standard Functions

3. General description of functions

3.1 List of main functions

- Control function using PID algorithm
- Process shutdown (in function of associated SDV position)
- Maintenance inhibit of measurement (from AI standard)
- Analogue input and output fault

3.2 Functional scheme



4. Interfaces description

INPUTS					OUTPUTS		
Field	HMI	Internal			Internal	HMI	Field
				PID Standard	CASCADE/AUTO/MANUAL status		
					Output value (0–100 %)		
					Output fault status		
					Safety trip status		
					MANUAL automatic setting		
					Analogue output (4-20 mA)		
				Option : Cascaded controllers	Master : Set point to Slave controller(Slave in cascade)		
				Option : Redundant valves	Second analogue output (4-20mA)		
				Option : Split range	2 nd output value (0–100 %)		
					Second analogue output (4-20mA)		
				Option : 1DC	Digital output instead of analogue output		

A Im= Alarm

5. Detailed description of functions

5.1 CASCADE / AUTO / MANUAL mode

5.1.1 Specific description

5.1.1.1 Definitions

- **MANUAL :** PID algorithm is stopped and the output value is set by the operator
- **AUTO :** PID algorithm runs with an operator set point
- **CASCADE :** PID algorithm runs with the set point set by a higher level automatic control (external set point)

Auto and cascade mode may be interlocked by a higher level standard.

5.1.1.2 Set point handling

The last set point entered by the operator is memorised and displayed (e.g. on a dedicated summary mimic).

When the PID controller is in MANUAL, the set point tracks the measurement .

When the PID controller is in AUTO, the external set point tracks the operator set point.

When the PID controller is in CASCADE, the operator set point tracks the external set point.

5.1.1.3 CASCADE / AUTO ↔ MANUAL transitions

- **CASCADE/AUTO → MANUAL transition**

The output value does not change because the HMI output value is aligned with the last calculated value.

- **MANUAL → CASCADE/AUTO transition**

The output value does not change because the initial calculated output value is aligned with the HMI value (and set point = measurement).

5.1.1.4 FREE ↔ CASCADE transitions

- **AUTO → CASCADE transition**

The external set point is aligned with the operator set point.

A set point change will be required by the higher level automatic control only after CASCADE mode status checking.

- **CASCADE → AUTO transition**

The operator set point is aligned with the external set point.

5.2 Output value handling

The output value range is from 0 to 100 %

5.3 Process shutdown

Process shutdown function is performed when the corresponding internal input is initiated (e.g. from the associated SDV closed status).

Upon initiation, actions will be safety trip animation and output value forced to the forcing value.

5.4 Maintenance inhibit of associated measurement

When the corresponding measurement is inhibited, the PID algorithm is stopped and the output value is frozen to the last calculated output value. The operator can not change the set point.

The operator can set the PID controller to MANUAL mode and change the output value.

If the PID controller is switched back to AUTO or CASCADE modes, the output value will not change and is frozen again.

5.5 Analogue output fault status

This status is active when the loop is open-circuit or when the corresponding card is faulty.

5.6 Measurement fault

When the associated measurement is in fault, the CASCADE/AUTO/MANUAL mode is forced to MANUAL.

5.7 Specific features when interlocked with RAI standard

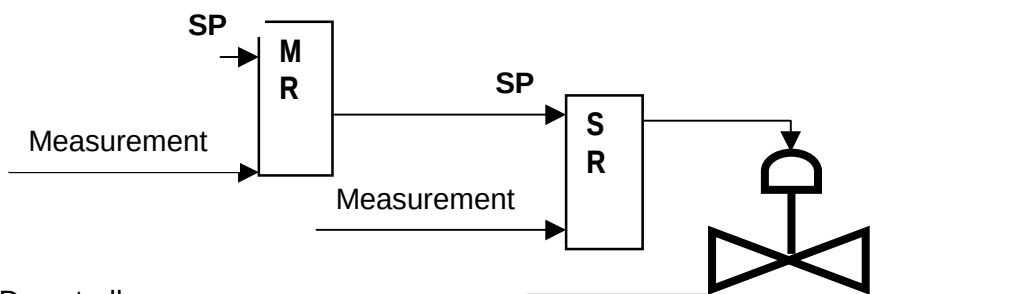
When the switching from PSS measurement to PCS measurement is active, the PCS transmitter inhibit will not affect the PSS transmitter, which is currently utilised by the PCS : the measurement is not frozen.

If a discrepancy alarm is active at the switching time, the PID controller will be forced to MANUAL, in order to avoid process upset. In this case, the discrepancy detection has to be considered at time t-1, while the fault detection is considered at time t.

5.8 Status of automatic switching to MANUAL mode

This status is active when the PID controller is forced to MANUAL upon measurement or analogue output fault or upon a situation as defined within the above paragraph; it will be reset after acknowledgement.

5.9 PID_MR / PID_SR Option : Cascaded controllers (Master/Slave).



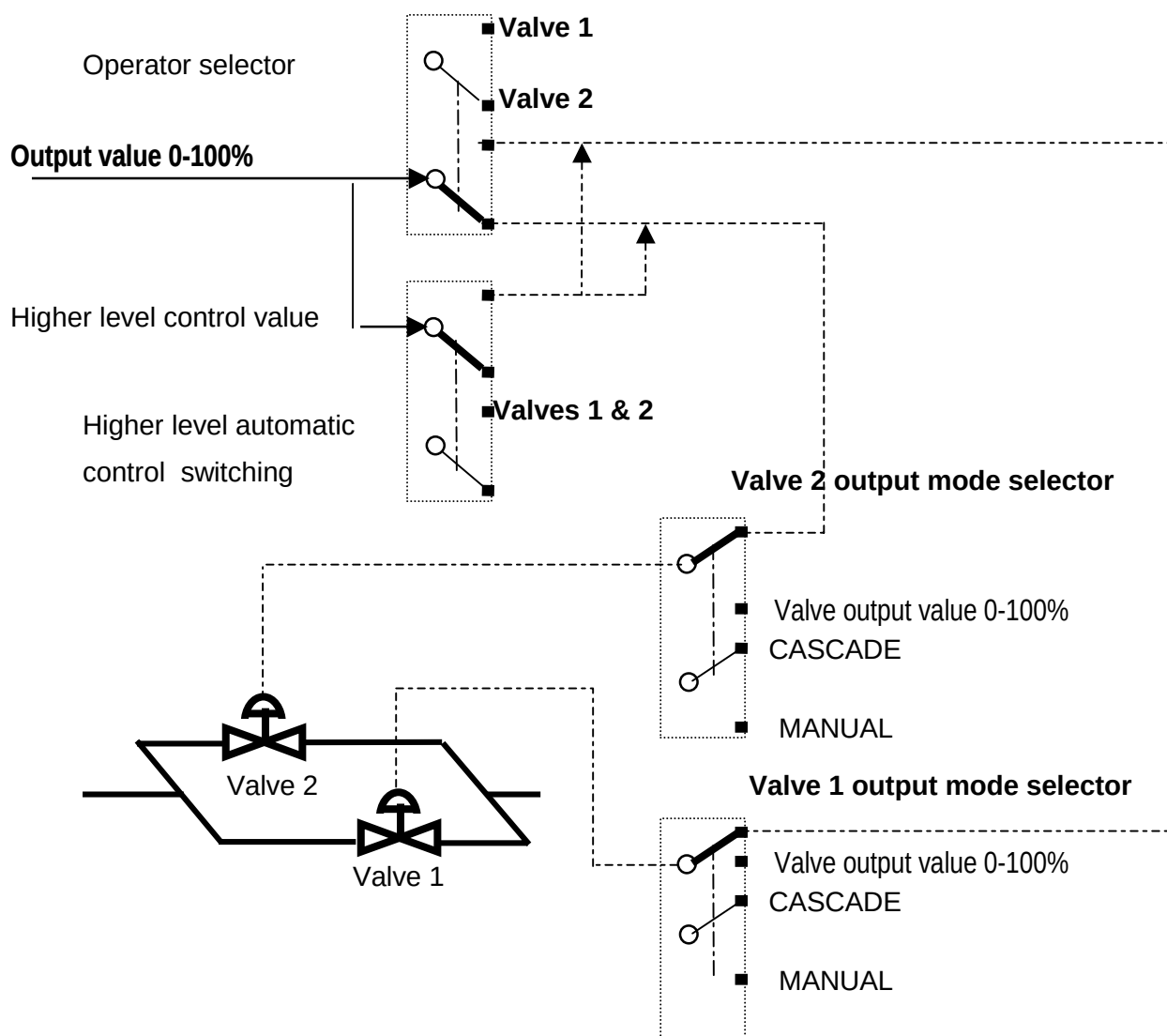
MR : Master PID controller.

SR : Slave PID controller

When the Slave controller is set to MANUAL or AUTO mode, the Master controller is forced to MANUAL mode with its output value tracking the operator set point of the Slave regulator. The operator can not change this output value.

The status of the automatic switching to MANUAL mode is active.

5.10 PID_RD Option : PID controller with redundant valves.



5.10.1 Normal situation

The operator can select the valve to be operated, the other valve is considered as a backup valve.

The selected valve is controlled by the PID controller output value, while the backup valve is set to 0 %.

Upon valves change over, a ramp may be implemented as necessary. Control of both valves by a higher level automatic control is available.

When the higher level control switching is active, both valves are controlled by the output value of the PID controller; the operator can not change the valve selector.

The last position of the manual switch is memorised and the normal control resumes with the last selected valve when the command of the higher level automatic control is no longer active.

5.10.2 Individual control of both valves in maintenance access

The maintenance operator has the possibility to control individually each valve by means of the output control block no matter the CASCADE / AUTO / MANUAL mode status of the PID. The access will be possible from the corresponding group mimic including both faceplates of the output control blocks. The group mimic is directly linked from the process mimic by means of a "soft key".

Both output control blocks may be set in CASCADE (normal situation) or MANUAL mode. When in MANUAL mode the output value can be changed.

The operator has to switch back output control to CASCADE mode in order to resume PID control.

5.10.2.1 Handling of CASCADE / AUTO / MANUAL mode of PID controller

The PID controller is forced to MANUAL when the output control block of the selected valve is in MANUAL. The operator can set the PID controller in AUTO/CASCADE when the output control block of the selected valve is in CASCADE.

The PID controller is forced to MANUAL when both output control blocks are in MANUAL during the control of both valves by a higher level automatic control. The operator can turn back the PID controller to AUTO/CASCADE when one of the output control blocks is set to CASCADE mode.

5.10.2.2 MANUAL ↔ CASCADE transitions of the output control blocks

5.10.2.2.1 CASCADE → MANUAL transition

The output value of the output control block does not change because the HMI output value is aligned with the last calculated value.

5.10.2.2.2 MANUAL → CASCADE transition

The output value of the PID controller is aligned with the value of the output control block of the selected valve, or with the value of the first output control block turned back to CASCADE mode in the case of control of both valves. Therefore, the output value of the concerned output control block does not change.

Concerning the backup valve, or the second valve in case of control of both valves, the calculated value (0 % or output value of the PID controller) may be reached by means of a ramp if necessary (as per § 5.10.1.).

5.10.3 Limitation of output value of the PID controller

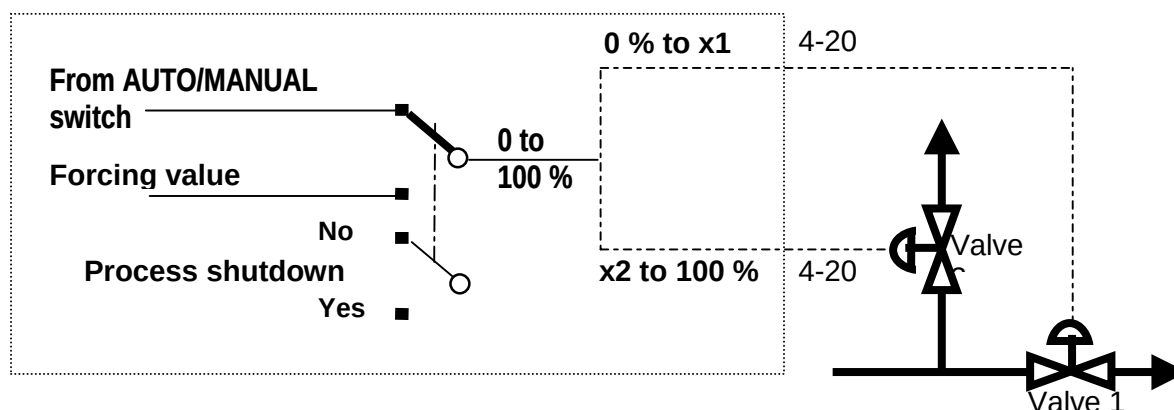
The output value of the PID controller will be limited by thresholds of the output control blocks, effective when PID mode is in AUTO or CASCADE :

- limited if both output control blocks have reached a limit, when both output control blocks are in CASCADE
- limited if the remaining output control block in CASCADE has reached a limit.

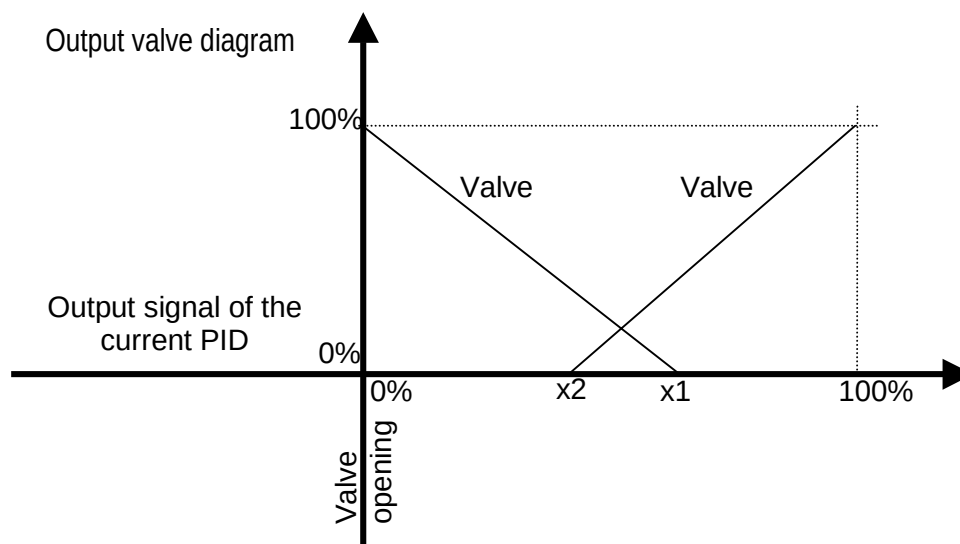
5.10.4 Process shutdown

The mode of the output control blocks (MANUAL/CASCADE) is not locked.

5.11 PID_SPR Option : split range PID controller



Example of a SPLIT RANGE :



5.11.1 General points

The Output value of the PID controller is split to 2 control valves. Each valve has its own 4-20 mA signal.

5.11.2 Individual control for both valves

The maintenance operator has the possibility to control individually each valve.

5.11.2.1 Access

The maintenance operator has the possibility to control individually each valve by means of the output control block, no matter the CASCADE / AUTO / MANUAL mode status of the PID. The access is possible from the corresponding group mimic including both faceplates of output control blocks. The group mimic is directly linked from the process mimic by means of a "soft key".

Both output control blocks may be set in CASCADE (normal situation) or MANUAL mode. When in MANUAL mode the output value can be changed.

The operator has to switch back output control block to CASCADE mode in order to resume PID control.

5.11.2.2 Handling of CASCADE / AUTO / MANUAL mode of PID controller

The PID controller is set and locked in MANUAL when the output control block of the selected valve is in MANUAL. The operator can set the PID controller in AUTO/CASCADE when the output control block of the selected valve is in CASCADE.

5.11.2.3 MANUAL ↔ CASCADE transitions of the output control blocks

5.11.2.3.1 CASCADE → MANUAL transition

The output value of the output control block does not change because the HMI output value is aligned with the last calculated value.

5.11.2.3.2 MANUAL → CASCADE transition

The output value of the PID controller is aligned with the value of the first output control block turned back to CASCADE mode. Therefore the output value of the concerned output control block does not change.

Concerning the second valve, the calculated value (output value of the PID controller) may be reached by means of a ramp if necessary (as per § 5.10.1.).

5.11.3 Limitation of output value of the PID controller

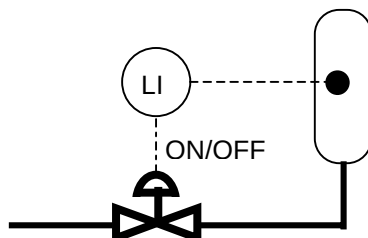
The output value of the PID controller will be limited by thresholds of the output control blocks, effective when PID mode is in AUTO or CASCADE :

- limited if both output control blocks have reached a limit, when both output control blocks are in CASCADE
- limited if the remaining output control block in CASCADE has reached a limit.

5.11.4 Process shutdown

The mode of output control blocks (MANUAL/CASCADE) is not locked.

5.12 PID_ON/OFF Option : PID controller with flip/flop analogue output



5.12.1 General points

The regulator modifies its output upon exceeding the maximum allowed deviation between the measurement and the set point (defined by the dead band parameter in engineering units).

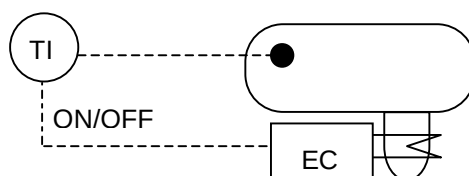
The action of this regulator is configured with an infinite gain, to quickly obtain the minimum or the maximum of the output value of the PID controller.

When the PID controller is in MANUAL, the operator controls the output value in the same way as with a standard PID controller.

5.12.2 MANUAL → CASCADE / AUTO transition

The output value does not change until the deviation (measurement - set point) becomes greater than the dead band.

5.13 PID_1DC Option : PID controller with a digital output



5.13.1 General points

The PID controller operates a digital output instead of an analogue output (e.g. electrical heater start/stop).

The output value turns from 0 (e.g. stop) to 1 (e.g. start) upon exceeding the maximum allowed deviation between the measurement and the set point (defined by the dead band parameter in engineering units).

When the PID controller is in MANUAL, the operator can change the output value.

5.13.2 CASCADE / AUTO → MANUAL transition

The output status does not change because the HMI output value tracks the last calculated value.

5.13.3 MANUAL → CASCADE / AUTO transition

The output value is set to 0 or 1 according to the HMI output value. The output status does not change until the deviation (measurement - set point) exceeds the dead band.

5.13.4 Process shutdown

The output value is forced to 0.

After a process shutdown reset, the output status does not change until the deviation exceeds the dead band.

6. Standard tuning parameters and variables

PARAMETERS	ACCESS LEVEL
Valve type (FC or FO)	Engineer
Direct or Reverse controller	Engineer
P, I, D (parameters of controller)	Maintenance
Set point limits (High and Low) or thresholds	Maintenance
Output limits (High and Low)	Maintenance
Dead band (PID_ON/OFF & PID_1DC)	Maintenance
Set point ramp (if required)	Maintenance
Sampling period	Engineer

7. Representation and animation description (HMI)

7.1 Events and values to be recorded

7.1.1 Events

- CASCADE / AUTO / MANUAL command
- Output fault status
- MANUAL automatic setting status
- CASCADE / MANUAL command of output control blocks (PID_RD, PID_SPR)

7.1.2 Values

- Operator Set point
- Operator output value
- Dead band

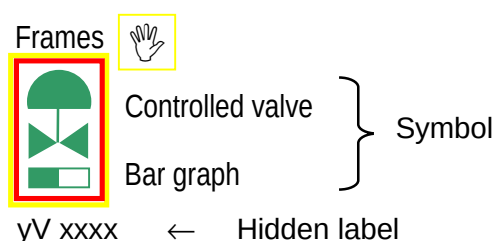
7.2 Alarms handling

Alarm Description	Priority
Output fault alarm	Level 1
MANUAL automatic setting alarm of PID controller	Level 1
MANUAL automatic setting alarm of valve output control blocks (PID-RD, PID-SPR)	Level 1

7.3 Control display

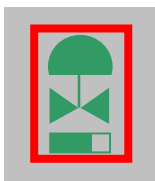
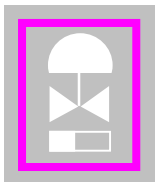
The hereafter description gives examples of representation. However, they may be amended dependant on the DCS features.

7.3.1 Controlled valve representation



- yV xxxx instrument label appears upon operator request (soft key)
- Symbol and yV xxxx instrument label are used as target area for the PID controller faceplate display

7.3.2 Animation of the controlled valve (Symbol and Frames)

Display description	Display	Valve and bargraph	Frames
Opening > 5%		Fluid colour	NA
Opening ≤ 5%		White	NA
Safety trip		As above	External frame : White
Output fault		As above	Internal frame : Red flashing before acknowledgement Red steady after acknowledgement
Communication or system fault		White	External frame : Magenta

The bar graph represents the opening percentage of the valve. This information is transmitted via the command signal or via the position transmitter if it exists.

The events which drive these frame displays may not be mutually exclusive. Therefore, the precedence on the display, from most to least important, shall be : magenta, white, blue, yellow

7.3.3 Animation of the “hand” symbol

7.3.3.1 General points

- An empty yellow “hand” symbol appears near the valve when the operator has no access to the set-point (generally when the controller is in AUTO).
- This empty yellow “hand” is not displayed when the associated measurement is in maintenance inhibit.
- A full yellow “hand” symbol appears near the valve when output value is available for the operator (generally when the controller is in MANUAL).
- There is no “hand” symbol displayed during the process shutdown.
- PID controller “MANUAL automatic setting” status is shown by means of a yellow frame around the “hand” symbol (with the alarming handling : flashing yellow /steady yellow).

7.3.3.2 Specificity of cascade regulators PID_MR, PID_SR option

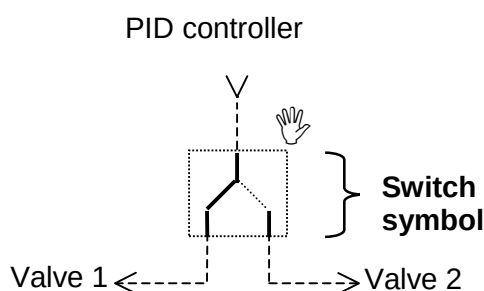
The yellow frame with the “hand” symbol in white is displayed for the Master controller when the Slave controller is not in CASCADE.

7.3.3.3 Specificity of PID_RD & PID_SPR options

A complete “hand” symbol animation with frame is implemented for valve output control blocks. The full yellow “hand” animation is shown when the output control block has been set in MANUAL by the maintenance operator.

7.3.4 Specific animation of PID_RD option : switching display of valves

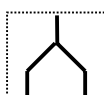
The switching status is displayed on the corresponding process mimic by means of a switch symbol :



This symbol is used as a target area to access the switch selector.

Operator valve switching possibility is shown by a full yellow “hand” symbol displayed near the switch symbol. This “hand” symbol is hidden during the monitoring of both valves by a higher level automatic control.

During the control of both valves by a higher level automatic control, the animation of the switch is :





7.4 Miscellaneous

Specific access to the PID controller faceplate display for cascade regulators PID_MR /PID_SR option :

Symbol and the yV xxxx instrument label are used as target areas to access a group mimic showing a summary of both controllers. The operator can then call up the faceplate of a PID controller by clicking on the corresponding dedicated target (faceplate is directly displayed).