Intelligent valve controller

Neles™ ND9000F
Device Revision 6

User's guide
Rev. 6.01

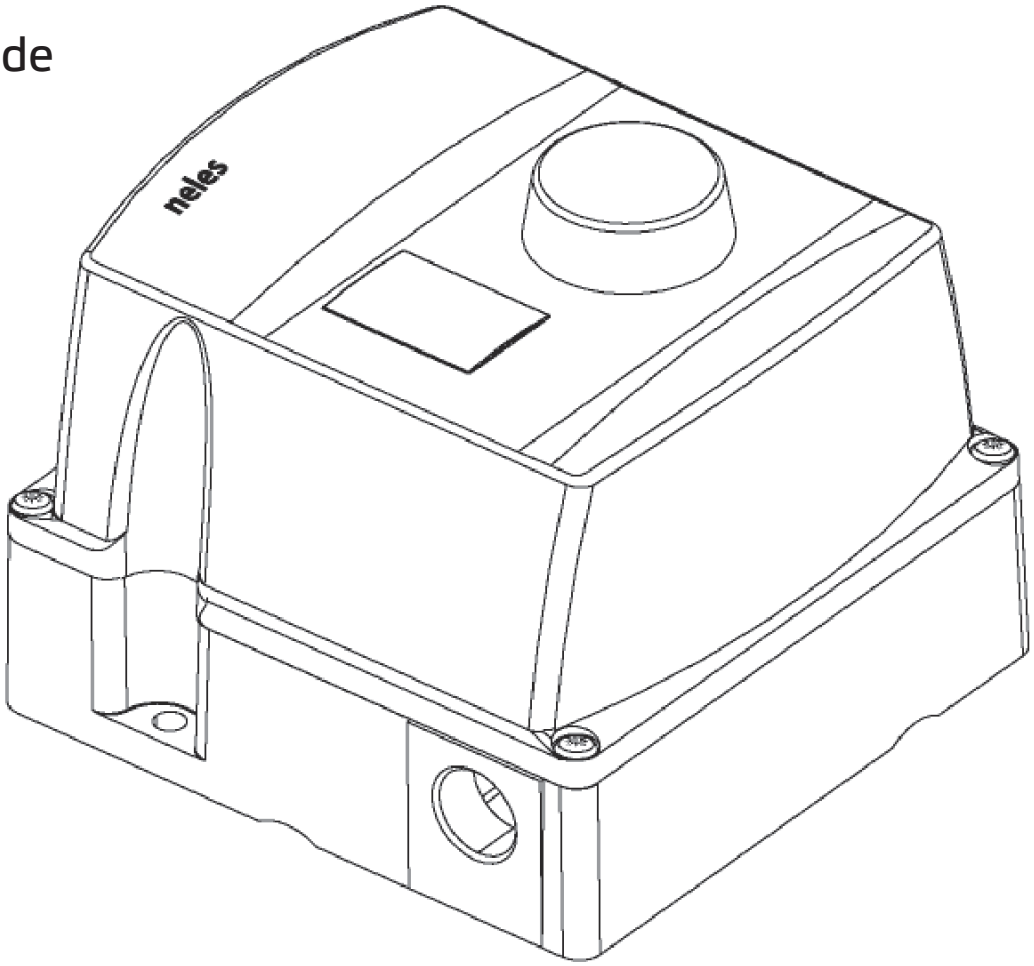

Table of Contents

1 Introduction....3
2 Device setup....3
2.1 Device Description installation....3
2.2 Basic set-up steps....3
2.3 PARAMETER SETTING SUMMARY....6
3 Function blocks....7
3.1 Resource block....7
3.1.1 Overview....7
3.1.2 Field diagnostics....13
3.2 Transducer block....14
3.2.1 Overview....14
3.2.2 Parameters....14
3.2.3 Trend Graphs....24
3.2.3.1 Introduction to Trend Graphs....24
3.2.3.2 Time Axis....24
3.2.3.3 Reference Value....24
3.2.3.4 Steady State Deviation....24
3.2.3.5 Dynamic State Deviation....25
3.2.3.6 Stiction....25
3.2.3.7 Stable State Load....25
3.2.3.8 Load for Opening....25
3.2.3.9 Spool Valve Position....26
3.2.3.10 Supply Pressure....26
3.2.3.11 Temperature....26
3.2.3.12 Daily Setpoint Reversals....26
3.2.3.13 Daily Valve Reversals....26
3.2.3.14 Daily Valve Reversals while Stable Setpoint....26
3.2.3.15 Daily Valve Position....26
3.2.3.16 Corrupted Communication Signals in Segment....26
3.3 Analog output block....26
3.3.1 Overview....26
3.3.2 Parameters....26
3.4 Analog Input function block....32
3.4.1 Overview....32
3.4.2 Parameters....32
3.5 PID function block....36
3.5.1 Overview....36
3.5.2 Parameters....37
3.6 Digital output block....44
3.6.1 Overview....44
3.6.2 Parameters....45
3.7 Discrete input block....49
3.7.1 Overview....49
3.7.2 Parameters....50
3.8 Output splitter block....53
3.8.1 Overview....53
3.8.2 Parameters....54
3.9 Input selector block....57
3.9.1 Overview....57
3.9.2 Parameters....58
4 LAS capability....61

1 Introduction

Neles ND9000F is a top-class intelligent valve controller designed to operate on all valve packages in all areas of industry. Its superior design features and unique diagnostics provide a solid foundation for performance optimization and proactive maintenance. It guarantees a high-quality end product in all operating conditions.

Foundation Fieldbus function blocks provide a general structure for specifying different types of device functions. ND9000F contains 10 function blocks:

- Resource block – Provides options that control the behavior of all other blocks and field diagnostics compliant to Namur NE107 specification.
- Transducer block - Provides valve control configuration, valve calibration and embedded valve tests.
- Analog Output block - Used if ND9000F is used as the standard positioner.
- Digital Output block - Used if ND9000F is used as the on/off controller.
- Analog Input block - Used to transmit valve analog position information to the field bus.
- Digital Input blocks (2 pcs) - Used to transmit the limit switch information (or optionally position sensor information in discrete form) to the field bus. Two DI blocks for both limits.
- PID controller block - Used in distributed field control.
- Input selector block - Input signal can be selected from four different inputs.
- Output splitter block - Output splitter block provides the capability to drive two control outputs from a single input.

The contents and usage of these blocks are described in this manual.

2 Device setup

2.1 Device Description installation

The Device Description (DD) is a set of 3 files that introduce the field device to the host system. Each host system has a DD library that contains DD's for most of the field devices.

If the host system's DD library does not already contain the DD for ND9000F, it can be downloaded from www.neles.com/ND9000.

- The ND9000F DD4 files are: 0601.ffo, 0601.sym and 060101.cff.
- The ND9000F DD5 files are: 0601.ff5, 0601.sy5 and 060101.cff

Most control and plant asset management systems have their own tools that can be used to transfer DD files to the DD library. In some cases, the DD files must be copied manually. The files must be copied under the folder 000e05/2328/. If this directory does not exist in the DD library, it must be created. See your control systems manual for more information.

2.2 Basic set-up steps

Follow these steps to get ND9000F up and running. This list may also be used for troubleshooting.

If ND9000F is supplied with valve and actuator, the tubes are mounted and ND9000F is adjusted in accordance with the customer's specifications. In this case, assembly related parameters and calibration is done.

Install the physical valve package according to the ND9000 Installation, Maintenance and Operating Instructions (IMO).

Setting assembly related parameters and calibration can be done via Local User Interface (LUI), via DTM and via fieldbus configurator.

See the ND9000 IMO for settings via Local User Interface (LUI).

Settings via DTM

1. See figure for assembly related parameter settings, see Figure 1.
2. Transducer block parameters, assembly related section See Figure 2

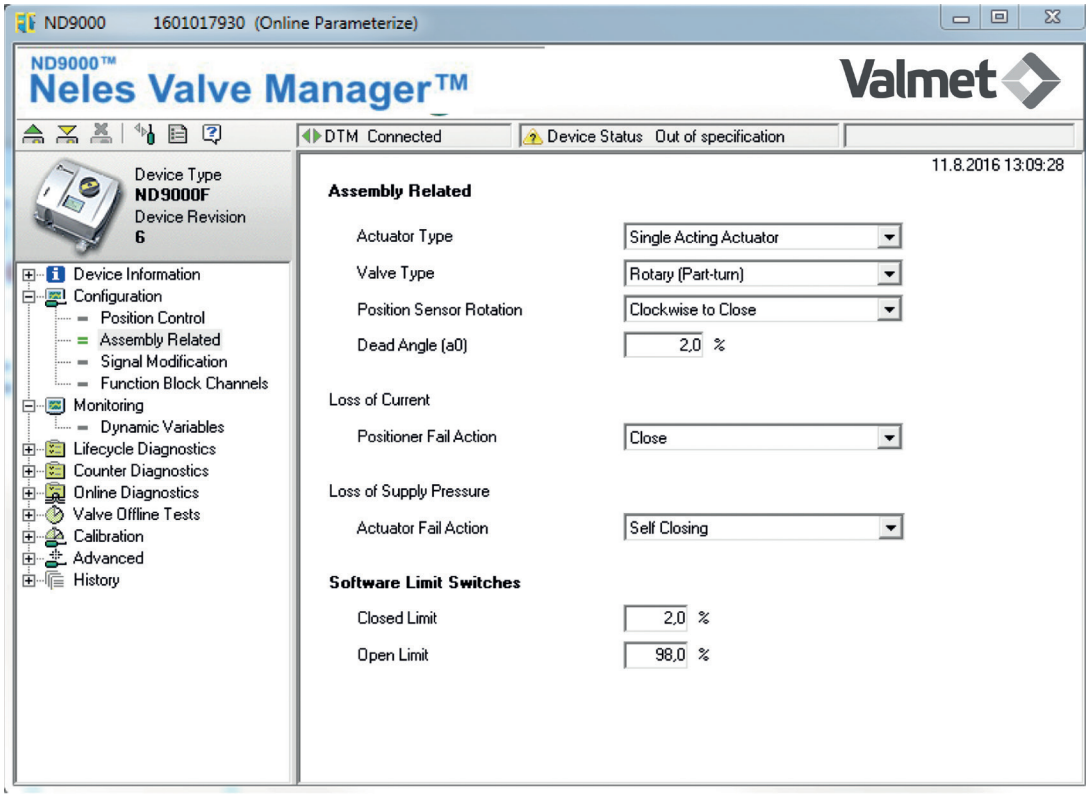

Figure 1. Assembly related parameters' setup in Neles Valve Manager DTM

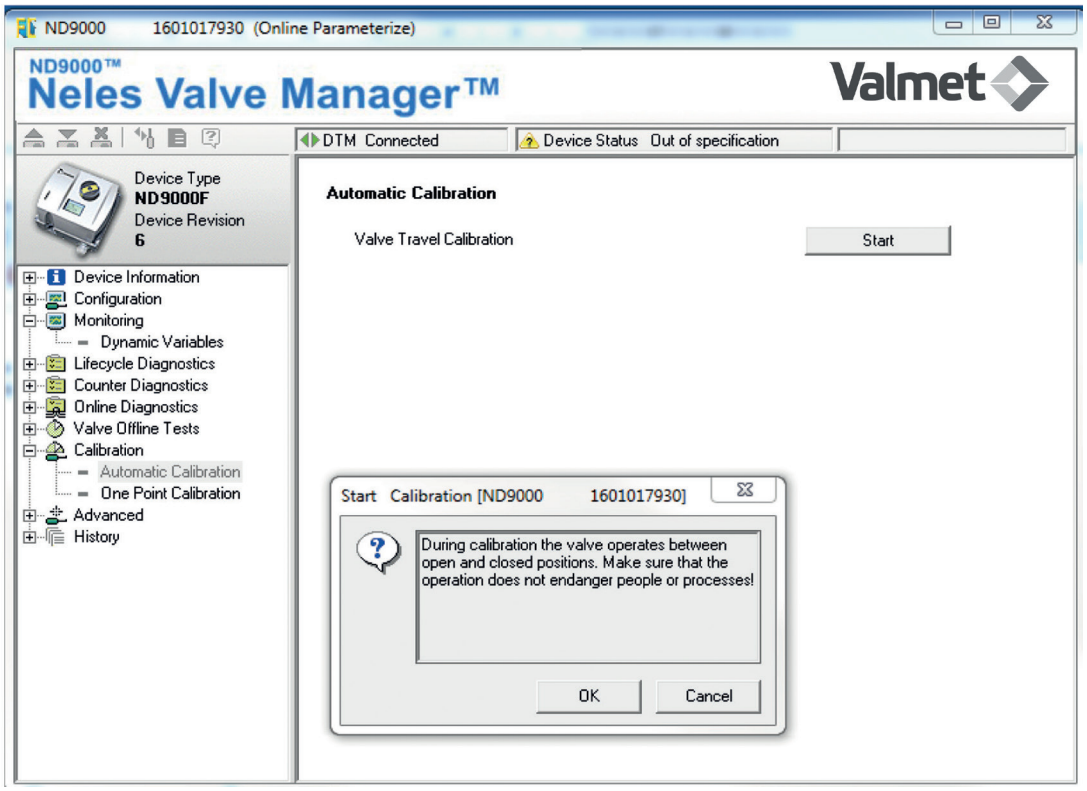

Figure 2. Automatic calibration in Neles Valve Manager DTM.

Settings via fieldbus configurator.

1. Set assembly related parameters, see chapter Transducer block parameters, assembly related section.
2. Set the Transducer block target mode to Out Of Service.
3. Run the calibration by setting SELF_CALIB_CMD parameter to value "Start automatic calibration". See Transducer block parameters, Calibration section.
4. Monitor the parameter SELF_CALIB_STATUS to see the calibration status. If the calibration fails, check the parameter SELF_CALIB_ERROR_CODE to find the reason for the failure, correct the setup and run the calibration again.
5. Set the Transducer block target mode back to Auto.

Use fieldbus configurator to activate and parametrize function blocks needed in application. See appropriate function block chapter in this document for details. Each function block do have BLOCK_ERR_DESC_1 parameter which help to sort out block configuration error. BLOCK_ERR_DESC_1 is showing the list of un-/ misconfigured parameters in block.

Neles Valve Manager DTM Performance View Report, DTM Status View and the resource block's field diagnostics parameters are indicating any errors preventing device to operate normally. In Resource block see the standard parameters: FD_[FAIL/OFFSPEC/MAINT/CHECK]_ACTIVE and extended parameters: FD_EXTENDED_ACTIVE_[1/2/3].

2.3 PARAMETER SETTING SUMMARY

Summary of commonly referred parameters and their recommended or typical settings in ND9000F positioner.

Parameter	**Default** (Note 5)	**Fail Open**	**Fail Close**
FEATURE_SEL (Resource Block)			
Fault State Supported	YES	YES	YES
SP (nonvolatile memory value) (AO-block)	0 [%]	0 [%]	0 [%]
IO_OPTS (AO-block)			
Fault state to value (Note 1)	NO	By the user	By the user
Fault State value on restart (Note 2)	NO	YES	YES
Increase to close	NO	NO	NO
Use PV for BKCAL_OUT	NO	YES	YES
SP tracks PV if MAN (Note 7)	NO	By the user	By the user
SP tracks PV if LO (Note 7)	NO	By the user	By the user
SP tracks RCAS or CAS if LO or MAN	NO	NO	NO
Target to MAN if fault state activated (Note8)	NO	By the user	By the user
FSTATE_TIME (AO-block) (Note 3)	0 [sec]	By the user	By the user
FSTATE_VAL (AO-block)	0 [%]	100 [%]	0 [%]
MODE_BLOCK (target) (AO-block)	OOS	CAS	CAS
SHED_OPT (AO-block)	Not initialised	Normal Shed_NormalReturn	Normal Shed_NormalReturn
CHANNEL (AO-block) (Note 6)	Not initialised	AO: Valve control, Readback compensation "3"	AO: Valve control, Readback compensation "3"
ASSEMBLY RELATED PARAMETERS (Transducer-block)			
VALVE_TYPE (Note 4)	ROTARY	According to the valve mechanical construction	
POSITIONER_FAIL_ACTION (Note 4)	CLOSE	OPEN	CLOSE
VALVE_ROTATION_DIRECTION (Note 4)	Clockwise close	According to the valve mechanical construction	
DEAD_ANGLE_COMP	0 [%]	According to the valve mechanical construction	
ACT_TYPE (Note 4)	Double acting	According to the valve mechanical construction	
PERFORMANCE_LEVEL	Optimum	Optimum	Optimum

Note 1: Applicable only in cases of FF H1 Segment communication failure. The common approach is to set the control valve to the fault state position in case of communication failure.

Note 2: Applicable only when the positioner is recovered from power failure. In order to activate this function, the parameter is set to YES and FSTATE_VAL is set as the predefined fixed valve position. Note that the valve will move to its mechanical fail-safe position during segment power failure or positioner air-supply failure.

Note 3: Time delay before going to fault state position after communication failure.

Note 4: At readily assembled control valve units these parameters are set by factory. If the value of an existing valve is modified, calibration must be performed. The value must be set according to the valve's mechanical construction.

Note 5: All positioners shipped from factory use these parameter values instead of the assembly related parameters that are set by factory for readily assembled control valve units.

Note 6: When AO CHANNEL AO: Valve control, Readback compensation "3" is used, valve position information does not pertain to the actual valve position, but all signal modifications are backwards compensated from the actual position. The actual valve position value can be read from the transducer block final position value. If the actual valve position needs to be AO BKCAL_OUT, the AO CHANNEL AO: Valve control "1" should be used.

Note 7: Applicable only when the AO block is not in normal operation mode. The common approach is to set "SP tracks PV if MAN" and "SP tracks PV if LO" to YES to achieve bumbles mode transfer.

Note 8: Applicable only when AO block goes to fault state. The common approach is to set "Target to MAN if fault state activated" to YES in critical control valves where human supervision is needed while the valve is set to normal operation.

3 Function blocks

3.1 Resource block

3.1.1 Overview

The resource block provides options that control the behavior of all other blocks. The block contains also device revision information and firmware and hardware version information.

Parameters

Resource block parameters are presented in table 1.

Table 1. Resource block parameters.

Resource block parameter name	Description
ST_REV	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in this block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	MODE_BLK contains the actual, target, permitted, and normal modes of the block • ACTUAL is the current mode of the block, which may differ from the target based on operating conditions. Its value is calculated as part of block execution. • TARGET is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested. • PERMITTED defines the modes which are allowed for an instance of the block. The permitted mode is configured based on application requirement. • NORMAL is the mode which the block should be set to during normal operating conditions. Resource block modes are: • Out of Service (O/S) - O/S mode stops all function block execution. The actual mode of the function blocks in this resource will be changed to O/S, but the target mode will not be changed. • Initialization Manual (IMan) - IMan shows that the resource is initializing or receiving a software download. • Automatic (Auto) - Auto mode allows normal operation of the resource.
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown. • Other; Non-specific error active. • BlockConfiguration; Error detected in block configuration. • LinkConfiguration; Error detected in link configuration. • SimulationActive; Simulation enabled in this block. For the resource block, Simulate Active will be used to indicate that the simulate hardware jumper is present. An active state (1) of this attribute will indicate that the jumper is present and that it is possible for the user to enable simulation in the AO function block. For the AO block, this indicates that simulation is either enabled or disabled. • LocalOverride; Output tracking or faultstate active. • DeviceFaultstate; Device faultstate set. • Device needs maintenance soon. • InputFailure; Process variable has bad status. • OutputFailure; Failure detected in output hardware. • MemoryFailure; Memory error detected. • LostStaticData; Static parameters cannot be recovered. • LostNVData; Non-Volatile parameters cannot be recovered. • ReadbackCheck; Failure detected in READBACK. • Device needs maintenance now. • PowerUp; Recovery from power failure. • OutOfService; Block actual mode is Out of Service.

Resource block parameter name	Description
RS_STATE	The overall state of the function block application state machine. • Undefined - Invalid state. • Start/Restart - This state will be entered after detection that power has been restored to a device. In this state, the memory and other hardware necessary for reliable operation will be tested. An important part of the recovery process is being able to restore static data, which includes both the "static" and "non-volatile" types of parameters. The validity of static memory will be tested. If the object's static data is bad, then the object's database will be set to its default values. A block should be issued, with the subcode set to either "Lost static data" or "Lost NV data" as appropriate. After successfully initializing, the associated resource block should generate a block alarm with the subcode set to "Power-up". If the hardware tests are successful, the resource state will change to the initialization state. Otherwise, resource state will change to the Failure state. • Initialization - The initialization state is entered from the Start/Restart or Failure states. In the Initialization state, all unreported function block alarms will be automatically confirmed and acknowledged. Once the system is detected to be Operational, block execution may be scheduled and the resource state will change to On-Line Linking. • On-line Linking - This state will be entered from the On-Line and Initialization state. In this state, the status of defined links will be evaluated. If all defined links are established, then the resource state will change to On-Line. • On-line - The On-Line state will be entered from the On-Line Linking state. In this state, the status of defined links will be evaluated. If one or more defined links are detected as not established, then the resource state will change to On-Line Linking • Standby - This state will be entered if the mode of the resource block is changed to Out-of-Service (O/S). In this state the actual mode of all function blocks in the resource will be forced to O/S mode. The mode of transducer blocks may not be affected. This state will be maintained until the mode is changed to Auto. On a change in the resource block mode to Auto, the state will change to Start/Restart. • Failure - This state may be entered from any state except Standby. Transition to this state is caused by the detection of a memory or other hardware failure, which would prevent reliable operation. The failure may pertain either to the whole device or only to the resource. Based on this state being active, a function block of the output class may change its output to a Fault State position. In this state, hardware status will be tested. If the hardware failure clears, then the state will change to Initialization.
TEST_RW	Read/write test parameter - used only for conformance testing.
DD_RESOURCE	String identifying the tag of the resource that contains the Device Description for this device.
MANUFAC_ID	Manufacturer identification number - used by an interface device to locate the DD file for the resource. Value: 000E05
DEV_TYPE	Manufacturer's model number associated with the resource - used by interface devices to locate the DD file for the resource. Value: 2328
DEV_REV	Manufacturer revision number associated with the resource - used by an interface device to locate the DD file for the resource. Value: 6
DD_REV	Revision of the DD associated with the resource - used by an interface device to locate the DD file for the resource. Value: 1

Resource block parameter name	Description
GRANT_DENY	The grant-deny parameter (which has two attributes, referred to as Grant and Deny) is used to allow the operator to grant or deny access permission to sets of function block parameters by other devices. The operation of these parameters is defined here, but their actual usage (if any) depends on the philosophy of the plant. Grant - Depending on the philosophy of the plant, the operator of a higher level device (HLD), or a local operator's panel (LOP) in the case of Local, may turn on an item of the Grant attribute - Program, Tuning, Alarm, or Local. By performing or allowing this action, the operator gives up control of the selected parameters to the HLD or LOP. The function block does not check writes to any of the selected parameters for grant-deny permission. It is up to other devices to obey and enforce the rules, because the function block has no way of knowing who is writing to it. Operators wishing to regain control of the parameters must clear the Grant item. The function block will then automatically set the corresponding Deny item. This indicates to the HLD or LOP that control has been taken away. • Program - A higher level device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. • Tune - A higher level device may change the tuning parameters of the block. • Alarm - A higher level device may change the alarm parameters of the block. • Local -A local operator's panel or hand-held device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. Deny - The Deny attribute is provided for use by a monitoring application in an interface device and may not be changed by an operator. It allows the monitoring application to determine whether control has been temporarily taken away during the execution of a batch program. This is carried out by firstly clearing one or all of the Denied items before the execution of a batch program, and then checking the Denied item after execution. The Grant item itself should not be checked for this condition, because the operator may have cleared and subsequently set the Grant item during batch program execution, a sequence that may be missed by a slowly scanning monitor program. The Denied item may not be cleared by the operator, thus latching the fact that control was taken away. • Program - The Program permission item has been turned off. • Tune Denied - The Tune permission item has been turned off. • Alarm Denied - The Alarm permission item has been turned off. Local Denied - The Local permission item has been turned off.
HARD_TYPES	The types of hardware available as channel numbers.
RESTART	Allows a manual restart to be initiated. Several degrees of restart are possible: • Run - This is the passive state of the parameter. • Restart resource - Not in use. • Restart with defaults - This restarts the device with defaults. • Restart processor - This restarts the processor.
FEATURES	Used to show supported resource block options. Value: Reports | Fault state | Hard write lock | Out Readback | Multi-bit alarm support
FEATURE_SEL	Used to select resource block options. • Reports - If set, the device supports alert reports. If not set, the master must poll for alerts. • Faultstate -Setting the SET_FSTATE parameter forces all output function blocks (AO and DO) in the resource to go to fault state. Individual output function blocks will go to Fault State due to a loss of communication to CAS_IN or IFS status in CAS_IN, regardless of this feature being selected. • Hard W Lock – This enables the use of the hardware write lock switch. See WRITE_LOCK. • Out Readback - If set, the AO.READBACK (valve position) runs backwards through the XD scaling to act as the PV for the AO block. If not set, READBACK is generated from AO.OUT. Both the OUT and READBACK parameters use XD_ SCALE. The PV and SP use PV_SCALE. • Multi-bit alarm support – This allows multiple errors being shown in the same alarm.
CYCLE_TYPE	Identifies the block execution methods available for this resource.
CYCLE_SEL	Used to select the block execution method for this resource.

Resource block parameter name	Description
MIN_CYCLE_T	Time duration of the shortest cycle interval of which the resource is capable. Value: 3200 (100 ms)
MEMORY_SIZE	Available configuration memory in the empty resource. To be checked before attempting a download.
NV_CYCLE_T	Minimum time interval specified by the manufacturer for writing copies of NV parameters to non-volatile memory. The NV memory is only updated if there has been a significant change in dynamic value. The last value saved in the NV memory will be available after restart. Zero means that NV data will only be copied to the NV memory when an external write request is received.
FREE_SPACE	Percentage of memory available for further configuration. Zero in a preconfigured device.
FREE_TIME	Percentage of block processing time that is free to process additional blocks.
SHED_RCAS, SHED_ROUT	SHED_RCAS and SHED_ROUT set the time limit for loss of communication from a remote device. All function blocks that support a remote cascade mode use these constants. Shedding from RCAS/ROUT shall not happen when SHED_RCAS or SHED_ROUT is set to zero
FAULT_STATE	Condition set by loss of communication to an output block, failure promoted to an output block or a physical contact. When the faultstate condition is set, the output function blocks will perform their FSTATE actions.
SET_FSTATE	Allows the faultstate condition to be manually initiated by selecting Set. See FEA-TURE_SEL
CLR_FSTATE	Writing a Clear to this parameter will clear the device fault state if the field condition, if any, has cleared.
MAX_NOTIFY	Maximum number of unconfirmed alert notification messages possible.
LIM_NOTIFY	Maximum number of unconfirmed alert notification messages permitted.
CONFIRM_TIME	The minimum time between retries of alert reports.
WRITE_LOCK	Displays the status of the hardware switch. If set, no writes from anywhere are allowed. Block inputs will continue to be updated. See /1/ for the location of the switch. See FEATURE_SEL.
UPDATE_EVT	An alert for any change in the static data, UDATE_EVT, is included in each block. This alert can notify the interface devices that keep track of changes that one or more changes have occurred. The relative parameter index and its associated block index are included in the alert, along with the new value of ST_REV. If more than one change has been added since the last reported Update Alert, as known from the difference between the last copy of ST_REV and that in the alert, it will be necessary for the interface device to update all static data. No alert will be generated while a block is in Out of Service mode so that downloads will not generate many update alerts. ST_REV will be incremented for each change to static data that occurs while the block is in O/S mode. On transition out of O/S mode, an update alert may be generated if the value of ST_REV for the block does not match that of the last reported alert. Update Alert has a fixed priority of 2, therefore it is auto-acknowledged (no operator intervention is required). • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration that gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value will be maintained constant until alert confirmation has been received – even if another change of state occurs. • Static Rev - the static revision of the block whose static parameter was changed and is being reported. It is possible for the present value of static revision to be greater than this because static can be changed at any time. • Relative Index - The OD index of the static parameter whose change caused this alert, minus the FB starting index. If the update event was caused by a write to multiple parameters at the same time, this attribute will be zero.

Resource block parameter name	Description
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration that gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value will be maintained constant until alert confirmation has been received - even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. • Value - The value of the associated parameter at the time the alert was detected.
ALARM_SUM	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block. • Current - The active status of each alarm. • Unacknowledged - The unacknowledged state of each alarm. • Unreported - The unreported status of each alarm. Disabled - The disabled state of each alarm.
ACK_OPTION	Selection of whether alarms associated with the function block will be automatically acknowledged.
WRITE_PRI	Priority of the alarm generated by clearing the write lock. • 0 = the associated alert may clear when the priority is changed to 0, but it will never occur. • 1 = the associated alert is not sent as a notification. If the priority is above 1, then the alert must be reported. • 2 = reserved for alerts that do not require the attention of a plant operator, e.g. diagnostic and system alerts. Block alarm, error alarm, and update event have a fixed priority of 2. • 3-7 = increasing higher priorities - advisory alarms. • 8-15 = increasing higher priority - critical alarms.
WRITE_ALM	This alert is generated if the write lock parameter is cleared. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Alarm State - A discrete enumeration which gives an indication of whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and an unreported change in alarm/event state was detected. The time stamp value will be maintained constant until alert confirmation has been received – even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. Discrete Value - The value of the associated parameter at the time the alert was detected
ITK_VER	Major revision number of the interoperability test case used in certifying this device as interoperable. The format and range of the version number is defined and controlled by the Fieldbus Foundation. Note: the value of this parameter will be zero (0) if the device has not been registered as interoperable by the FF.
DEVICE_SER_NUM	Device machine plate serial number.
FBI_SOFTWARE_REVISION	Fieldbus interface board software revision number.
FBI_HARDWARE_REVISION	Fieldbus interface board hardware revision number.
FBI_BOARD_SN	Fieldbus interface board serial number.
VC_SOFTWARE_REVISION	Valve controller board software revision number.
VC_HARDWARE_REVISION	Valve controller board hardware revision number.

Resource block parameter name	Description
VC_BOARD_SN	Valve controller board serial number.
DEVICE_TEST_STATUS	This parameter is intended for use by Valmet personnel.
IDENTIFICATION_DATA_TAG1-12	These parameters are intended for use by Valmet personnel.
LUI_LOCK	Option to lock Local user interface remotely to prevent unauthorized access.
BRAND	This parameter is intended for use by Valmet personnel.
FD_VER	Version of Field Diagnostics specification used in the implementation.
FD_FAIL_ACTIVE	Bit string parameter reflecting active error conditions for 'Failed' category.
FD_OFFSPEC_ACTIVE	Bit string parameter reflecting active error conditions for 'Off specification' category.
FD_MAINT_ACTIVE	Bit string parameter reflecting active error conditions for 'Maintenance' category.
FD_CHECK_ACTIVE	Bit string parameter reflecting active error conditions for 'Check function' category.
FD_FAIL_MAP	Selection of error conditions to be detected as active for 'Failed' category.
FD_OFFSPEC_MAP	Selection of error conditions to be detected as active for 'Off specification' category.
FD_MAINT_MAP	Selection of error conditions to be detected as active for 'Maintenance' category.
FD_CHECK_MAP	Selection of error conditions to be detected as active for 'Check function' category.
FD_FAIL_MASK	Selection of error conditions to be suppressed from broadcasting as alarms in 'Failed' category.
FD_OFFSPEC_MASK	Selection of error conditions to be suppressed from broadcasting as alarms in 'Off specification' category.
FD_MAINT_MASK	Selection of error conditions to be suppressed from broadcasting as alarms in 'Maintenance' category.
FD_CHECK_MASK	Selection of error conditions to be suppressed from broadcasting as alarms in 'Check function' category.
FD_FAIL_ALM	Alarm parameter which is used to broadcast a change in the associated active condition in 'Failed' category.
FD_OFFSPEC_ALM	Alarm parameter which is used to broadcast a change in the associated active condition in 'Off specification' category.
FD_MAINT_ALM	Alarm parameter which is used to broadcast a change in the associated active condition in 'Maintenance' category.
FD_CHECK_ALM	Alarm parameter which is used to broadcast a change in the associated active condition in 'Check function' category.
FD_FAIL_PRI	Priority of alarm in 'Failed' category.
FD_OFFSPEC_PRI	Priority of alarm in 'Off Specification' category.
FD_MAINT_PRI	Priority of alarm in 'Maintenance' category.
FD_CHECK_PRI	Priority of alarm in 'Function Check' category.
FD_SIMULATE	Parameter which is used to simulate error condition when simulation is enabled.
FD_RECOMMEN_ACT	Recommended action to alleviate the most severe (active) error condition.
FD_EXTENDED_ACTIVE_1	Detailed information of active error condition presented in diagnostics extension 1.
FD_EXTENDED_MAP_1	Diagnostics enable map for diagnostics extension 1.
FD_EXTENDED_ACTIVE_2	Detailed information of active error condition presented in diagnostics extension 2.
FD_EXTENDED_MAP_2	Diagnostics enable map for diagnostics extension 2.
FD_EXTENDED_ACTIVE_3	Detailed information of active error condition presented in diagnostics extension 3.
FD_EXTENDED_MAP_3	Diagnostics enable map for diagnostics extension 3.

3.1.2 Field diagnostics

The resource block contains parameters supporting diagnostics according to the Foundation fieldbus specification. User can configure all diagnostics conditions to the following four NAMUR NE107 categories:

- Failed
- Function Check
- Off Specification
- Maintenance

The active error condition is shown in FD_FAIL_ACTIVE, FD_OFFSPEC_ACTIVE, FD_MAINT_ACTIVE, FD_CHECK_ACTIVE parameters. Detailed information of active error conditions is provided in parameters FD_EXTENDED_ACTIVE_1, FD_ EXTENDED_ACTIVE_2 and FD_EXTENDED_ACTIVE_3.

The following table shows the supported field diagnostics conditions and their default categories. Also recommended action to alleviate the error condition is presented in the table.

Table 2. Field diagnostics conditions and recommended actions

Field diagnostics condition	Default diagnostics category	Recommended action
Check Function	Function check	Set Transducer Block into AUTO mode.
Device in Manual Mode	Function check	Set Device into AUTO mode via LUI.
Offline Test or Calibration Running	Function check	Wait until calibration or offline test done.
Counter Limit Exceeded	Maintenance	If other diagnostics is not active device is operating normally. Increase counter limit value.
Reversal Counter Limit Exceeded	Maintenance	If other diagnostics is not active device is operating normally. Increase counter limit value.
Load for Opening Low Limit Exceeded	Maintenance	Check Load For Opening trend and Low limit values.
Load for Opening High Limit Exceeded	Maintenance	Check Load For Opening trend and Low limit values
Stiction Low Limit Exceeded	Maintenance	Check Stiction trend and Low limit values.
Stiction High Limit Exceeded	Maintenance	Check Stiction trend and Low limit values.
Fieldbus Communication Failure Rate Limit Exceeded	Maintenance	Check FF-H1 communication.
Daily Reversal Trend Limit Exceeded	Maintenance	Check Reversal trend and limit values.
Calibration Recommended	Maintenance	Device calibration is recommended.
Dynamic State Deviation Limit Exceeded	Off specification	Check Dynamic State Deviation trend and limit values.
Supply Pressure Limit Exceeded	Off specification	Check device pressure supply and limit values.
Temperature Limit Exceeded	Off specification	Check device operating temperature and limit values.
Hunting Detected	Off specification	Check the linkages. Check position control performance level.
Steady State Deviation Limit Exceeded	Off specification	Check Steady State Deviation trend and limit values.
Spool Valve Problem Detected	Off specification	Check spool valve and if necessary change and calibrate.
Position Sensor Out Of Range Detected	Off specification	Incorrect assembly of valve position measurement shaft.
Device in Reduced Performance Mode	Off specification	Sensor failure has degraded positioner's ability to perform.
Supply Pressure Too Low for Single Acting Actuator	Off specification	Supply pressure is too low to drive valve. Check pressure supply.

Field diagnostics condition	Default diagnostics category	Recommended action
Valve Position High Limit Exceeded	Off specification	Check valve and actuator mechanical stoppers.
Valve Position Low Limit Exceeded	Off specification	Check valve and actuator mechanical stoppers.
Pressure Sensor Failure Detected	Off specification	Change ND9000 to a new one in next maintenance.
Spool Valve Sensor Failure Detected	Off specification	Change the spool valve fastener and calibrate device.
Temperature Sensor Failure Detected	Off specification	Change ND9000 to a new one in next maintenance.
Electronics Failure Detected	Failed	Change ND9000 to a new one.
Pneumatics Problem Detected	Failed	Check positioner, actuator and connections for leakage.
Friction Problem Detected	Failed	Maintain valve and/or actuator immediately.
Position Sensor Failure Detected	Failed	Change ND9000 to a new one.
Prestage Failure Detected	Failed	Change prestage unit, reboot and calibrate device.
Internal Communication Failure Detected	Failed	Change ND9000 to a new one.

3.2 Transducer block

3.2.1 Overview

The basic function of the transducer block is to receive the valve position setpoint signal either from the AO or DO block, and to control the valve position according to that signal. The transducer block also provides the valve position measurement and limit switch information to the AO, AI, DO and DI blocks. The data exchange between the transducer block and AO, AI, DO and DI blocks is configured by the CHANNEL parameter located in AO, AI, DO and DI blocks.

The transducer block provides following device functions:
- **Calibration**
- **Valve diagnostics:** travel counters, trends, histograms and on-line measurements.
- **Valve test:** Multipoint Step test, Dynamic loop test, Deadband test and Valve analysis test.
- **Event log**
- **Flow characterisation**

3.2.2 Parameters

The transducer block parameters are presented in table 2.

Table 3. Transducer block parameters.

Transducer block parameter name	Description
ST_REV	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in this block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify the grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	Transducer block modes are: • Out of Service (O/S) - The block is not being evaluated. The FINAL_VALUE is maintained at previous value. • Manual (Man) - Manual mode indicates that the device cannot follow the AO.OUT signal. Manual mode is entered when the target mode is Auto and either MAN mode is selected from LUI, calibration is active or device failure is active. • Automatic (Auto) - Normal operation, device follows the AO.OUT signal.

Transducer block parameter name	Description
BLOCK_ERR	This parameter reflects the error status related to the hardware or software components associated with a block. It is a bit string, meaning that multiple errors may be shown.
UPDATE_EVT	An alert for any change in the static data, UPDATE_EVT, is included in each block. This alert can notify the interface devices that keep track of changes that one or more changes have occurred. The relative parameter index and its associated block index are included in the alert, along with the new value of ST_REV. If more than one change was added since the last reported Update Alert, as known from the difference between the last copy of ST_REV and that in the alert, it will be necessary for the interface device to update all static data. No alert will be generated while a block is in Out of Service mode, so that downloads do not generate many update alerts. ST_REV will be incremented for each change to static data that occurs while the block is in O/S mode. On transition out of O/S mode, an update alert may be generated if the value of ST_REV for the block does not match that of the last reported alert. Update Alert has a fixed priority of 2, therefore it is auto-acknowledged (no operator intervention is required).
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration that gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value will be maintained constant until alert confirmation has been received - even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. Value - The value of the associated parameter at the time the alert was detected.
TRANSDUCER_DIRECTORY	A directory that specifies the number and starting indices of the transducers in the transducer block.
TRANSDUCER_TYPE	Identifies the transducer.
XD_ERROR	Reports device failures.
COLLECTION_DIRECTORY	A directory that specifies the number, starting indices, and DD Item IDs of the data collections in each transducer within a transducer block.
FINAL_VALUE	Valve position setpoint after dead angle compensation, characterization, speed limiting, range limiting and cutoff functions.
FINAL_VALUE_RANGE	This parameter defines high and low limits for the valve position. NOTE: FINAL_VALUE_CUTOFF overrides FINAL_VALUE_RANGE.
FINAL_VALUE_CUTOFF_HI	If the FINAL_VALUE is more positive than this value, the valve is forced to its maximum high value.
FINAL_VALUE_CUTOFF_LO	If the FINAL_VALUE is more negative than this value (default 2 %), the valve is forced to its maximum low value (fully closed against mechanical limit).
FINAL_POSITION_VALUE	The measured valve position, which is fed back to AO block as AO.READBACK signal.
ACT_MAN_ID	The actuator manufacturer identification.
ACT_MODEL_NUM	The actuator model number.
ACT_SN	The actuator serial number.
VALVE_MAN_ID	The valve manufacturer identification.
VALVE_MODEL_NUM	The valve model number.
VALVE_SN	The valve serial number.
VALVE_PACKAGE_INFO	Manufacturer specific bit enumeration
PROCESS_APPLICATION_INFO	Manufacturer specific bit enumeration
XD_CAL_LOC	The location of last positioner calibration. This describes the physical location at which the calibration was performed.
XD_CAL_DATE	The date of the last positioner calibration.
XD_CAL_WHO	The name of the person responsible for the last positioner calibration.

Assembly related parameters **The following parameters are assembly related. For proper operation of the device, these parameter values must match with the physical valve package.** See ND9000 Installation, Maintenance and Operating Instructions for details.	
ACT_TYPE	Actuator type selection. Options: • Undefined • Double acting actuator • Single acting actuator
VALVE_TYPE	Valve type selection. Options are: • Undefined • Linear • Rotary • Neles CV globe • Linear without compensation
VALVE_ROTATION_DIRECTION	Describes the valve rotation direction. • Standard : Clockwise to close • Nonstandard : Counter clockwise to close
DEAD_ANGLE_COMP	The α0 setting is designed for Neles segment and ball valves. This setting takes into account the "dead angle" α0 of the ball valves. The entire signal range is then used for effective valve opening 90° - α0.
POSITIONER_FAIL_ACTION	Configuration of action taken during the LOSS OF SUPPLY POWER (supply pressure is unavailable). This action ALSO takes place when the positioner software observes a fatal device failure. In both of these cases the spool valve feeds C1 (pneumatic connector) and releases C2 pressure. Options are: • Undefined • Close • Open
ACT_FAIL_ACTION	Actuator fail safe position after LOSS OF SUPPLY POWER. Informational only
SW_LIMIT_SWITCH_OPEN	If software limit switches are used this parameter will set the trigger level to open limit switch
SW_LIMIT_SWITCH_CLOSE	If software limit switches are used this parameter will set the trigger level to close limit switch
Position control	
FINAL_VALUE_RATE_DN	The maximum valve travel rate in closing direction is limited to the value of this parameter. Value zero means that rate limiting is not active.
FINAL_VALUE_RATE_UP	The maximum valve travel rate in opening direction is limited to the value of this parameter. Value zero means that rate limiting is not active.
PERFORMANCE_LEVEL	Target performance level of the valve position control. Options are: • Aggressive - In order to optimize the control performance the device responds immediately to signal changes, overshoots • Fast - Fast response to signal changes, small overshooting • Optimum - Very small overshoot with minimum step response time • Stable - No overshooting, slow response to input signal changes • Max stability - No overshooting, deadband may increase, slow but stable behavior • Capacity booster, Aggressive (*) • Capacity booster, Fast (*) • Capacity booster, Optimum (*) • Capacity booster, Stable (*) (*) For use with volume boosters and/or very fast actuators; additional performance levels with capacity booster can be used. Characteristics of these extended levels are the same as without capacity booster. However, for performance level settings with capacity booster, adaptive properties of the ND9000 control algorithm are disabled.
Calibration	
SINGLE_POINT_CALIB_RANGE	Valve opening angle in degrease. (Used only during the 1 point calibration)
SELF_CALIB_CMD	Initiation of a self-calibration procedure. Options: • Idle • Start automatic calibration • Start 1 pt calibration • Cancel current calibration procedure NOTE: Writable only in OOS mode.

SELF_CALIB_STATUS	Result or status of the self-calibration procedure. • Idle • Cancelled • Error • Calibration is running • Calibration was successful
SELF_CALIB_ERROR_CODE	Self-calibration error code. • Indicates no error • Calibration not initialized properly • An invalid operation was requested • Channel status was bad during calibration • The test timeout has expired • There is not enough pressure during position calibration • The state machines have entered to unknown state • Parameters write function failed when storing spool pos • Parameters write function failed when storing valve pos • Parameters write function failed when storing pressure c1 • Paraters write function failed when storing pressure c2 • Paraters write function failed when storing supply pressure • Paraters write function failed when storing input current • Spool pos values not in valid range • Valve pos values not in valid range • Pressure c1 values not in valid range • Pressure c2 values not in valid range • Supply pressure values not in valid range • Input current values not in valid range • Spool pos values difference too small • Valve pos values difference too small • Pressure c1 values difference too small • Pressure c2 values difference too small • Supply pressure values difference too small • Input current values difference too small • pressure channel C1 sensor gain invalid • pressure channel C1 sensor gain diff invalid • pressure channel C2 sensor gain invalid • pressure channel C2 sensor gain diff invalid • pressure channel SUPPLY sensor gain invalid • pressure channel SUPPLY sensor gain diff invalid • Calib process was not able to get the temporary ownership • Unable to write Spring tuner store values into database • Spring tuner store values out of valid range • Unable to write pwm calibration store value into database • Pwm calibration store value out of valid range • Tune failed to move the valve • Range error in spring tuner • prestage diagnostics range
Flow characterisation	
CHAR_TYPE	Type of linearisation. Options: • No characterization • Characterization polynom - the characterization curve defined by the polynomial factor is in use. • User defined curve - the characterization curve defined in the user table is in use.
CHAR_POLYNOMIAL_FACTOR	Polynomial characterization is described by the formula f(x)=x/(S+x*(1-S)), where x is the input value and S is the polynomial factor. • S=1, results linear transfer function • 0<S<1, function implements quick opening • S > 1, function implements equal percentage characterization curve
CHAR_USER_TABLE	User defined characterisation table.
On-line measurements	
COMM_FAIL_RATE_24H_AVG	This parameter monitors the fieldbus communication failure rate, in percent. The value has a moving average of last 24 hours. In ideal circumstances, the value should remain zero. The bigger the value, the worse the fieldbus signal. The decreasing of the fieldbus signal quality may result from poor segment design (trunk and spur lengths, termination, shielding, grounding), loose connections or electro-magnetic disturbances (EMC).

NBR_COMM_ERRS_DURING_	
LAST_MIN	This parameter indicates the number of fieldbus communication errors detected during the previous one minute. The value of this parameter resets to zero every 1 min.
PRESSURE_C1	Pressure measurement from C1 pneumatic connector.
PRESSURE_C2	Pressure measurement from C2 pneumatic connector.
SUPPLY_PRESSURE	Supply pressure measurement.
DEVICE_TEMPERATURE	Device temperature measurement.
TOTAL_OPERATION_TIME	Device total operation time in hours.
Travel counters	
VALVE_TOTAL_TRAVEL	Amount of valve total movement.
VALVE_REVERSALS	Amount of changes in valve movement direction.
ACTUATOR_TOTAL_TRAVEL	Amount of actuator total movement.
ACTUATOR_REVERSALS	Amount of changes in actuator movement direction.
SETPOINT_TOTAL_TRAVEL	Amount of setpoint total movement.
SETPOINT_REVERSALS	Amount of changes in setpoint movement direction.
SPOOL_VALVE_TOTAL_TRAVEL	Amount of spool valve total movement.
SPOOL_VALVE_REVERSALS	Amount of changes in spool valve movement direction.
Trends ND9000F continuously stores trend data into the device memory. The trends are used to diagnose the valve package condition over time. See section Trend Graphs, page 25.	
TREND_SELECTOR	TREND_SELECTOR is used for selecting a trend which is displayed in TREND_ DATA_* vectors. The trends are: • Steady state deviation Average • Steady state deviation Cumulative time • Steady state deviation Standard deviation • Dynamic deviation Average • Dynamic deviation Cumulative time • Dynamic deviation Standard deviation • Stiction Average • Stiction number of measurements • Stiction Stable curve offset • Stiction Stable curve number of measurements • Stiction Close-to-open curve offset • Stiction Close-to-open curve number of measurements • Stiction Open-to-close curve offset • Stiction Open-to-close curve number of measurements • Load for opening Average • Load for opening Minimum • Load for opening Maximum • Load for opening Number of measurements • Load for opening Standard deviation • Supply pressure Average • Supply pressure Minimum • Supply pressure Maximum • Temperature Average • Temperature Minimum • Temperature Maximum • Spool valve travel Average • Spool valve travel Standard deviation • Fieldbus communication failure rate • Total operation time • Valve reversals • Setpoint reversals • Valve travel • Valve reversals while stable setpoint • Load for closing Average • Load for closing Minimum • Load for closing Maximum • Load for closing nbr of meas • Load for closing Standard deviation • Spool valve compensation • Counter ratio • Valve position

TREND_STATUS	Status of trend read operation.
TREND_DATA_NOW	Latest trend data, time interval varies from 0 to 24 hours.
TREND_DATA_LAST_15_DAYS	Trend data values of the last 15 days, i.e. days 1-15 prior to now. Latest full day of the period first.
TREND_DATA_PREVIOUS_15_ DAYS	Trend data values of the previous 15 days, i.e. days 16-30 prior to now. Latest full day of the period first.
TREND_DATA_PREVIOUS_15_ DAYS	Trend data values of the previous 15 days, i.e. days 16-30 prior to now. Latest full day of the period first.
TREND_DATA_LAST_12_MONTHS	Trend data values of last 12 full months, latest full month first.
TREND_DATA_LAST_25_YEARS	Trend data values of all full years, latest full year first.
TREND_DATA_REFERENCE_VALUE	Reference value of the trend, determined during the first few months of device operation.
Histogram	
VALVE_TRAVEL_HISTOGRAM	Valve position histogram shows the valve operating areas. Element 1: closed position; elements 2-11: operating range 0-100% divided to 10% areas; 12th element: closed position.
Alarm settings ND9000F reports an alarm if on-line measurements, travel counters or trends exceed alarm limits. The alarm settings are defined with following parameters.	
POS_ALERT_HI	User defined threshold limit for position high alert. Valve position greater than the limit will trigger a position high alert. Default: 120 %, Range: 0-130 %
POS_ALERT_LO	User defined threshold limit for position low alert. Valve position smaller than the limit will trigger a position low alert. Default: -20 %, Range: -30 - 100 %
VALVE_POS_ALERT_LATCH_TIME	User defined activation time for valve position alert. Default: 30 s, Range: 0-36000 s
TOTAL_OPERATION_TIME_ WARNING_LIM	Warning limit for total operation time. Default: 216000 h, Range: 0-Float maximum
VALVE_TOTAL_TRAVEL_WARNING_ LIM	Warning limit for valve total travel. Default: 250000, Range: 0-Float maximum
VALVE_REVERSALS_WARNING_LIM	Warning limit for valve reversals. Default: 1000000, Range: 0-Integer maximum
VALVE_REVERSALS_TREND_ WARN_LIM	Warning limit for valve reversals trend. Default: 10000, Range: 0-Integer maximum
VALVE_REV_SSP_TREND_WARN_ LIM	Warning limit for valve reversals while stable setpoint trend. Default: 5000, Range: 0-Integer maximum
SP_REVERSALS_TREND_ WARNING_ LIM	Warning limit for setpoint reversals trend. Default: 1000, Range: 0-Integer maximum
VALVE_TRAVEL_TREND_ WARNING_ LIM	Warning limit for valve total travel trend. Default: 2500, Range: 0-Float maximum
ACTUATOR_TOTAL_TRAVEL_ WARN_LIM	Warning limit for actuator total travel. Default: 250000, Range: 0-Float maximum
ACTUATOR_REVERSALS_ WARNING_ LIM	Warning limit for actuator reversals. Default: 1000000, Range: 0-Integer maximum
SPOOL_VALVE_TOT_TRAVEL_ WARN_LIM	Warning limit for spool valve total travel. Default: 10000000, Range: 0-Float maximum
SPOOL_VALVE_REVERSALS_ WARN_LIM	Warning limit for spool valve reversals. Default: 10000000, Range: 0-Float maximum
STEADY_STATE_DEVIATION_ WARN_LIM	Warning limit for steady state deviation. Steady state deviation average value is checked against the warning limit with 24-hour intervals. If the limit is exceeded, a warning is activated. Default: 3 %, Range: 0-100 %
STEADY_STATE_DEVIATION_ ALARM_LIM	Online alarm limit for steady state deviation. Steady state deviation measurement must be over this limit value for a time indicated by STEADY_STATE_DEVIATION_ LATCH_TIME. Default: 5 %, Range: 0-Float maximum
STEADY_STATE_DEV_LATCH_ TIME	Online alarm activation time for steady state deviation. Default: 30 s, Range: 0-Float maximum
DYNAMIC_STATE_DEV_WARNING_ LIM	Warning limit for dynamic deviation. Dynamic deviation average value is checked against the warning limit with 24-hour intervals. If the limit is exceeded, a warning is activated. Default: 20 %, Range: 0-100 %

STICTION_LO_WARNING_LIM	Lower warning limit for stiction. Stiction average value is checked against the warning limit with 24-hour intervals. If the limit is exceeded, a warning is activated. Default: 0 bar, Range: -1000 - Float maximum
STICTION_HI_WARNING_LIM	Upper warning limit for stiction. Stiction average value is checked against the warning limit with 24-hour intervals. If the limit is exceeded, a warning is activated. Default: 4 bar, Range: -1000 - Float maximum
STICTION_LO_ALARM_LIM	Online lower alarm limit for stiction. Stiction measurement must be below this limit value for a time indicated by STICTION_LATCH_NBR. Default: 0 bar, Range: -1000 - Float maximum
STICTION_HI_ALARM_LIM	Online upper alarm limit for stiction. Stiction measurement must be above this limit value for a time indicated by STICTION_LATCH_NBR. Default: 10 bar, Range: -1000 - Float maximum
STICTION_LATCH_NBR	Online alarm activation number for stiction. Default: 10, Range: 1-Float maximum
LOAD_FOR_OPENING_LO_ WARNING_LIM	Lower warning limit for load for opening. Load for opening average value is checked against the warning limit with 24-hour intervals. If the limit is exceeded, a warning is activated. Default: 0 bar, Range: -1000 - Float maximum
LOAD_FOR_OPENING_HI_ WARNING_LIM	Upper warning limit for load for opening. Load for opening average value is checked against the warning limit with 24-hour intervals. If the limit is exceeded, a warning is activated. Default: 0 bar, Range: -1000 - Float maximum
LOAD_FOR_OPENING_LO_ALARM_ LIM	Online lower alarm limit for load for opening. Load for opening measurement must be below this limit value for a time indicated by LOAD_FOR_OPENING_LATCH_ NBR. Default: 0 bar, Range: -1000 - Float maximum
LOAD_FOR_OPENING_HI_ALARM_ LIM	Online upper alarm limit for load for opening. Load for opening measurement must be above this limit value for a time indicated by LOAD_FOR_OPENING_LATCH_ NBR. Default: 0 bar, Range: -1000 - Float maximum
LOAD_FOR_OPENING_LATCH_ NBR	Online alarm activation number for load for opening. Default: 10, Range: 1-Float maximum
LOAD_FOR_CLOSING_LO_ WARNING_LIM	Lower warning limit for load for closing. Load for closing average value is checked against the warning limit with 24-hour intervals. Default: 0 bar, Range: -1000 - Float maximum
LOAD_FOR_CLOSING_HI_ WARNING_LIM	Upper warning limit for load for closing. Load for closing average value is checked against the warning limit with 24-hour intervals. Default: 0 bar, Range: -1000 - Float maximum
LOAD_FOR_CLOSING_LO_ ALARM_LIM	Online lower alarm limit for load for closing. Load for closing measurement must be below this limit value for a time indicated by LOAD_FOR_CLOSING_LATCH_NBR. Default: 0 bar, Range: -1000 - Float maximum
LOAD_FOR_CLOSING_HI_ALARM_ LIM	Online upper alarm limit for load for closing. Load for closing measurement must be above this limit value for a time indicated by LOAD_FOR_CLOSING_LATCH_NBR. Default: 0 bar, Range: -1000 - Float maximum
LOAD_FOR_CLOSING_LATCH_ NBR	Online alarm activation number for load for closing. Default: 10, Range: 1-Float maximum
SUPPLY_PRESSURE_LO_ALARM_ LIM	Online alarm lower limit for supply pressure. Supply pressure measurement must be below this limit value for a time indicated by SUPPLY_PRESSURE_LATCH_TIME. Default: 1.4 bar, Range: 0-Float maximum
SUPPLY_PRESSURE_HI_ALARM_ LIM	Online alarm upper limit for supply pressure. Supply pressure measurement must be above this limit value for a time indicated by SUPPLY_PRESSURE_LATCH_TIME. Default: 8 bar, Range: 1-Float maximum
SUPPLY_PRESSURE_LATCH_TIME	Online alarm activation time for supply pressure. Default: 30 s, Range: 0-Float maximum
DEVICE_TEMPERATURE_LO_ ALARM_LIM	Online alarm lower limit for circuit board temperature. Temperature measurement must be below this limit value for a time indicated by DEVICE_TEMPERATURE_ LATCH_TIME. Default: -40 C, Range: -40 C - +85 C
DEVICE_TEMPERATURE_HI_ ALARM_LIM	Online alarm upper limit for circuit board temperature. Temperature measurement must be above this limit value for a time indicated by DEVICE_TEMPERATURE_ LATCH_TIME. Default: +85 C, Range: -40 C - +85 C
DEVICE_TEMPERATURE_LATCH_ TIME	Online alarm activation time for temperature. Default: 120 s, Range: 0-Float maximum
COMM_FAIL_RATE_ALARM_LIM	Alarm limit for fieldbus communication failure. Default: 0 %, Range: 0-100 %

Online Valve Signature	
ONLINE_SIGNATURE_PRES_TABLE_UP	Online Valve signature data to valve open direction.
ONLINE_SIGNATURE_PRES_TABLE_DOWN	Online Valve signature data to valve close direction.
Event log ND9000F stores 8,000 latest events and associated time stamps to the device memory.	
EVENT_LOG_SELECTOR	This parameter is used to select the events that are displayed in the parameters EVENT_LOG_EVENT_TIME_STAMP and EVENT_LOG_EVENT. Options are: • Idle • Show 25 latest events • Show next 25 events • Show previous 25 events
EVENT_LOG_STATUS	Displays the trend selection procedure status.
EVENT_LOG_EVENT_TIME_STAMP	This vector displays 25 time stamps for the corresponding events shown in the parameter EVENT_LOG_EVENT. The time stamp is shown in operating hours. The current operating hours are displayed in the parameter TOTAL_OPERATION_TIME.
EVENT_LOG_EVENT	This vector displays 25 events.
Diagnostics reset	
RESET_DIAGNOSTICS	This parameter resets the diagnostic data. Options are: • Idle • Valve travel counters • Actuator travel counters • Setpoint travel counters • Spool valve travel counters • Reset all trends and speed histograms • Valve travel vs. time histogram • Event log • Reset everything
Off-line valve tests The off-line valve tests are used to test the valve package condition when the process is not running.	
TEST_TYPE	This parameter selects the test type to be run. Options: • None • Multipoint step test • Dynamic loop test • Deadband test • Valve analysis test

TEST_SETTINGS	This parameter is a vector of 24 elements that define the test settings. The test settings are different for each test type. **Multipoint Step test** 1. **STEP 1**: Test Init Time: the time given to the valve to reach the starting point of the Multipoint Step test. 2. **STEP 1:** Duration - the time between successive steps. The total test time is Init Time + Duration. 3. **STEP 1:** Start Position - starting valve position for the Multipoint Step test 4. **STEP 1:** End Position - ending position of the valve 5-24 Configuration of successive steps 2-6. Each successive step is configured exactly as for STEP 1. If fewer than 6 steps are desired, set the configuration values to zero. The test will stop to the first zero-configured-step. **Dynamic loop test** 1. **Test Init Time** - the time given to the valve to reach the starting point of the test 2. **Ramp Time** - duration of ramp time. Total test time is then Init Time + 2*Ramp Time 3. **Start Position** - starting setpoint for test 4. **End Position** - ending setpoint for test. Note that the end setpoint may be smaller than the start setpoint. When this is the case, the loop runs downwards in time. 5-24 Not used in this test **Deadband test** 1. **Test Init Time** - the time given to the valve to reach the starting point of the valve deadband test 2. **Test Time** - the time that the test waits between successive 0.1% steps. The total test time cannot be estimated. The absolute maximum is 40***Test Time**. Note that when the input signal direction changes, the waiting time is 2***Test Time**. 3. Start setpoint - starting valve position for the valve deadband test 4-24 Not used in this test **Valve analysis test** 1. **Test Init Time** - the time given to valve to reach the 0% position. 2. **Ramp Time** - duration of ramp time. Total test time is then **Init Time** + 4* **Ramp Time** + 2* **Steady Time**. 3. **Start setpoint** - measurement point of hysteresis, the position at which the valve stops for static hysteresis measurement. 4. **Steady Time** - used to store the steady time in the hysteresis position. This is also the amount of time in which the test is held in a 100% position before the descending ramp is started. 5-24 Not used in this test
TEST_CTRL	This parameter is used to start the valve test; Options; • Idle • Start test • Cancel test NOTE: Writable only in OOS mode.
TEST_STATUS	This parameter displays the status of the valve test. Displayed status values are: • Idle • Test was OK • Initializing • Running • Cancelled • Test parameters incorrect • Test failed

KEY_FIG_STEP	Once the step test is run, the key figures of the test are calculated and displayed in this vector. Note that the key figure calculation is performed only on the first step; The vector elements are: 1. Test starting setpoint 2. est ending setpoint 3. Testing time 4. **Dead Time Td (s)** - the time that the valve requires to move at least 0.005% after the input signal change has occurred. 5. **Step Response Time T86 (s)** - the time elapsed when the valve reaches 86.5% of the realized step size (not the nominal stepwise change in the setpoint) 6. **Overshoot** - the size of overshoot as a percentage of the realized step. 7. **Travel Gain** - the ratio between the step size of the control signal and the position measurement. In optimum case the value is 1.0.
KEY_FIG_DYNAMIC_LOOP	Once the dynamic loop test is run, the key figures of the test are calculated and displayed in this vector. The vector elements are: 1. Test starting setpoint 2. Test ending setpoint 3. Testing time 4. **Maximum dynamic error band** - the maximum difference in valve travel for any single setpoint value during the loop. The value is calculated by the device from the loop size minus 10% from the start and 10% from the end. 5. **Setpoint at max error** - the value of the setpoint at the point at which Maximum
Dynamic Error Band is measured.	
KEY_FIG_ANALYSIS	Once the analysis test is run, the key figures of the test are calculated and displayed in this vector. The vector elements are: 1. Test starting setpoint 2. Stable time 3. Ramp time 4. **Static Hysteresis** - during the steady time, the last 80 msec valve position is averaged in the opening ramp. The same average is calculated while closing the valve. The hysteresis is the difference of these values. 5. **Sensitivity** - a percentage of change in input signal that is measured when the valve starts moving again after the steady state of the opening ramp is completed. 6. **Load for Opening** - the pressure difference recorded (in bars) when the valve starts to move from a closed position. 7. **Seat Load** - the absolute pressure difference (in bars) between the supply pressure (spring to open) or air pressure (spring to close) and the pressure at which the valve first closes. 8. **Stroking range o2c close** - the pressure difference recorded (in bars) when the valve starts to move from position 1% to closed direction. 9. **Stroking range o2c open** - the pressure difference recorded (in bars) when the valve starts to move from position 99% to closed direction. 10. **Stroking range c2o close** - the pressure difference recorded (in bars) when the valve starts to move from position 1% to open direction. 11 **Stroking range c2o open** - the pressure difference recorded (in bars) when the valve starts to move from position 99% to open direction.
KEY_FIG_DEADBAND	Once the deadband test has been run, the key figures of the test are calculated and displayed in this vector. The vector elements are: 1. Test starting setpoint 2. Testing time 3. **Deadband** - the range through which a control valve's input signal may be varied, upon reversal of direction, without initiating an observable change in the position of the closure member.
TEST_DATA_SELECTOR	The test data is stored in the device memory. This parameter is used to select which part of the test data is shown in the parameter TEST_DATA.
TEST_DATA_STATUS	Displays the test data read operation status.
TEST_DATA_TIME_RESOLUTION	This parameter indicates the time resolution (ms) of the TEST_DATA vector.
TEST_DATA	Test data vector. Test data can only be visualized by Neles DTM and EDD tools.
CM_DIAG_DATA_1	TREND_DATA_LAST_15_DAYS.1 values for each TREND_SELECTOR items. Used by FieldCare condition monitoring.
CM_DIAG_DATA_2	TREND_DATA_LAST_15_DAYS.1 values for each TREND_SELECTOR items. Used by FieldCare condition monitoring.

3.2.3 Trend Graphs

3.2.3.1 Introduction to Trend Graphs

Trends are continuously saved in the device memory. Trends display the previous 30 full days, 12 full months, and up to 25 full years. In addition, trends show a Now value, which is the average value of the previous 0-24 hours. Figure 3 shows a sample trend in Neles Valve Manager DTM.

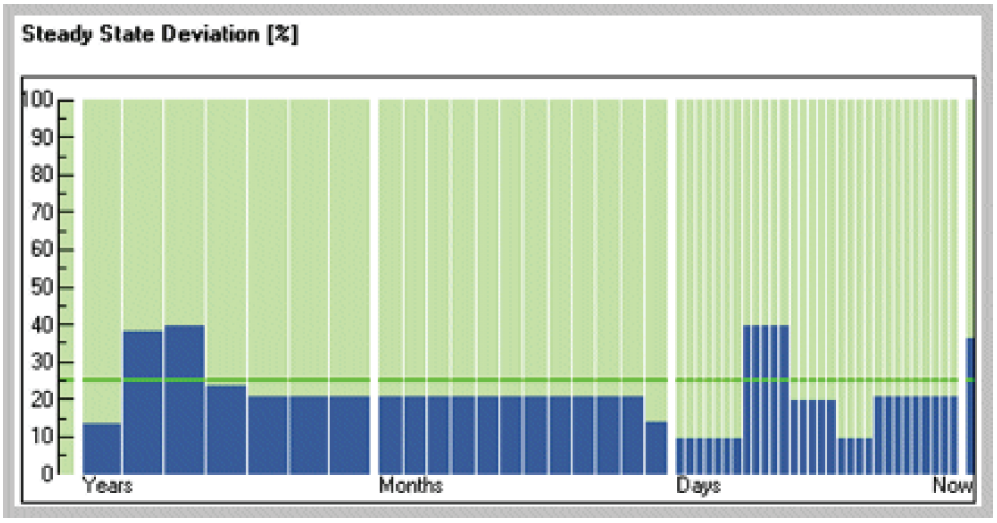

Figure 3. A sample trend graph

3.2.3.2 Time Axis

The time axis of the trend is displayed from left to right, with the oldest values on the left and the newest values on the right. The trend adjusts periodically along the time axis as follows:

- When 24 hours have passed, a new **Day** value is added to the trend and the device begins to calculate a new Now value.
- When 30 days have passed, a new **Month** value is added to the trend.
- When 12 months have passed and 12 new **Month** values have been calculated, a new Year value is added to the trend.

3.2.3.3 Reference Value

The green line on the trend represents the **reference value** of the trend. Reference value represents valve performance at its best. During the first three months of operation, the device calculates reference values for all trends. Note that the device does not calculate reference values if supply pressure is not connected.

You can use reference values later for analyzing changes in the trend.

3.2.3.4 Steady State Deviation

Steady State Deviation is used to determine the basic control accuracy of the valve. It is updated whenever the setpoint is considered to have reached the desired position as precisely as possible. Figure 2 illustrates this concept. Steady State Deviation trend is updated during the periods marked steady.

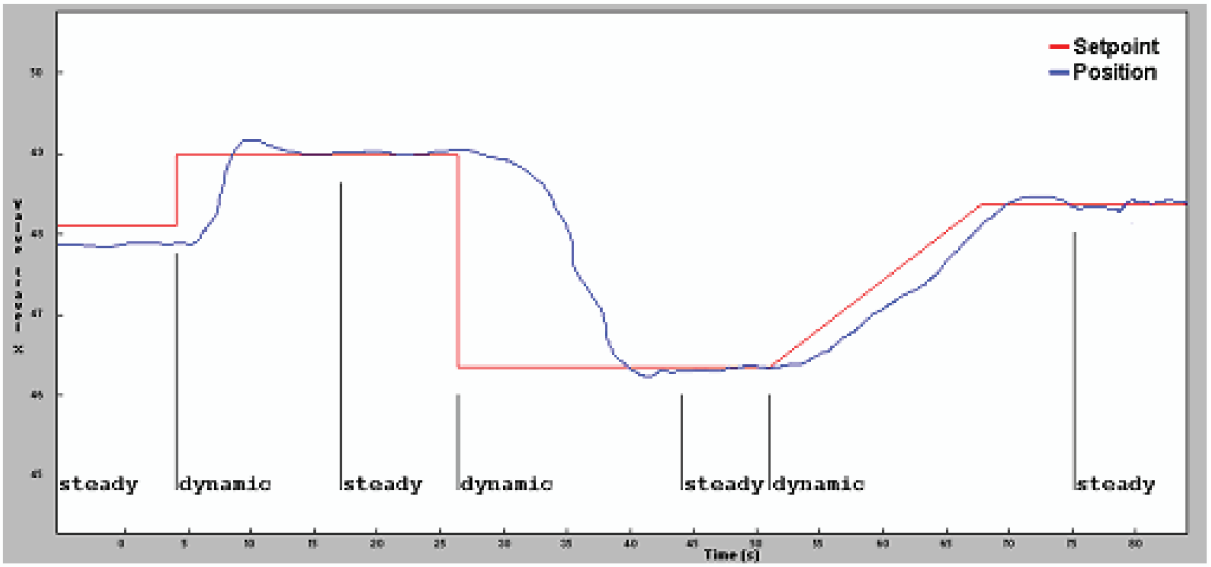

Figure 4. This graph illustrates steady states and dynamic states.

3.2.3.5 Dynamic State Deviation

Dynamic State Deviation can be used to estimate valve dynamics such as response times. It is updated whenever the setpoint changes and the valve is expected to move accordingly. Updating continues throughout the valve movement and is switched back to Steady State when both setpoint and valve position have reached a steady state.

Figure 4 illustrates this concept. The Dynamic State Deviation trend is updated during the periods marked dynamic.

3.2.3.6 Stiction

Stiction, Stable State Load, and **Load for Opening** are the three pneumatic load measurements. You can use the Stiction value to estimate internal frictions in the control valve package:

- **Increased** stiction suggests an increase in internal friction, which can cause accuracy problems and ultimately prevent the valve from moving.
- **Decreased** stiction suggests a decrease in internal friction. This may indicate problems such as extensive wear or valve shaft break.

Whenever the valve moves, required pneumatic pressure in the actuator is registered. The stiction value can be calculated when measurements in both upscale and downscale directions have been registered.

3.2.3.7 Stable State Load

This trend displays Stable State Load measurement, which is especially significant for single-acting actuators since you can use it estimate the actuator spring force and spring state. The trend is based on the pneumatic pressure measurement that is carried out whenever the valve is in a stable state.

If the spring is broken, Stable State Load decreases noticeably.

3.2.3.8 Load for Opening

You can use Load for Opening to estimate the following:

- Seat wear, especially in butterfly valves
- Medium crystallization in e.g. ball valves

The Load for Opening trend is updated whenever the valve is opened from a fully closed position. Like stiction, this trend is based on pneumatics measurement.

3.2.3.9 Spool Valve Position

This trend displays the Spool Valve Position, which is measured as a percentage of the movement range. Spool Valve Position is typically in the middle of the range, but changes in the trend may suggest an actuator (pneumatic) leak, especially with single-acting actuators.

3.2.3.10 Supply Pressure

You can use Supply Pressure trend as follows:
- To analyze possible problems with supply pressure
- To monitor pressure values that exceed device specifications

3.2.3.11 Temperature

The Temperature trend displays the device temperature on the Printed Circuit Board (PCB) temperature. You can use measurement to monitor temperature values exceeding device specifications.

3.2.3.12 Daily Setpoint Reversals

The Setpoint Reversals trend displays how many setpoint reversals have occurred in the past 24 hours. Monthly and yearly values are averages of these daily values.

3.2.3.13 Daily Valve Reversals

The Valve Reversals trend displays how many valve reversals have occurred in the past 24 hours. Monthly and yearly values are averages of these daily values.

3.2.3.14 Daily Valve Reversals while Stable Setpoint

The Valve Reversals while Stable Setpoint trend displays the amount of valve reversals that the setpoint does not change that have occurred in the past 24 hours. Monthly and yearly values are averages of these daily values.

3.2.3.15 Daily Valve Position

The Valve Position is the daily average of valve position. For example, if the valve has been at 0 % for half the time and at 100 % for the remaining time, after which the Valve Position trend displays 50 %.

3.2.3.16 Corrupted Communication Signals in Segment

Corrupted communication signals in segment displays the percentage of failed communication data frames that failed in the last 24 hours.

3.3 Analog output block

3.3.1 Overview

The AO block essentially takes the valve position setpoint from another block to CAS_IN and passes it to the transducer block through the CHANNEL reference. The transducer block then controls the valve position.

If desired, the AO block can be configured to make some signal modifications (scaling, limiting, invert) between the CAS_IN and CHANNEL signals.

In addition to these functions, the AO block contains several advanced options that are explained in detail in the next section.

3.3.2 Parameters

The AO block parameters are described in the table 4.

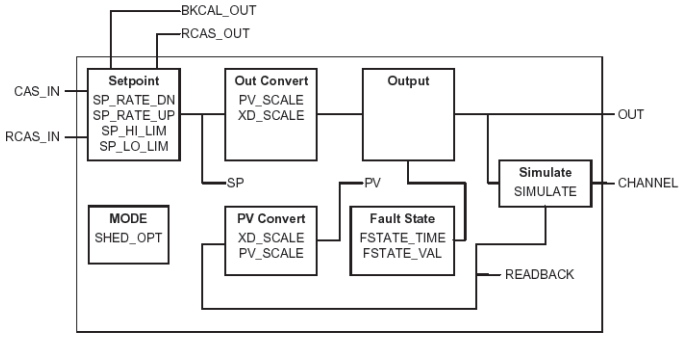

Figure 5. AO block schematic.

Table 4. Analog output block parameters.

AO block parameter name	Description
ST_REV	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in this block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify the grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	• MODE_BLK contains the actual, target, permitted, and normal modes of the block. • ACTUAL is the current mode of the block, which may differ from the target based on operating conditions. Its value is calculated as part of block execution. • TARGET is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested. • PERMITTED defines the modes which are allowed for an instance of the block. The permitted mode is configured based on application requirement. • NORMAL is the mode which the block should be set to during normal operating conditions. AO block modes are: • Out of Service (O/S) - The block is not being evaluated. The output is maintained at last value. Setpoint is maintained at last value. • Initialisation Manual (IMan) - AO block actual mode is underway to change to the target mode. If actual mode stays on Iman, READBACK signal from the transducer block may have BAD status. The setpoint may be maintained or optionally initialized to the process variable parameter value. The IMan mode is used to indicate that there is no path to the final element. • Local Override (LO) - In local override mode, the block output is being set to track the value of the FSTATE_VAL parameter. The algorithm initialises so that no bump is experienced when the mode switches from LO back to the target mode. The setpoint may be maintained or optionally initialised to the process variable parameter value. • Manual (Man) - The block output is not being calculated, although it may be limited. It is directly set by the operator through an interface device. The algorithm initialises so that no bump is experienced when the mode switches. The setpoint may be maintained or optionally initialised to the process variable parameter value or to the setpoint value associated with the previous (retained) target mode. Man mode can be used for maintenance or troubleshooting where the OUT value may need to be directly adjusted. • Automatic (Auto) - A local setpoint value is used by the normal block algorithm in determining the primary output value. An operator may write to the local setpoint value through an interface device. • Cascade (Cas) - A setpoint value supplied by another function block through the Cascade input parameter is used by the normal block algorithm in determining the primary output value. This connection between function blocks is defined by a link object. • Remote-Cascade (RCas) - The block setpoint is being set by a Control Application running on an interface device through the remote-cascade in parameter. Based on this setpoint, the normal block algorithm determines the primary output value. A remote-cascade out parameter is maintained by the block to support the initialization of the control application when the block mode is not remote-cascade. A remote-cascade out parameter is maintained by the block to support the initialization of the control application when the block mode is not remote-cascade.

AO block parameter name	Description
BLOCK_ERR	This parameter reflects the error status related to the hardware or software components associated with a block. It is a bit string, meaning that multiple errors may be shown. • Other - Non-specific error active. • BlockConfiguration - Error detected in block configuration. • LinkConfiguration - Error detected in link configuration. • SimulationActive - Simulation enabled in this block. For the resource block, Simulate Active will be used to indicate that the simulate hardware jumper is present. • An active state (1) of this attribute will indicate that the jumper is present and that it is possible for the user to enable simulation in the AO function block. For AO block this indicates that the simulation is either enabled or disabled. • LocalOverride - Output tracking or faultstate active. • DeviceFaultstate - Device faultstate set. • Device needs maintenance soon • InputFailure - Process variable has bad status. • OutputFailure - Failure detected in output hardware. • MemoryFailure - Memory error detected. • LostStaticData - Static parameters cannot be recovered. • LostNVData - Non-Volatile parameters cannot be recovered. • ReadbackCheck - Failure detected in READBACK. • Device needs maintenance now • PowerUp - Recovery from power failure. • OutOfService - Block actual mode is Out of Service.
PV	Either valve position setpoint calculated from AO.OUT value (default) or measured valve position calculated from the AO.READBACK value. See FEATURE_SEL. See NOTE 1.
SP	The AO block setpoint is calculated from CAS_IN (Cascade mode), RCAS_IN (Remote cascade mode) or entered by the user (Auto mode). See NOTE 1.
OUT	The AO block output (valve position setpoint) is either calculated from the SP (Auto, Cascade, Remote cascade) or tracks FSTATE_VAL (fault state active), or entered by the user (Manual mode). This signal is passed to the transducer block through the CHANNEL reference. See NOTE 1.
SIMULATE	This parameter acts as a switch at the interface between the AO function block and the transducer block. When the enable switch is on, the simulate value and status become the READBACK value and status, and the transducer block is ignored. The status can be used to simulate transducer faults. The transducer attribute value and status reflect the transducer readback value and status when simulation is enabled; the transducer maintains the previous output and ignores the OUT of the AO block. It is necessary to show that a block has a simulated value, without touching the status of parameters that may be linked elsewhere. The block alarm parameter will provide this visibility through the 'simulate' active attribute. When disabled, the simulation parameter should take on the value and status it would supply if enabled. See FEATURE_SEL. • Simulate Status - Used for the transducer status when simulation is enabled. • Simulate Value - Used for the transducer value when simulation is enabled. • Transducer Status - Status of value supplied by the transducer. • Transducer Value - Current value supplied by the transducer. • Enable/disable - Enable/disable simulation.
PV_SCALE	The scale of the PV, as default 0-100 %. The high and low scale values, engineering unit code, and number of digits to the right of the decimal point to be used in displaying the PV parameter and parameters which have the same scaling as PV. • EU_100 - The engineering unit value that represents the upper end range of the associated block parameter. • EU_0 - The engineering unit value that represents the lower end range of the associated block parameter. • UNITS_INDEX - Units code index for the engineering unit descriptor for the associated block value. • DECIMAL - The number of digits to the right of the decimal point that should be used by an interface device when displaying the specified parameter.

AO block parameter name	Description
XD_SCALE	The scale of the transducer, as default 0-100%. Since the valve position is expressed as a percentage of the valve movement span, the only valid unit is %.
GRANT_DENY	The grant-deny parameter (which has two attributes referred to as 'Grant' and 'Deny') is used to allow the operator to either grant or deny access permission to sets of function block parameters by other devices.. The operation of these parameters is defined here, but the actual usage (if any) depends on the philosophy of the plant. Grant - Depending on the philosophy of the plant, the operator of a higher-level device (HLD), or a local operator's panel (LOP) in the case of Local, may turn on an item of the Grant attribute - Program, Tuning, Alarm, or Local. By performing or allowing this action, the operator gives up control of the selected parameters to the HLD or LOP. The function block does not check writes to any of the selected parameters for grant-deny permission. Because the function block has no way of knowing who is writing to it, It is up to other devices to obey and enforce the rules. Operators wishing to regain control of the parameters must clear the Grant item. The function block will then automatically set the corresponding Deny item. This indicates to the HLD or LOP that control has been taken away. • Program - A higher-level device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. • Tune - A higher-level device may change the tuning parameters of the block. • Alarm - A higher-level device may change the alarm parameters of the block. • Local -A local operator's panel or hand-held device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. Deny - The Deny attribute is provided for use by a monitoring application in an interface device and may not be changed by an operator. It allows the monitoring application to determine if control has been temporarily taken away during the execution of a batch program. This is carried out by firstly clearing one or all of the Denied items before the execution of a batch program, and then checking the Denied item after execution. The Grant item itself should not be checked for this condition, because the operator may have cleared and subsequently set the Grant item during batch program execution, a sequence that might be missed by a slowly scanning monitor program. The Denied item may not be cleared by the operator, thus latching the fact that control was taken away. • Program - The Program permission item has been turned off. • Tune Denied - The Tune permission item has been turned off. • Alarm Denied - The Alarm permission item has been turned off. Local Denied - The Local permission item has been turned off.
IO_OPTS	Contains options that the user may select to alter the AO block processing. • SP tracks PV if Man - Enables the setpoint to track the process variable when the target mode of the block is Man. • SP tracks PV if LO - Enables the setpoint to track the process variable when the actual mode of the block is LO. • SP tracks RCas or Cas if LO or Man - Enables the setpoint to track the RCas or Cas parameter based on the retained target mode when the actual mode of the block is LO or Man. When SP-PV track options are enabled, then SP Track retained target will have precedence in the selection of the value to track when the actual mode is Man and LO. • Increase to close - Indicates whether the output value should be inverted before it is communicated to the I/O channel. • Fault state to value - The output action to take when failure occurs. If set, go to the FSTATE_VAL. If not set, freeze. • Fault state restart - If the device is restarted, it will use the value of FSTATE_VAL; otherwise it will use the non-volatile value. This does not act like fault state, just uses the value. • Target to Man if fault state activated - If Fault State is activated, set the target mode to Man, thus losing the original target. This latches an output block into the manual mode. • PV for BKCAL_OUT - The BKCAL_OUT value is normally the working SP. This option changes it to the PV.
STATUS_OPTS	Options that the user may select in the block processing of status. • Propagate Fault Backward - If the status from the actuator is Bad and Device failure or Fault State Active or Local Override is active, propagate this as Bad, Device Failure or Good Cascade, Fault State Active or Local Override to BKCAL_ OUT respectively without generating an alarm. The use of these sub-statuses in BKCAL_OUT is determined by this option. Through this option, the user may determine whether alarming (sending of an alert) will be performed by the block or propagated upstream for alarming.
READBACK	This parameter indicates the measured valve position, in transducer units (%). See NOTE 1.

AO block parameter name	Description
CAS_IN	This parameter is the remote setpoint value, which comes from another Fieldbus block, or a DCS block through a defined link. This setpoint is used in Cascade mode. See NOTE 1.
SP_RATE_DN	Ramp rate at which downward setpoint changes are acted on in Auto mode, in PV units per second. If the ramp rate is set to zero or the block is in a mode other than Auto, then the setpoint will be used immediately.
SP_RATE_UP	Ramp rate at which upward setpoint changes are acted on in Auto mode, in PV units per second. If the ramp rate is set to zero or the block is in a mode other than Auto, then the setpoint will be used immediately.
SP_HI_LIM	The setpoint high limit is the highest setpoint operator entry that can be used for the block.
SP_LO_LIM	The setpoint low limit is the lowest setpoint operator entry that can be used for the block.
CHANNEL	This parameter defines the signal configuration between AO and transducer block. • 0 = Not initialised • 1 = AO: Valve control (not writeable if DO channel active) • 2 = AO: No transducer connection • 3 = AO: Valve control, readback compensation (not writeable if DO channel active) Example: Channel selection 1 results in the valve position being controlled by the AO block. The AO.OUT signal will be used as valve position setpoint
FSTATE_TIME	The Fault State parameters determine the response of an output block if one or more of the following conditions exists for a time that exceeds FSTATE_TIME: loss of communications to CAS_IN, or Initiate Fault State status is at CAS_IN when the target mode is CAS, or Initiate Fault State status is at RCAS_IN when the target mode is RCAS. If one of these conditions exists, then the block will go to the defined Fault State. FSTATE_TIME is the time in seconds from the detection of failure of the output block remote setpoint to the output action of the block output, if the condition still exists.
FSTATE_VAL	The preset OUT value to use when failure occurs. This value will be used if IO_OPTS "Faultstate to value" is selected.
BKCAL_OUT	The value and status required by an upper block's BKCAL_IN so that the upper block may prevent reset windup and provide bumbles transfer to closed loop control. Depending on IO_OPTS, the value is either SP (default) or PV.
RCAS_IN	Target setpoint and status provided by a supervisory Host. See NOTE 1.
SHED_OPT	Defines the action to be taken on remote control device timeout. See SHED_RCAS and SHED_ROUT. • Undefined - Invalid • Normal shed, normal return - Actual mode changes to the next lowest priority non-remote mode permitted but returns to the target remote mode when the remote computer completes the initialization handshake. • Normal shed, no return - Target mode changes to the next lowest priority non-remote mode permitted. The target remote mode is lost, and cannot be returned to. • Shed to Auto, normal return - Actual mode changes to Auto on detection of a shed condition. • Shed to Auto, no return - Target mode changes to Auto on detection of a shed condition. • Shed to Manual, normal return - Actual mode changes to Man on detection of a shed condition. • Shed to Manual, no return - Target mode changes to Man on detection of a shed condition. • Shed to Retained target, normal return - Shed to previous target mode and return target remote mode after communications are re-established. • Shed to Retained target, no return - Target mode changes to retained target mode.
RCAS_OUT	Block setpoint and status after ramping - provided to a supervisory Host for back calculation and to allow action to be taken under limiting conditions or mode change. See NOTE 1.

AO block parameter name	Description
UPDATE_EVT	An alert for any change in the static data, UDATE_EVT, is included in each block. This alert can notify the interface devices that keep track of changes that one or more changes have occurred. The relative parameter index and its associated block index are included in the alert, along with the new value of ST_REV. If more than one change has been added since the last reported Update Alert, as known from the difference between the last copy of ST_REV and that in the alert, it will be necessary for the interface device to update all static data. No alert will be generated while a block is in Out of Service mode, so that downloads do not generate many update alerts. ST_REV will be incremented for each change to static data that occurs while the block is in O/S mode. On the transition out of O/S mode, an update alert may be generated if the value of ST_REV for the block does not match that of the last reported alert. Update Alert has a fixed priority of 2, therefore it is auto-acknowledged (no operator intervention is required). • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration which gives an indication of whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received - even if another change of state occurs. • Static Rev - The static revision of the block whose static parameter was changed and is being reported. It is possible for the present value of static revision to be greater than this because static can be changed at any time. • Relative Index - The OD index of the static parameter whose change caused this alert, minus the FB starting index. If the update event was caused by a write to multiple parameters at the same time, then this attribute will be zero.
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration which gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received – even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. • Value - The value of the associated parameter at the time the alert was detected.
BLOCK_ERR_DESC_1	The BLOCK_ERR_DESC_1 parameter lists un- or misconfigured parameters of the function block.

Note 1. All input and output parameters are structures composed of status and value, but some contained parameters (internal parameters, not accessible by other blocks) have the same data type, for example, RCAS_IN, ROUT_IN, SP and PV.
The Status field is composed of three parts: Quality, Sub-Status and Limits.
Quality – This indicates the quality of the parameter value.

- Good Cascade – The quality of the value is good, and it may be part of a cascade structure.
- Good Non-Cascade – The quality of the value is good, and the block doesn't support a cascade path.
- Uncertain – The quality of the value is lower than normal, but the value may still be useful.
- Bad – The value is not useful.

Sub-Status – The sub-status is a complement of the quality status and takes information to initialize or break a cascade control, alarms and others. There are different sets of sub-status for each quality.
Limits - This provides information as to whether the associated value is limited or not, as well its direction. The limits are classified as: Not Limited, High Limited, Low Limited and Constant.

3.4 Analog Input function block

3.4.1 Overview

Analog Input block (AI) takes the measured analog valve position information (0-100 %) from the Transducer block and makes it accessible through it's OUT parameter. The CHANNEL parameters defines, whether the position information comes from the valve position sensor (AI: Valve Position) or if the position information is readback compensated (AI: Valve position with readback compensation).

The AI block schematic is presented in Figure 6.

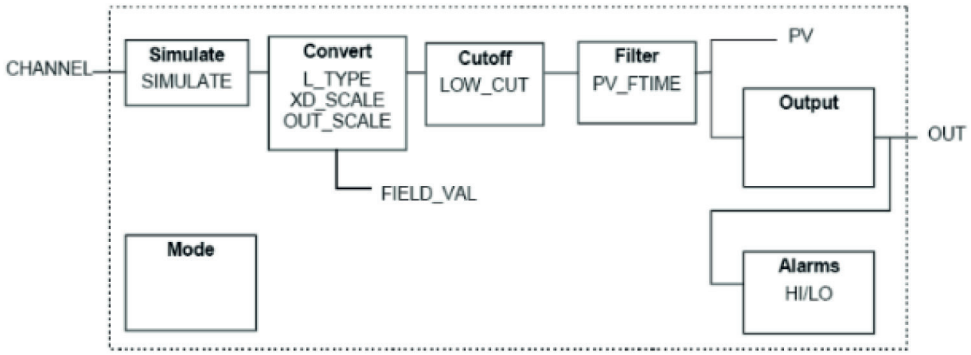

Figure 6. AI block schematic.

3.4.2 Parameters

AI block parameter name	Description
ST_REV	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in this block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify the grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	MODE_BLK contains the actual, target, permitted, and normal modes of the block. • ACTUAL is the current mode of the block, which may differ from the target based on operating conditions. Its value is calculated as part of block execution. • TARGET is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested. • PERMITTED defines the modes which are allowed for an instance of the block. The permitted mode is configured based on application requirement. • NORMAL is the mode which the block should be set to during normal operating conditions. AI block modes are: • Out of Service (O/S) - The block is not being evaluated. The output is maintained at last value. • Manual (Man) - The block output is set by the user. • Automatic (Auto) – The block output is set by the block.

AI block parameter name	**Description**
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown. The standard specifies following bit string enumerations for the block_err parameter: • Other; Non-specific error active. • BlockConfiguration; Error detected in block configuration. • LinkConfiguration; Error detected in link configuration. • LocalOverride; Faultstate active. • DeviceFaultstate; Device faultstate set. • Device needs maintenance soon • InputFailure; Process variable has bad status. • OutputFailure; Failure detected in output hardware. • MemoryFailure; Memory error detected. • LostStaticData; Static parameters cannot be recovered. • LostNVData; Non-Volatile parameters cannot be recovered. • Device needs maintenance now • PowerUp; Recovery from power failure. • OutOfService; Block actual mode is Out of Service.
PV	Process variable of the block (position measurement).
OUT	The primary analog value calculated as a result of executing the AI block. • Valve position measured by position sensor (channel: Valve Position) • Calculated readback compensated valve position (channel: Valve Position with readback compensation)
SIMULATE	SIMULATE allows the transducer analog input or output to the block to be manually supplied when simulate is enabled. When simulation is disabled, the simulate value and status track the actual value and status.
XD_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point used with the value obtained from the transducer for a specified channel.
OUT_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point to be used in displaying the OUT parameter and parameters which have the same scaling as OUT.
GRANT_DENY	The grant-deny parameter (which has two attributes referred to as 'Grant' and 'Deny') is used to allow the operator to either grant or deny access permission to sets of function block parameters by other devices.. The operation of these parameters is defined here, but the actual usage (if any) depends on the philosophy of the plant. Grant - Depending on the philosophy of the plant, the operator of a higher-level device (HLD), or a local operator's panel (LOP) in the case of Local, may turn on an item of the Grant attribute - Program, Tuning, Alarm, or Local. By performing or allowing this action, the operator gives up control of the selected parameters to the HLD or LOP. The function block does not check writes to any of the selected parameters for grant-deny permission. Because the function block has no way of knowing who is writing to it, It is up to other devices to obey and enforce the rules. Operators wishing to regain control of the parameters must clear the Grant item. The function block will then automatically set the corresponding Deny item. This indicates to the HLD or LOP that control has been taken away. • Program - A higher-level device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. • Tune - A higher-level device may change the tuning parameters of the block. • Alarm - A higher-level device may change the alarm parameters of the block. • Local -A local operator's panel or hand-held device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. Deny - The Deny attribute is provided for use by a monitoring application in an interface device and may not be changed by an operator. It allows the monitoring application to determine if control has been temporarily taken away during the execution of a batch program. This is carried out by firstly clearing one or all of the Denied items before the execution of a batch program, and then checking the Denied item after execution. The Grant item itself should not be checked for this condition, because the operator may have cleared and subsequently set the Grant item during batch program execution, a sequence that might be missed by a slowly scanning monitor program. The Denied item may not be cleared by the operator, thus latching the fact that control was taken away. • Program - The Program permission item has been turned off. • Tune Denied - The Tune permission item has been turned off. Alarm Denied - The Alarm permission item has been turned off. Local Denied - The Local permission item has been turned off.

AI block parameter name	Description
IO_OPTS	Options which the user may select to alter the block processing. • **Low cutoff:** The AI low cutoff algorithm is enabled • **Units Conversion:** Device will perform units conversion on the channel value so that it will match the units set in XD_SCALE. The scope of conversion is up to the manufacturer and may include nothing. If the units of XD_SCALE are set to a value not supported by the device then the block will remain in O/S after being configured
STATUS_OPTS	Options which the user may select in the block processing of status. • **Propagate Fault Forward.** If the status from the sensor is Bad, Device failure or Bad, Sensor failure, propagate it to OUT without generating an alarm. The use of these sub-status in OUT is determined by this option. Through this option, the user may detemine whether alarming(sending of an alert) will be done by the block or propagated downstream for alarming. • **Uncertain if Limited** Set the output status of an input or calculation block to uncertain if the measured or calculated value is limited. • **BAD if Limited** Set the output status to Bad if the sensor is at a high or low limit. Note: Bad if limited has priority over Uncertain if limited. • **Uncertain if Man Mode** Set the output status of an input or calculation block to uncertain if the actual mode of the block is Man.Target to Next Permitted
CHANNEL	This parameter defines the signal configuration between the AI block and the transducer block. • 0 = Not initialised • 31 = AI: Valve position • 32 = AI: Valve Position with readback compensation
L_TYPE	Determines if the values passed by the transducer block to the AI block may be used directly (Direct) or if the value is in different units and must be converted linearly (Indirect), or with square root (Ind Sqr Root), using the input range defined by the transducer and the associated output range.
LOW_CUT	Limit used in square root processing. A value of zero percent of scale is used in block processing if the transducer value falls below this limit. This feature may be used to eliminate noise near zero for a flow sensor.
PV_FTIME	Time constant of a single exponential filter for the PV, in seconds.
FIELD_VAL	Raw value of the field device discrete input, with a status reflecting the Transducer condition.
UPDATE_EVT	An alert for any change in the static data, UDATE_EVT, is included in each block. This alert can notify the interface devices that keep track of changes that one or more changes have occurred. The relative parameter index and its associated block index are included in the alert, along with the new value of ST_REV. If more than one change has been added since the last reported Update Alert, as known from the difference between the last copy of ST_REV and that in the alert, it will be necessary for the interface device to update all static data. No alert will be generated while a block is in Out of Service mode, so that downloads do not generate many update alerts. ST_REV will be incremented for each change to static data that occurs while the block is in O/S mode. On the transition out of O/S mode, an update alert may be generated if the value of ST_REV for the block does not match that of the last reported alert. Update Alert has a fixed priority of 2, therefore it is auto-acknowledged (no operator intervention is required). • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration which gives an indication of whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received - even if another change of state occurs. • Static Rev - The static revision of the block whose static parameter was changed and is being reported. It is possible for the present value of static revision to be greater than this because static can be changed at any time. • Relative Index - The OD index of the static parameter whose change caused this alert, minus the FB starting index. If the update event was caused by a write to multiple parameters at the same time, then this attribute will be zero.

AI block parameter name	**Description**
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration which gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received – even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. • Value - The value of the associated parameter at the time the alert was detected.
ALARM_SUM	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ACK_OPTION	Selection of whether alarms associated with the block will be automatically acknowledged.
ALARM_HYS	Amount the PV must return within the alarm limits before the alarm condition clears. Alarm hysteresis is expressed as a percent of the PV span.
HI_HI_PRI	Priority of the high high alarm.
HI_HI_LIM	The setting for high high alarm in engineering units.
HI_PRI	Priority of the high alarm.
HI_LIM	The setting for high alarm in engineering units.
LO_PRI	Priority of the low alarm.
LO_LIM	The setting for the low alarm in engineering units.
LO_LO_PRI	Priority of the low low alarm.
LO_LO_LIM	The setting of the low low alarm in engineering units.
HI_HI_ALM	The status of high high alarm and its associated time stamp.
HI_ALM	The status of high alarm and its associated time stamp.
LO_ALM	The status of low alarm and its associated time stamp.
LO_LO_ALM	The status of low low alarm and its associated time stamp.
BLOCK_ERR_DESC_1	The BLOCK_ERR_DESC_1 parameter lists un- or misconfigured parameters of the function block.

3.5 PID function block

3.5.1 Overview

The basic function of the PID block is to control the OUT signal in such way that the difference between the SP and the IN signal minimises.

The Process Value to be controlled is connected to the IN input. This value is passed through a filter, the time constant of which is PV_FTIME. The value is then shown as the PV, which is used in conjunction with the SP in the PID algorithm. A PID will not integrate if the limit status of IN is constant. A full PV and DV alarm sub-function is provided. The PV has a status, although it is a Contained parameter. This status is a copy of IN's status unless the IN is good and there is a PV or block alarm.

The full cascade SP sub-function is used, with rate and absolute limits. Additional control options cause the SP value to track the PV value when the block is in IMan, LO, Man or Rout actual mode. Limits do not cause SP-PV tracking.

A switch for BYPASS is available to the operator if the Bypass Enable control option is true. Bypass is used in secondary cascade controllers that have a bad PV. The Bypass Enable option is necessary because not all cascade control schemes will be stable if BYPASS is true. BYPASS may only be changed when the block mode is Man or O/S. While it is set, the value of SP, in percent of range, is passed directly to the target output, and the value of OUT is used for BKCAL_OUT. When the mode is changed to Cas, the upstream block is requested to initialise to the value of OUT. When a block is in Cas mode, on transition out of bypass the upstream block is requested to initialise to the PV value, regardless of the "Use PV for BKCAL_OUT" option

GAIN, RESET, and RATE are the tuning constants for the P, I and D terms, respectively. Gain is a dimensionless number. RESET and RATE are time constants expressed in seconds. There are existing controllers that are tuned by the inverse value of some or all of them, such as proportional band and repeats per minute. The human interface of these parameters should be able to display the user's preference.

The Direct Acting control option, if true, causes the output to increase when the PV exceeds the SP. If false, the output will decrease when the PV exceeds the SP. It will make the difference between positive and negative feedback, so it must be set properly and never changed whilst in an automatic mode. The setting of the option must also be used when calculating the limit state for BKCAL_OUT.

The output supports the feed forward algorithm. The FF_VAL input brings in an external value, which could be proportional to some disturbance in the control loop. The value is converted to a percentage of output span using the values of the parameter FF_SCALE. This value is multiplied by the FF_GAIN and added to the target output of the PID algorithm. If the status of FF_VAL is Bad, the last usable value will be used, because this prevents bumping the output. When the status returns to good, the block will adjust its integral term to maintain the previous output.

The derivative action of PID block is based either on the change in process variable or on the change in error. The custom parameter DERIVATIVE_ACTION_SOURCE has options for selecting the algorithm which is used: Measurement or Control error.

The PID block schematic is presented in figure 7.

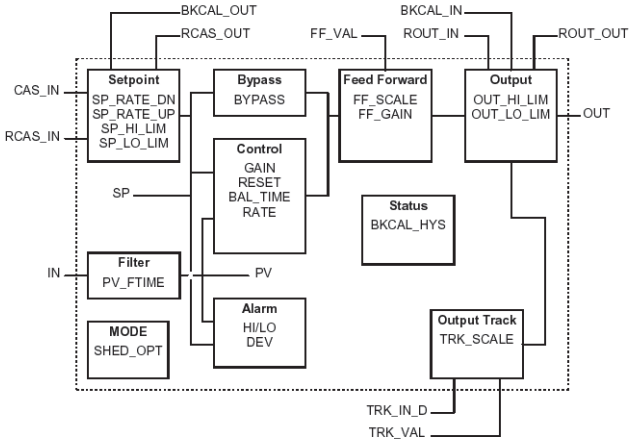

Figure 7. PID block schematic.

3.5.2 Parameters

The PID block parameters are presented in table 5.

Table 5. PID block parameters

PID block parameter name	Description
ST_REV	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in this block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify the grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	MODE_BLK contains the actual, target, permitted, and normal modes of the block. • ACTUAL is the current mode of the block, which may differ from the target based on operating conditions. Its value is calculated as part of block execution. • TARGET is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested. • PERMITTED defines the modes which are allowed for an instance of the block. The permitted mode is configured based on application requirement. • NORMAL is the mode which the block should be set to during normal operating conditions. PID controller block modes are: • Out of Service (O/S) - The block is not being evaluated. The output is maintained at last value. Setpoint is maintained at last value. • Initialisation Manual (IMan) - The block output is being set in response to the back-calculation input parameter status. When the status indicates that there is no path to the final output element, the PID block initialises to provide a smooth transfer when the condition clears. The setpoint may be maintained or optionally initialized to the process variable parameter value. • Local Override (LO) - In local override mode, the block output is set to track the value of the TRK_VAL parameter. The algorithm must initialise so that no bump is experienced when the mode switches from LO back to the target mode. The setpoint may be maintained or optionally initialised to the process variable parameter value. • Manual (Man) - The block output is not being calculated, although it may be limited. It is directly set by the operator through an interface device. The algorithm initialises so that no bump is experienced when the mode switches. The setpoint may be maintained or optionally initialised to the process variable parameter value or to the setpoint value associated with the previous (retained) target mode. • Automatic (Auto) - A local setpoint value is used by the normal block algorithm in determining the primary output value. An operator may write to the local setpoint value through an interface device. • Cascade (Cas) - A setpoint value supplied by another function block through the Cascade input parameter is used by the normal block algorithm in determining the primary output value. This connection between function blocks is defined by a link object. • Remote-Cascade (RCas) - The block setpoint is set by a Control Application running on an interface device through the remote-cascade in parameter. Based on this setpoint, the normal block algorithm determines the primary output value. A remote-cascade out parameter is maintained by the block to support the initialisation of the control application when the block mode is not remote-cascade. • Remote-Output (ROut) - The block output is set by a Control Application running on an interface Device through the remote-output in parameter. The algorithm must initialise so that no bump is experienced when the mode switches. A remote output out parameter is maintained by the block to support initialisation of the control application when the block mode is not remote-output. The setpoint may be maintained or optionally initialised to the process variable value.

PID block parameter name	Description
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown. The standard specifies following bit string enumerations for the block_err parameter: • Other; Non-specific error active. • BlockConfiguration; Error detected in block configuration. • LinkConfiguration; Error detected in link configuration. • LocalOverride; Faultstate active. • DeviceFaultstate; Device faultstate set. • Device needs maintenance soon • InputFailure; Process variable has bad status. • OutputFailure; Failure detected in output hardware. • MemoryFailure; Memory error detected. • LostStaticData; Static parameters cannot be recovered. • LostNVData; Non-Volatile parameters cannot be recovered. • Device needs maintenance now • PowerUp; Recovery from power failure. • OutOfService; Block actual mode is Out of Service.
PV	The controlled process variable is scaled and filtered from the IN signal. See PV_SCALE and PV_FTIME. See NOTE 1.
SP	The PID controller setpoint is calculated from CAS_IN (Cascade mode), RCAS_IN (Remote cascade mode), or entered by the user (Auto mode). See SP_HI_LIM, SP_LO_LIM, SP_RATE_UP, SP_RATE_DN and SP_RAMP. See NOTE 1.
OUT	The PID controller output is calculated by the control algorithm (Cas, Rcas and Auto mode), copied from ROUT_IN (Rout mode) or entered by the user (Man mode). See NOTE 1.
PV_SCALE	The scale of the process variable. The high and low scale values, engineering units code, and number of digits to the right of the decimal point are to be used when displaying the PV parameter and for those parameters which have the same scaling as PV. • EU_100 - The engineering unit value that represents the upper end of range of the associated block parameter. • EU_0 - The engineering unit value that represents the lower end of range of the associated block parameter. • UNITS_INDEX - Units code index for the engineering unit descriptor for the associated block value. • DECIMAL - The number of digits to the right of the decimal point that should be used by an interface device when displaying the specified parameter.
OUT_SCALE	The scale of the process variable.

PID block parameter name	Description
GRANT_DENY	The grant-deny parameter (which has two attributes referred to as 'Grant' and 'Deny') is used to allow the operator to either grant or deny access permission to sets of function block parameters by other devices.. The operation of these parameters is defined here, but the actual usage (if any) depends on the philosophy of the plant. Grant - Depending on the philosophy of the plant, the operator of a higher-level device (HLD), or a local operator's panel (LOP) in the case of Local, may turn on an item of the Grant attribute - Program, Tuning, Alarm, or Local. By performing or allowing this action, the operator gives up control of the selected parameters to the HLD or LOP. The function block does not check writes to any of the selected parameters for grant-deny permission. Because the function block has no way of knowing who is writing to it, It is up to other devices to obey and enforce the rules. Operators wishing to regain control of the parameters must clear the Grant item. The function block will then automatically set the corresponding Deny item. This indicates to the HLD or LOP that control has been taken away. • Program - A higher-level device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. • Tune - A higher-level device may change the tuning parameters of the block. • Alarm - A higher-level device may change the alarm parameters of the block. • Local -A local operator's panel or hand-held device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. Deny - The Deny attribute is provided for use by a monitoring application in an interface device and may not be changed by an operator. It allows the monitoring application to determine if control has been temporarily taken away during the execution of a batch program. This is carried out by firstly clearing one or all of the Denied items before the execution of a batch program, and then checking the Denied item after execution. The Grant item itself should not be checked for this condition, because the operator may have cleared and subsequently set the Grant item during batch program execution, a sequence that might be missed by a slowly scanning monitor program. The Denied item may not be cleared by the operator, thus latching the fact that control was taken away. • Program - The Program permission item has been turned off. • Tune Denied - The Tune permission item has been turned off. • Alarm Denied - The Alarm permission item has been turned off. • Local Denied - The Local permission item has been turned off.
CONTROL_OPTS	Options that the user may select to alter the calculations performed in a control block. • Bypass Enable - This parameter, if true, allows BYPASS to be set. Some control algorithm applications cannot provide closed loop control if bypassed. • SP-PV Track in Man - Permits the setpoint to track the process variable when the target mode of the block is Man. • SP-PV Track in Rout - Permits the setpoint to track the process variable when the actual mode of the block is ROut. • SP-PV Track in LO or IMAN - Permits the setpoint to track the process variable when the actual mode of the block is LO or IMan. • SP Track retained target - Permits the setpoint to track the RCas or Cas parameter based on the retained target mode when the actual mode of the block is IMan, LO, Man, or ROut. • Direct Acting – Defines the relationship between a change in PV and corresponding change in output. When Direct is selected, an increase in PV results in an increase in the output. • Track Enable - This enables the external tracking function. If true, the value in TRK_VAL will replace the value of OUT if TRK_IN_D becomes true and the target mode is not Man. • Track in Manual - This enables TRK_VAL to replace the value of OUT when the target mode is Man and TRK_IN_D is true. The actual mode will then be LO. • Use PV for BKCAL_OUT - The BKCAL_OUT and RCAS_OUT values are normally the working SP. This option changes it to the PV. • Obey SP limits if Cas or Rcas - Normally the setpoint will not be restricted to the setpoint limits except when entered by a human interface device. However, if this option is selected, the setpoint will be restricted to the setpoint absolute and rate limits in the Cas and RCas modes. • No OUT limits in Manual; Do not apply OUT_HI_LIM or OUT_LO_LIM when target and actual modes are Man. Trust the operator to do the right thing.

PID block parameter name	Description
STATUS_OPTS	• Options that the user may select in the block processing of status. • IFS if BAD IN Set Initiate fail-safe status in the OUT parameter if the status of the IN parameter is BAD. • IFS if BAD CAS_IN Set Initiate fail safe status in the OUT parameter if the status of the CAS_IN parameter is BAD. • Use Uncertain as Good If the status of the IN parameter is Uncertain, treat it as Good. Otherwise, treat it as BAD. • Target to Manual if BAD IN Set the target mode to Man if the status of the IN parameter is BAD. This latches a PID block into the Man state if the input ever goes bad. • Target to next permitted mode if BAD CAS_IN • Target to Man if BAD TRK_IN_D • IFS if BAD TRK_IN_D Target to next permitted mode if BAD CAS_IN Set the target mode to next permitted mode if the target mode is CAS and the status of CAS_IN is BAD. This latches a control block into the next permitted mode if the CAS_IN is being used in control and the status goes bad.
IN	The primary input value of the block i.e. the raw measurement signal from the process. See NOTE 1.
PV_FTIME	Time constant of a single exponential filter between IN and PV, in seconds.
BYPASS	The normal control algorithm may be bypassed through this parameter. When bypass is set, the setpoint value (in percent) will be directly transferred to the output. To prevent a bump on transfer to/from bypass, the setpoint will automatically be initialised to the output value or process variable, respectively, and the path broken flag will be set for one execution. See CONTROL_OPTS.
CAS_IN	This parameter is the remote setpoint value, which must come from another Fieldbus block, or a DCS block through a defined link. This setpoint is used in Cascade mode. See NOTE 1.
SP_RATE_DN	Ramp rate at which downward setpoint changes are acted on in Auto mode, in PV units per second. If the ramp rate is set to zero or the block is in a mode other than Auto, then the setpoint will be used immediately.
SP_RATE_UP	Ramp rate at which upward setpoint changes are acted on in Auto mode, in PV units per second. If the ramp rate is set to zero or the block is in a mode other than Auto, then the setpoint will be used immediately.
SP_HI_LIM	The setpoint high limit is the highest setpoint operator entry that can be used for the block.
SP_LO_LIM	The setpoint low limit is the lowest setpoint operator entry that can be used for the block.
GAIN	Controller gain, dimensionless.
RESET	The integral time constant, in seconds per repeat.
BAL_TIME	This parameter is used to specify the time constant (in seconds) at which the integral term will move to obtain balance when the output is limited and the mode is Auto, Cas, or RCas.
RATE	Defines the derivative time constant, in seconds.
BKCAL_IN	The value and status from a lower block's BKCAL_OUT that is used to prevent reset windup and to initialise the control loop. See NOTE 1.
OUT_HI_LIM	Limits the maximum output value.
OUT_LO_LIM	Limits the minimum output value.
BKCAL_HYS	The amount that the block output must change away from its output limit before the limit status is turned off, expressed as a percentage of the span of the output.

PID block parameter name	Description
BKCAL_OUT	The value and status required by an upper block's BKCAL_IN so that the upper block may prevent reset windup and provide a smooth transfer to closed loop control. Depending on CONTROL_OPTS, the value is either SP (default) or PV. See NOTE 1.
RCAS_IN	Target setpoint and status provided by a supervisory Host to an analog control or output block. See NOTE 1.
ROUT_IN	Target output and status provided by a Host to the control block for use as the output (ROut mode). See NOTE 1.
SHED_OPT	Defines action to be taken on remote control device timeout. See SHED_RCAS and SHED_ROUT. • Undefined - Invalid • Normal shed, normal return - Actual mode changes to the next lowest priority nonremote mode permitted but returns to the target remote mode when the remote computer completes the initialisation handshake. • Normal shed, no return - Target mode changes to the next lowest priority non-remote mode permitted. The target remote mode is lost, and cannot be returned to. • Shed to Auto, normal return - Actual mode changes to Auto on detection of a shed condition. • Shed to Auto, no return - Target mode changes to Auto on detection of a shed condition. • Shed to Manual, normal return - Actual mode changes to Man on detection of a shed condition. • Shed to Manual, no return - Target mode changes to Man on detection of a shed condition. • Shed to Retained target, normal return - Shed to previous target mode and return target remote mode after communications are re-established. • Shed to Retained target, no return - Target mode changes to retained target mode.
RCAS_OUT	Block SP or PV (depending on CONTROL_OPTS) and status after ramping - provided to a supervisory Host for back calculation and to allow action to be taken under limiting conditions or mode change. See NOTE 1.
ROUT_OUT	Block output and status - provided to a Host for back calculation in ROut mode and to allow action to be taken under limited conditions or mode change. See NOTE 1.
TRK_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point, associated with TRK_VAL.
TRK_IN_D	This discrete input is used to initiate external tracking of the block output to the value specified by TRK_VAL. See NOTE 1.
TRK_VAL	This input is used as the track value when external tracking is enabled by TRK_IN_ D. See NOTE 1.
FF_VAL	The feed forward value and status. See NOTE 1.
FF_SCALE	The feed forward input scale.
FF_GAIN	The gain that the feed forward input is multiplied by before it is added to the calculated control output.

PID block parameter name	Description
UPDATE_EVT	An alert for any change in the static data, UDATE_EVT, is included in each block. This alert can notify the interface devices that keep track of changes that one or more changes have occurred. The relative parameter index and its associated block index are included in the alert, along with the new value of ST_REV. If more than one change has been added since the last reported Update Alert, as known from the difference between the last copy of ST_REV and that in the alert, it will be necessary for the interface device to update all static data. No alert will be generated while a block is in Out of Service mode, so that downloads do not generate many update alerts. ST_REV will be incremented for each change to static data that occurs while the block is in O/S mode. On the transition out of O/S mode, an update alert may be generated if the value of ST_REV for the block does not match that of the last reported alert. Update Alert has a fixed priority of 2, therefore it is auto-acknowledged (no operator intervention is required). • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration which gives an indication of whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received - even if another change of state occurs. • Static Rev - The static revision of the block whose static parameter was changed and is being reported. It is possible for the present value of static revision to be greater than this because static can be changed at any time. • Relative Index - The OD index of the static parameter whose change caused this alert, minus the FB starting index. If the update event was caused by a write to multiple parameters at the same time, then this attribute will be zero.
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration which gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received – even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. • Value - The value of the associated parameter at the time the alert was detected.
ALARM_SUM	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block. • Current - The active status of each alarm. • Unacknowledged - The unacknowledged state of each alarm. • Unreported - The unreported status of each alarm. • Disabled - The disabled state of each alarm.
ACK_OPTION	Selection of whether alarms associated with the function block will be automatically acknowledged.
ALARM_HYS	Amount the PV must return within the alarm limits before the alarm condition clears. Alarm Hysteresis is expressed as a percentage of the PV span.

PID block parameter name	Description
HI_HI_PRI, HI_PRI, LO_PRI, LO_ LO_PRI, DV_HI_PRI, DV_LO_PRI	Priority of the alarm. • 0 = the associated alert may clear when the priority is changed to 0, but it will never occur. • 1 = the associated alert is not sent as a notification. If the priority is above 1, then the alert must be reported. • 2 = reserved for alerts that do not require the attention of a plant operator, e.g. diagnostic and system alerts. Block alarm, error alarm, and update event have a fixed priority of 2. • 3-7 = increasing higher priorities - advisory alarms. • 8-15 = increasing higher priority - critical alarms.
HI_HI_LIM, HI_LIM, LO_LIM, LO_ LO_LIM, DV_HI_LIM, DV_LO_LIM	The setting for alarm limit in engineering units.
HI_HI_ALM	The status for high high alarm and its associated time stamp. The high high alarm is generated when the PV value crosses the HI_HI_LIM value. ALARM_HYS is valid here. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been noticed. • Alarm State - A discrete enumeration that gives an indication of whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm state was detected that is not reported. The time stamp value will be maintained constant until alert confirmation has been received – even if another change of state occurs. • Subcode – In this case, always "Other". • Value - The value of the associated parameter at the time the alert was detected.
HI_ALM	The status for high alarm and its associated time stamp. See HI_HI_ALM.
LO_ALM	The status for lo alarm and its associated time stamp. See HI_HI_ALM.
LO_LO_ALM	The status for lo lo alarm and its associated time stamp. See HI_HI_ALM.
DV_HI_ALM	The status for deviation low and its associated time stamp. The deviation low alarm is generated when the difference between SP and PV crosses the DV_HI_LIM value. The ALARM_HYS is valid here. See HI_HI_ALM.
DV_LO_ALM	The status for deviation high and its associated time stamp. See DV_LO_ALM.
BLOCK_ERR_DESC_1	The BLOCK_ERR_DESC_1 parameter lists un- or misconfigured parameters of the function block.
DERIVATIVE_ACTION_SOURCE	Selector for the signal in derivative calculation. Options are. • Measurement • Control error

Note 1. All input and output parameters are structures composed of status and value, but some contained parameters (internal parameter, not accessible by other blocks) have the same data type: RCAS_IN, ROUT_IN, SP and PV, for example. The Status field is composed of three parts: Quality, Sub-Status and Limits.

Quality – This indicates the quality of the parameter value.

- Good Cascade – The quality of the value is good, and it may be part of a cascade structure.
- Good Non-Cascade – The quality of the value is good, and the block does not support a cascade path.
- Uncertain – The quality of the value is lower than normal, but the value may still be useful.
- Bad – The value is not useful.

Sub-Status – The sub-status is a complement of the quality status and takes information to initialise or break a cascade control, alarms and others. There are different sets of sub-status for each quality.

Limits – This provides information as to whether the associated value is limited or not, as well its direction. The limits are classified as: Not Limited, High Limited, Low Limited, and Constant.

3.6 Digital output block

3.6.1 Overview

The DO block essentially takes the (discrete) valve position setpoint from another block to CAS_IN_D and passes it to the transducer block through the CHANNEL reference. The transducer block then controls the valve position.

The DO block is used, if the positioner is required to be used as an on/off controller. It is not possible to use the DO and AO block at the same time. This is prevented by the CHANNEL parameters of these blocks.

The DO block schematics is presented in figure 8.

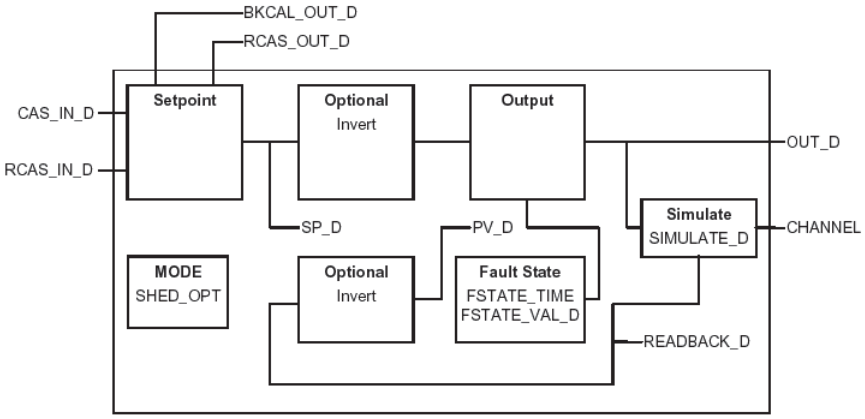

Figure 8. DO block schematic.

3.6.2 Parameters

The DO block parameters are presented in table 5.

Table 6. Digital output block parameters.

DO block parameter name	Description
ST_REV	The revision level of the static data related to the function block. The revision value will be incremented each time a static parameter value in this block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify the grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	MODE_BLK contains the actual, target, permitted, and normal modes of the block. • ACTUAL is the current mode of the block, which may differ from the target based on operating conditions. Its value is calculated as part of block execution. • TARGET is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested. • PERMITTED defines the modes which are allowed for an instance of the block. The permitted mode is configured based on application requirement. • NORMAL is the mode to which the block should be set during normal operating conditions. DO block modes are: • Out of Service (O/S) - The block is not being evaluated. The output is maintained at last value. Setpoint is maintained at last value. • Initialisation Manual (IMan) - DO block actual mode is under way to change to the target mode. If actual mode stays on Iman, READBACK_D signal from the transducer block may have BAD status. The setpoint may be maintained or optionally initialised to the process variable parameter value. The IMan mode is used to indicate that there is no path to the final element. • Local Override (LO) - In local override mode, the block output is being set to track the value of the FSTATE_VAL_D parameter. • Manual (Man) - The block output is not being calculated, although it may be limited. It is directly set by the operator through an interface device. Man mode can be used in maintenance or troubleshooting where the OUT value may need to be directly adjusted. • Automatic (Auto) - A local setpoint value is used by the normal block algorithm in determining the primary output value. An operator may write to the local setpoint value through an interface device. • Cascade (Cas) - A setpoint value supplied by another function block through the Cascade input parameter is used by the normal block algorithm in determining the primary output value. This connection between function blocks is defined by a link object. • Remote-Cascade (RCas) - The block setpoint is being set by a Control Application running on an interface device through the remote-cascade in parameter. Based on this setpoint, the normal block algorithm determines the primary output value. A remote-cascade out parameter is maintained by the block to support initialisation of the control application when the block mode is not remote-cascade.
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown. The standard specifies following bit string enumerations for the block_err parameter: • Other; Non-specific error active. • BlockConfiguration; Error detected in block configuration. • LinkConfiguration; Error detected in link configuration. • LocalOverride; Faultstate active. • DeviceFaultstate; Device faultstate set. • Device needs maintenance soon • InputFailure; Process variable has bad status. • OutputFailure; Failure detected in output hardware. • MemoryFailure; Memory error detected. • LostStaticData; Static parameters cannot be recovered. • LostNVData; Non-Volatile parameters cannot be recovered. • Device needs maintenance now • PowerUp; Recovery from power failure. • OutOfService; Block actual mode is Out of Service.

DO block parameter name	Description
PV_D	Valve position measurement in discrete form. Either copied from OUT_D or calculated from READBACK_D. See FEATURE_SEL. See NOTE 1.
SP_D	Valve position setpoint in discrete form. Either calculated from CAS_IN_D (CAS mode) or entered by user (Auto mode). See NOTE 1.
OUT_D	DO block output. See NOTE 1.
SIMULATE_D	Allows the transducer discrete input or output to the block to be manually supplied when simulate is enabled. When simulate is disabled, the simulate value and status track the actual value and status.
PV_STATE	Index to the text describing the states of a discrete PV.
XD_STATE	Index to the text describing the states of a discrete for the value obtained from the transducer.
GRANT_DENY	The grant-deny parameter (which has two attributes referred to as 'Grant' and 'Deny') is used to allow the operator to either grant or deny access permission to sets of function block parameters by other devices.. The operation of these parameters is defined here, but the actual usage (if any) depends on the philosophy of the plant. Grant - Depending on the philosophy of the plant, the operator of a higher-level device (HLD), or a local operator's panel (LOP) in the case of Local, may turn on an item of the Grant attribute - Program, Tuning, Alarm, or Local. By performing or allowing this action, the operator gives up control of the selected parameters to the HLD or LOP. The function block does not check writes to any of the selected parameters for grant-deny permission. Because the function block has no way of knowing who is writing to it, It is up to other devices to obey and enforce the rules. Operators wishing to regain control of the parameters must clear the Grant item. The function block will then automatically set the corresponding Deny item. This indicates to the HLD or LOP that control has been taken away. • Program - A higher-level device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. • Tune - A higher-level device may change the tuning parameters of the block. • Alarm - A higher-level device may change the alarm parameters of the block. • Local -A local operator's panel or hand-held device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. Deny - The Deny attribute is provided for use by a monitoring application in an interface device and may not be changed by an operator. It allows the monitoring application to determine if control has been temporarily taken away during the execution of a batch program. This is carried out by firstly clearing one or all of the Denied items before the execution of a batch program, and then checking the Denied item after execution. The Grant item itself should not be checked for this condition, because the operator may have cleared and subsequently set the Grant item during batch program execution, a sequence that might be missed by a slowly scanning monitor program. The Denied item may not be cleared by the operator, thus latching the fact that control was taken away. • Program - The Program permission item has been turned off. • Tune Denied - The Tune permission item has been turned off. • Alarm Denied - The Alarm permission item has been turned off. • Local Denied - The Local permission item has been turned off.

DO block parameter name	Description
IO_OPTS	Contains options that the user may select to alter the AO block processing. • Invert - Indicates whether the discrete input value should be logically inverted before it is stored in the process variable. A discrete value of zero (0) will be considered to be a logical zero(0) and an non-zero discrete value will be considered to be a logical (1) e.g. if invert is selected, the logical NOT of a non-zero field value would result in a zero(0) discrete output, the logical NOT of a zero field value would result in a discrete output value of one(1). • SP tracks PV if Man - Permits the setpoint to track the process variable when the target mode of the block is Man. • SP tracks PV if LO - Permits the setpoint to track the process variable when the actual mode of the block is LO. • SP tracks RCas or Cas if LO or Man - Permits the setpoint to track the RCas or Cas parameter based on the retained target mode when the actual mode of the block is LO or Man. When SP-PV track options are enabled, then SP Track retained target will have precedence in the selection of the value to track when the actual mode is Man and LO. • Fault state to value - The output action to take when failure occurs. If set, go to the FSTATE_VAL_D. If not set, freeze. • Fault state restart - Use the value of FSTATE_VAL_D if the device is restarted, otherwise use the non-volatile value. This does not act like fault state, but merely uses the value. • Target to Man if fault state activated - Set the target mode to Man, thus losing the original target, if Fault State is activated. This latches an output block into the manual mode. • PV for BKCAL_OUT - The BKCAL_OUT value is normally the working SP. This option changes it to the PV.
STATUS_OPTS	Options that the user may select in the block processing of status. • Propagate Fault Backward - If the status from the actuator is Bad, Device failure or Fault State Active or Local Override is active, propagate this as Bad, Device Failure or Good Cascade, Fault State Active or Local Override to BKCAL_OUT respectively, without generating an alarm. The use of these sub-statuses in BKCAL_OUT is determined by this option. Through this option, the user may determine whether alarming (sending of an alert) will be performed by the block or propagated upstream for alarming.
READBACK_D	Discrete valve position measurement. The enumerations for the VALUE are; • 0 = Close • 1 = Open • 2 = Intermediate See CHANNEL. See NOTE 1.
CAS_IN_D	Discrete valve position setpoint from the control system. See NOTE 1.
CHANNEL	This parameter defines the signal configuration between the DO block and transducer block. • 0 = Not initialised • 11 = Valve control, READBCK_D from position sensor (not writable if AO channel in configured) • 12 = Valve control, READBACK_D from limit switch (not writable if AO channel in configured) • 13 = No transducer connection
FSTATE_TIME	The Fault State parameters determine the response of an output block if one or more of the following conditions exists for a time that exceeds FSTATE_TIME: loss of communications to CAS_IN or Initiate Fault State is at CAS_IN when the target mode is CAS; or Initiate Fault State status is at RCAS_IN when the target mode is RCAS. If one of these conditions exists, then the block will go to defined Fault State. FSTATE_TIME is the time in seconds from the detection of failure of the output block remote setpoint to the output action of the block output if the condition still exists.
FSTATE_VAL_D	The preset OUT value to use when failure occurs. This value will be used if the IO_OPTS "Faultstate to value" is selected.
BKCAL_OUT_D	The output value and status provided to an upstream discrete block. This information is used to provide bumbles transfer to closed loop control. See NOTE 1.

DO block parameter name	Description
RCAS_IN_D	Target setpoint and status provided by a supervisory Host. See NOTE 1.
SHED_OPT	Defines action to be taken on remote control device timeout. See SHED_RCAS and SHED_ROUT. • Undefined - Invalid • Normal shed, normal return - Actual mode changes to the next lowest priority nonremote mode permitted but returns to the target remote mode when the remote computer completes the initialisation handshake. • Normal shed, no return - Target mode changes to the next lowest priority non-remote mode permitted. The target remote mode is lost, and cannot be returned to. • Shed to Auto, normal return - Actual mode changes to Auto on detection of a shed condition. • Shed to Auto, no return - Target mode changes to Auto on detection of a shed condition. • Shed to Manual, normal return - Actual mode changes to Man on detection of a shed condition. • Shed to Manual, no return - Target mode changes to Man on detection of a shed condition. • Shed to Retained target, normal return - Shed to previous target mode and return target remote mode after communications are re-established. • Shed to Retained target, no return - Target mode changes to retained target mode.
RCAS_OUT_D	Block setpoint and status provided to a supervisory Host for back calculation and to allow action to be taken under limiting conditions or mode change.
UPDATE_EVT	An alert for any change in the static data, UDATE_EVT, is included in each block. This alert can notify the interface devices that keep track of changes that one or more changes have occurred. The relative parameter index and its associated block index are included in the alert, along with the new value of ST_REV. If more than one change has been added since the last reported Update Alert, as known from the difference between the last copy of ST_REV and that in the alert, it will be necessary for the interface device to update all static data. No alert will be generated while a block is in Out of Service mode, so that downloads will not generate many update alerts. ST_REV will be incremented for each change to static data that occurs while the block is in the O/S mode. On transition out of O/S mode, an update alert may be generated if the value of ST_REV for the block does not match that of the last reported alert. Update Alert has a fixed priority of 2, therefore it is auto-acknowledged (no operator intervention is required). • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been noticed. • Update State - A discrete enumeration which gives an indication of whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value will be maintained constant until alert confirmation has been received – even if another change of state occurs. • Static Rev - the static revision of the block whose static parameter was changed and is being reported. It is possible for the present value of static revision to be greater than this because static can be changed at any time. • Relative Index - The OD index of the static parameter whose change caused this alert, minus the FB starting index. If the update event was caused by a write to multiple parameters at the same time, then this attribute will be zero.

DO block parameter name	Description
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration which gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received – even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. • Value - The value of the associated parameter at the time the alert was detected.
BLOCK_ERR_DESC_1	The BLOCK_ERR_DESC_1 parameter lists un- or misconfigured parameters of the function block.

NOTE 1. All input and output parameters are structures composed of status and value, but some contained parameters (internal parameter, not accessible by other blocks) have that the same data type, for example, RCAS_IN, ROUT_IN, SP and PV. The Status field is composed of three parts: Quality, Sub-Status and Limits.

Quality – This indicates the quality of the parameter value.

- Good Cascade – The quality of the value is good, and it may be part of a cascade structure.
- Good Non-Cascade – The quality of the value is good, and the block doesn't support a cascade path.
- Uncertain – The quality of the value is lower than normal, but the value may still be useful.
- Bad – The value is not useful.

Sub-Status – The sub-status is a complement of the quality status and takes information to initialise or break a cascade control, alarms and others. There are different sets of sub-status for each quality.

Limits – This provides information as to whether the associated value is limited or not, as well the direction. The limits are classified as: Not Limited, High Limited, Low Limited, Constant.

3.7 Discrete input block

3.7.1 Overview

The DI block is used to transmit the limit switch information (optionally position sensor information in discrete form) to the bus system. There are 2 DI blocks, one block for each limit.

The DI block schematic is presented in figure 9.

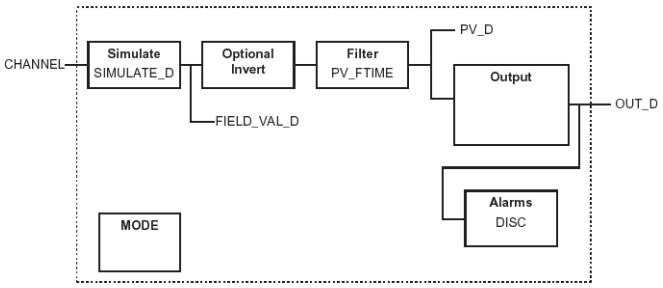

Figure 9. DI block schematic.

3.7.2 Parameters

The DI block parameters are presented in the table 7.

Table 7. Discrete input block parameters.

DI block parameter name	Data type
ST_REV	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in this block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify the grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	MODE_BLK contains the actual, target, permitted, and normal modes of the block. • ACTUAL is the current mode of the block, which may differ from the target based on operating conditions. Its value is calculated as part of block execution. • TARGET is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested. • PERMITTED defines the modes which are allowed for an instance of the block. The permitted mode is configured based on application requirement. • NORMAL is the mode to which the block should be set during normal operating conditions. DI block modes are: • Out of Service (O/S) - The block is not being evaluated. The output is maintained at last value. Setpoint is maintained at last value. • Manual (Man) - The block output is not being calculated, although it may be limited. It is directly set by the operator through an interface device. Man mode can be used for maintenance or troubleshooting where the OUT value may need to be adjusted directly. • Automatic (Auto) - A local setpoint value is used by the normal block algorithm in determining the primary output value. The local setpoint value may be written to by an operator through an interface device.
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, meaning that multiple errors may be shown. • Other - Non-specific error active. • BlockConfiguration – Error detected in block configuration. • LinkConfiguration – Error detected in link configuration. • SimulationActive - Simulation enabled in this block. For the resource block, Simulate Active will be used to indicate that the simulate hardware jumper is present. An active state (1) of this attribute will indicate that the jumper is present and that it is possible for the user to enable simulation in the AO function block. For the AO block this indicates that simulation is either enabled or disabled. • LocalOverride - Output tracking or faultstate active. • DeviceFaultstate - Device faultstate set. • Device needs maintenance soon • InputFailure - Process variable has bad status. • OutputFailure - Failure detected in output hardware. • MemoryFailure - Memory error detected. • LostStaticData - Static parameters cannot be recovered. • LostNVData - Non-Volatile parameters cannot be recovered. • ReadbackCheck - Failure detected in READBACK. • Device needs maintenance now • PowerUp - Recovery from power failure. • OutOfService - Block actual mode is Out of Service.
PV_D	Valve position measurement in discrete form. The value is either transferred from limit switch or calculated based on the position sensor measurement. See CHANNEL. See NOTE 1.
OUT_D	The DI block output (valve position in discrete form) is either calculated from the PV_D (Auto mode) or entered by the user (Manual mode). See NOTE 1.

DI block parameter name	**Data type**
SIMULATE_D	Allows the transducer discrete input or output to the block to be manually supplied when simulate is enabled. When simulation is disabled, the simulate value and status track the actual value and status.
XD_STATE	Index to the text describing the states of a discrete for the value obtained from the transducer.
OUT_STATE	Index to the text describing the states of a discrete output.
GRANT_DENY	The grant-deny parameter (which has two attributes referred to as Grant and Deny) is used to allow the operator to grant or deny access permission to sets of function block parameters by other devices. The operation of these parameters is defined here, but their actual usage (if any) depends on the philosophy of the plant. Grant - Depending on the philosophy of the plant, the operator or a higher level device (HLD), or a local operator's panel (LOP) in the case of Local, may turn on an item of the Grant attribute - Program, Tuning, Alarm, or Local. By performing or allowing this action, the operator gives up control of the selected parameters to the HLD or LOP. The function block does not check writes to any of the selected parameters for grant-deny permission. It is up to other devices to obey and enforce the rules, because the function block has no way of knowing who is writing to it. Operators wishing to regain control of the parameters must clear the Grant item. The function block will then automatically set the corresponding Denied item. This indicates to the HLD or LOP that control has been taken away. • Program - A higher level device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. • Tune - A higher level device may change the tuning parameters of the block. • Alarm - A higher level device may change the alarm parameters of the block. • Local - A local operator's panel or hand-held device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. Deny - The Deny attribute is provided for use by a monitoring application in an interface device and may not be changed by an operator. It allows the monitoring application to determine whether control has been temporarily taken away during the execution of a batch program. This is performed by firstly clearing one or all of the Denied items before the execution of a batch program, then checking the Denied item after execution. The Grant item itself should not be checked for this condition, because the operator may have cleared and subsequently set the Grant item during batch program execution, a sequence that might be missed by a slowly scanning monitor program. The Deny item may not be cleared by the operator, thus latching the fact that control was taken away. • Program - The Program permission item has been turned off. • Tune Denied - The Tune permission item has been turned off. • Alarm Denied - The Alarm permission item has been turned off. • Local Denied - The Local permission item has been turned off.
IO_OPTS	Contains options that the user may select to alter the DI block processing. • Invert; Indicates whether the discrete input value should be logically inverted before it is stored in the process variable. A discrete value of zero (0) will be considered to be a logical zero (0) and an non-zero discrete value will be considered to be a logical (1) e.g. if invert is selected, the logical NOT of a non-zero field value would result in a zero (0) discrete output, the logical NOT of a zero field value would result in a discrete output value of one (1).
STATUS_OPTS	Options that the user may select in the block processing of status. • Propagate Fault Forward - If the status from the sensor is Bad, Device failure or Bad, Sensor failure, propagate it to OUT without generating an alarm. The use of these sub-status in OUT is determined by this option. Through this option, the user may determine whether alarming (sending of an alert) will be performed by the block or propagated downstream for alarming. • Uncertain if Man Mode - Set the output status of an input or calculation block to uncertain if the actual mode of the block is Man.
CHANNEL	This parameter defines the signal configuration between the DI block and transducer block. • 0 = Not initialised • 21 = Valve position <= software limit switch CLOSE • 22 = Valve position >= software limit switch OPEN • 23 = Limit switch LS1 • 24 = Limit switch LS2 • 25 = No transducer connection

DI block parameter name	**Data type**
PV_FTIME	PV_FTIME may be used to set the time that the hardware must be in one state before it gets passed to the PV_D.
FIELD_VAL_D	The FIELD_VAL_D displays the true on/off state of the hardware, using XD_STATE.
UPDATE_EVT	An alert for any change in the static data, UDATE_EVT, is included in each block. This alert can notify the interface devices that keep track of changes that one or more changes have occurred. The relative parameter index and its associated block index are included in the alert, along with the new value of ST_REV. If more than one change has been added since the last reported Update Alert, as known from the difference between the last copy of ST_REV and that in the alert, it will be necessary for the interface device to update all static data. No alert will be generated while a block is in Out of Service mode, so that downloads do not generate many update alerts. ST_REV will be incremented for each change to static data that occurs while the block is in O/S mode. On transition out of O/S mode, an update alert may be generated if the value of ST_REV for the block does not match that of the last reported alert. Update Alert has a fixed priority of 2, therefore it is auto-acknowledged (no operator intervention is required). • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been noticed. • Update State - A discrete enumeration that gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received – even if another change of state occurs. • Static Rev - the static revision of the block whose static parameter was changed and is being reported. It is possible for the present value of static revision to be greater than this because static can be changed at any time. • Relative Index - The OD index of the static parameter whose change caused this alert, minus the FB starting index. If the update event was caused by a write to multiple parameters at the same time, then this attribute will be zero.
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration which gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received – even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. • Value - The value of the associated parameter at the time the alert was detected.
ALARM_SUM	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block. • Current - The active status of each alarm. • Unacknowledged - The unacknowledged state of each alarm. • Unreported - The unreported status of each alarm. • Disabled - The disabled state of each alarm.
ACK_OPTION	Selection of whether alarms associated with the function block will be automatically acknowledged.

DI block parameter name	Data type
DISC_PRI	Priority of the discrete alarm. • 0 = the associated alert may clear when the priority is changed to 0, but it will never occur. • 1 = the associated alert is not sent as a notification. If the priority is above 1, then the alert must be reported. • 2 = reserved for alerts that do not require the attention of a plant operator, e.g. diagnostic and system alerts. Block alarm, error alarm, and update event have a fixed priority of 2. • 3-7 = increasing higher priorities - advisory alarms. • 8-15 = increasing higher priority - critical alarms.
DISC_LIM	State of discrete input that will generate an alarm.
DISC_ALM	The status and time stamp associated with the discrete alarm.
BLOCK_ERR_DESC_1	The BLOCK_ERR_DESC_1 parameter lists un- or misconfigured parameters of the function block.

Note 1. All input and output parameters are structures composed of status and value, but some contained parameter (internal parameter, not accessible by other blocks) have the same data type, for example, RCAS_IN, ROUT_IN, SP and PV.
The Status field is composed of three parts: Quality, Sub-Status and Limits.
Quality – This indicates the quality of the parameter value.
- Good Cascade – The quality of the value is good, and it may be part of a cascade structure.
- Good Non-Cascade – The quality of the value is good, and the block doesn't support a cascade path.
- Uncertain – The quality of the value is lower than normal, but the value may still be useful.
- Bad – The value is not useful.

Sub-Status – The sub-status is a complement of the quality status and takes information to initialise or break a cascade control, alarms and others. There are different sets of sub-status for each quality.
Limits – This provides information whether the associated value is limited or not, as well the direction. The limits are classified as: Not Limited, High Limited, Low Limited, Constant.

3.8 Output splitter block

3.8.1 Overview

The output splitter block provides the capability to drive two control outputs from a single input. Each output is a linear function of a certain amount of input. Back calculation support is provided using the same linear function in reverse. Cascade initialisation is supported by a decision table for combinations of input and output conditions.

This block would normally be used in the split ranging or sequencing of multiple valve applications. A typical split range application has both valves closed when the splitter input is 50%. As the input drops to 0%, one valve opens fully. The other valve opens as the input rises above 50 %. A typical sequencing application has both valves closed at 0% input. One valve opens fully as the input rises to 50 %, and the other remains closed. The second valve opens as the input rises above 50%, and the first valve may either remain open or may shut off quickly.

Because this block is in the control path, it is able to pass limit and cascade initialisation information back to the upstream block

The OS block schematic is presented in Figure 10.

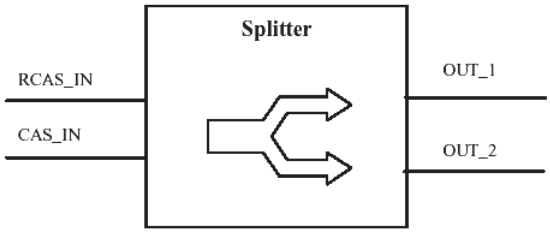

Figure 10. OS block schematic.

3.8.2 Parameters

The OS block parameters are presented in the table 7.

OS block parameter name	Description
ST_REV	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in this block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify the grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	MODE_BLK contains the actual, target, permitted, and normal modes of the block. • ACTUAL is the current mode of the block, which may differ from the target based on operating conditions. Its value is calculated as part of block execution. • TARGET is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested. • PERMITTED defines the modes which are allowed for an instance of the block. The permitted mode is configured based on application requirement. • NORMAL is the mode that the block should be set to during normal operating conditions. OS block modes are: • Out of Service (O/S) - The block is not being evaluated. The output is maintained at last value. Setpoint is maintained at last value. • Initialisation Manual (IMan) - OS block actual mode is under way to change to the target mode. • Automatic (Auto) - A local setpoint value is used by the normal block algorithm in determining output values. The local setpoint value may be written to by an operator through an interface device. • Cascade (Cas) - A setpoint value supplied by another function block through the Cascade input parameter is used by the normal block algorithm in determining the primary output value. This connection between function blocks is defined by a link object.
BLOCK_ERR	This parameter reflects the error status related to the hardware or software components associated with a block. It is a bit string, meaning that multiple errors may be shown. • Other - Non-specific error active. • BlockConfiguration – Error detected in block configuration. • LinkConfiguration – Error detected in link configuration. • SimulationActive - Simulation enabled in this block. For the resource block, Simulate Active will be used to indicate that the simulate hardware jumper is present. An active state (1) of this attribute will indicate that the jumper is present and that it is possible for the user to enable simulation in the function block. For the block this indicates simulation is either enabled or disabled. • LocalOverride - Output tracking or faultstate active. • DeviceFaultstate - Device faultstate set. • Device needs maintenance soon • InputFailure - Process variable has bad status. • OutputFailure - Failure detected in output hardware. • MemoryFailure - Memory error detected. • LostStaticData - Static parameters cannot be recovered. • LostNVData - Non-Volatile parameters cannot be recovered. • ReadbackCheck - Failure detected in READBACK. • Device needs maintenance now • PowerUp - Recovery from power failure. • OutOfService - Block actual mode is Out of Service.
SP	The OS block setpoint calculated from CAS_IN (Cascade mode) or entered by the user (Auto mode).
OUT_1	OS block output 1.
OUT_2	OS block output 2.
OUT_1_RANGE	The display scaling for the OUT_1.
OUT_2_RANGE	The display scaling for the OUT_2.

OS block parameter name	Description
GRANT_DENY	The grant-deny parameter (which has two attributes referred to as Grant and Deny) is used to allow the operator to grant or deny access permission to sets of function block parameters by other devices. The operation of these parameters is defined here, but their actual usage (if any) depends on the philosophy of the plant. Grant - Depending on the philosophy of the plant, the operator or a higher level device (HLD), or a local operator's panel (LOP) in the case of Local, may turn on an item of the Grant attribute - Program, Tuning, Alarm, or Local. By performing or allowing this action, the operator gives up control of the selected parameters to the HLD or LOP. The function block does not check writes to any of the selected parameters for grant-deny permission. It is up to other devices to obey and enforce the rules, because the function block has no way of knowing who is writing to it. Operators wishing to regain control of the parameters must clear the Grant item. The function block will then automatically set the corresponding Denied item. This indicates to the HLD or LOP that control has been taken away. • Program - A higher level device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. • Tune - A higher level device may change the tuning parameters of the block. • Alarm - A higher level device may change the alarm parameters of the block. Local - A local operator's panel or hand-held device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. Deny - The Deny attribute is provided for use by a monitoring application in an interface device and may not be changed by an operator. It allows the monitoring application to determine whether control has been temporarily taken away during the execution of a batch program. This is performed by firstly clearing one or all of the Denied items before the execution of a batch program, then checking the Denied item after execution. The Grant item itself should not be checked for this condition, because the operator may have cleared and subsequently set the Grant item during batch program execution, a sequence that might be missed by a slowly scanning monitor program. The Deny item may not be cleared by the operator, thus latching the fact that control was taken away. • Program - The Program permission item has been turned off. • Tune Denied - The Tune permission item has been turned off. • Alarm Denied - The Alarm permission item has been turned off. • Local Denied - The Local permission item has been turned off.
STATUS_OPTS	Options that the user may select in the block processing of status. • Propagate Fault Backward - If the status from the actuator is Bad, Device failure or Fault State Active or Local Override is active, propagate this as Bad, Device Failure or Good Cascade, Fault State Active or Local Override to BKCAL_OUT respectively without generating an alarm. The use of these sub-statuses in BKCAL_OUT is determined by this option. Through this option, the user may determine whether alarming (sending of an alert) will be performed by the block or propagated upstream for alarming.
CAS_IN	This parameter is the remote setpoint value, which comes from another Fieldbus block, or a DCS block through a defined link. This setpoint is used in Cascade mode.
BKCAL_OUT	The value and status required by an upper block's BKCAL_IN so that the upper block may prevent reset windup and provide a smooth transfer to closed loop control.
IN_ARRAY	An array which contains the values of the input or scaling variables. See Figure 9.
OUT_ARRAY	An array which contains the values of the output or scaling variables. See Figure 9.
LOCKVAL	Flag for holding the first output at current value when the other output is non-zero. See Figure 9.
BKCAL_IN_1	The back calculated input required to initialise a lower cascade 1.
BKCAL_IN_2	The back calculated input required to initialise a lower cascade 2.
BAL_TIME	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds.
HYSTVAT	This parameter contains the amount of hysteresis. Hysteresis in the switching point may be required because the output may change by a full stroke of the valve.

OS block parameter name	Description
UPDATE_EVT	An alert for any change in the static data, UDATE_EVT, is included in each block. This alert can notify the interface devices that keep track of changes that one or more changes have occurred. The relative parameter index and its associated block index are included in the alert, along with the new value of ST_REV. If more than one change has been added since the last reported Update Alert, as known from the difference between the last copy of ST_REV and that in the alert, it will be necessary for the interface device to update all static data. No alert will be generated while a block is in Out of Service mode, so that downloads do not generate many update alerts. ST_REV will be incremented for each change to static data that occurs while the block is in O/S mode. On transition out of O/S mode, an update alert may be generated if the value of ST_REV of the block does not match that of the last reported alert. Update Alert has a fixed priority of 2, therefore it is auto-acknowledged (no operator intervention is required). • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been observed. • Update State - A discrete enumeration that gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value will be maintained constant until alert confirmation has been received – even if another change of state occurs. • Static Rev - the static revision of the block whose static parameter was changed and is being reported. It is possible for the present value of static revision to be greater than this because static can be changed at any time. • Relative Index - The OD index of the static parameter whose change caused this alert, minus the FB starting index. If the update event was caused by a write to multiple parameters at the same time, then this attribute will be zero.
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been noticed. • Update State - A discrete enumeration that gives an indication as to whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received - even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. • Value - The value of the associated parameter at the time the alert was detected.
BLOCK_ERR_DESC_1	The BLOCK_ERR_DESC_1 parameter lists un- or misconfigured parameters of the function block.

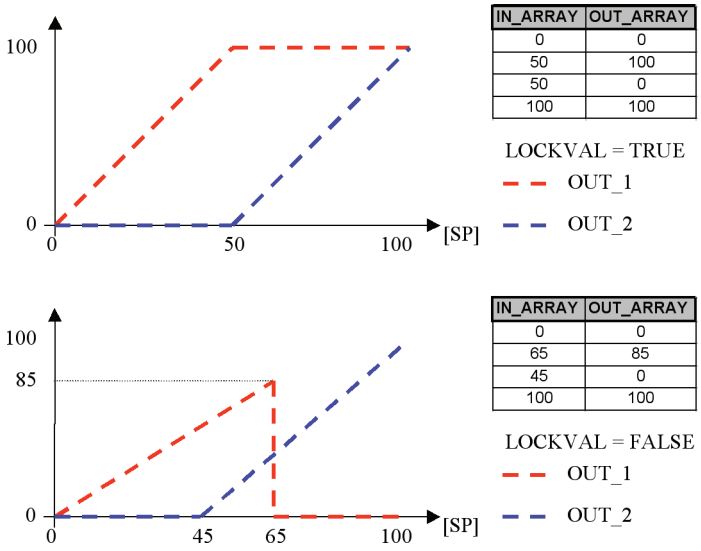

Figure 11. Function of IN_ARRAY, OUT_ARRAY and LOCKVAL.

3.9 Input selector block

3.9.1 Overview

The signal selector block provides a selection of up to four inputs and generates an output based on the configured action. This block normally receives its inputs from AI blocks. The block performs maximum, minimum, middle, average and 'first good' signal selection.

With a combination of parameter configuration options, the block can function as either a rotary position switch, or a validated priority selection based on the use of the first good parameter and the disable n parameter. As a switch, the block can receive switching information from either the connected inputs or from an operator input. The block also supports the concept of a middle selection. Although the normal configuration for this feature would be with three signals, the block should generate an average of the middle two if four signals are configured or the average of two if three are configured and a bad status is passed to one of the inputs. Logic is provided for handling uncertain and bad signals in conjunction with configured actions. The intended application of this block is to provide control signal selection in the forward path only, therefore, no back calculation support is provided. SELECTED is a second output that indicates which input has been selected by the algorithm.

The IS block schematic is presented in figure 12.

Figure 12. IS block schematic.

3.9.2 Parameters

The IS block parameters are presented in the table 8.

IS block parameter name	Description
ST_REV	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in this block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify the grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	MODE_BLK contains the actual, target, permitted, and normal modes of the block. • ACTUAL is the current mode of the block, which may differ from the target based on operating conditions. Its value is calculated as part of block execution. • TARGET is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested. • PERMITTED defines the modes which are allowed for an instance of the block. The permitted mode is configured based on application requirement. • NORMAL is the mode which the block should be set to during normal operating conditions. IS block modes are: • Out of Service (O/S) - The block is not being evaluated. The output is maintained at last value. • Manual (Man) - The block output is not being calculated, although it may be limited. It is directly set by the operator through an interface device. The Man mode can be used in maintenance or troubleshooting where the OUT value may need to be adjusted directly. • Automatic (Auto) – The block output is calculated through normal block execution.
BLOCK_ERR	This parameter reflects the error status related to the hardware or software components associated with a block. It is a bit string, meaning that multiple errors may be shown. • Other - Non-specific error active. • BlockConfiguration – Error detected in block configuration. • LinkConfiguration – Error detected in link configuration. • SimulationActive - Simulation enabled in this block. For the resource block, Simulate Active will be used to indicate that the simulate hardware jumper is present. An active state (1) of this attribute will indicate that the jumper is present and that it is possible for the user to enable simulation in the function block. For the block this indicates simulation is either enabled or disabled. • LocalOverride - Output tracking or faultstate active. • DeviceFaultstate - Device faultstate set. • Device needs maintenance soon • InputFailure - Process variable has bad status. • OutputFailure - Failure detected in output hardware. • MemoryFailure - Memory error detected. • LostStaticData - Static parameters cannot be recovered. • LostNVData - Non-Volatile parameters cannot be recovered. • ReadbackCheck - Failure detected in READBACK. • Device needs maintenance now • PowerUp - Recovery from power failure. • OutOfService - Block actual mode is Out of Service.
OUT	The IS block output is calculated from IN parameters based on DISABLE_n, SELECT_TYPE and OP_SELECT parameters.
OUT_RANGE	This is the display scaling for the output.

IS block parameter name	Description
GRANT_DENY	The grant-deny parameter (which has two attributes referred to as Grant and Deny) is used to allow the operator to grant or deny access permission to sets of function block parameters by other devices. The operation of these parameters is defined here, but their actual usage (if any) depends on the philosophy of the plant. Grant - Depending on the philosophy of the plant, the operator or a higher level device (HLD), or a local operator's panel (LOP) in the case of Local, may turn on an item of the Grant attribute - Program, Tuning, Alarm, or Local. By performing or allowing this action, the operator gives up control of the selected parameters to the HLD or LOP. The function block does not check writes to any of the selected parameters for grant-deny permission. It is up to other devices to obey and enforce the rules, because the function block has no way of knowing who is writing to it. Operators wishing to regain control of the parameters must clear the Grant item. The function block will then automatically set the corresponding Denied item. This indicates to the HLD or LOP that control has been taken away. • Program - A higher level device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. • Tune - A higher level device may change the tuning parameters of the block. • Alarm - A higher level device may change the alarm parameters of the block. • Local - A local operator's panel or hand-held device may change the target mode, setpoint (if the block mode is Man or Auto), or output (if the block mode is Man) of the block. Deny - The Deny attribute is provided for use by a monitoring application in an interface device and may not be changed by an operator. It allows the monitoring application to determine whether control has been temporarily taken away during the execution of a batch program. This is performed by firstly clearing one or all of the Denied items before the execution of a batch program, then checking the Denied item after execution. The Grant item itself should not be checked for this condition, because the operator may have cleared and subsequently set the Grant item during batch program execution, a sequence that might be missed by a slowly scanning monitor program. The Deny item may not be cleared by the operator, thus latching the fact that control was taken away. • Program - The Program permission item has been turned off. • Tune Denied - The Tune permission item has been turned off. • Alarm Denied - The Alarm permission item has been turned off. • Local Denied - The Local permission item has been turned off.
STATUS_OPTS	Options that the user may select in the block processing of status.
IN_1	Input of the block.
IN_2	Input of the block.
IN_3	Input of the block.
IN_4	Input of the block.
DISABLE_1	If DISABLE_1 is true then IN_1 is ignored.
DISABLE_2	If DISABLE_2 is true then IN_2 is ignored.
DISABLE_3	If DISABLE_3 is true then IN_3 is ignored.
DISABLE_4	If DISABLE_4 is true then IN_4 is ignored.
SELECT_TYPE	This parameter determines how the output of the block is calculated. The parameter has five values: • First Good: transfer the value of the first remaining input to the output of the block. • Minimum: sort the inputs by value. Transfer the lowest value to the output of the block. • Maximum: sort the inputs by value. Transfer the highest value to the output of the block. • Middle: sort the inputs by value. If there are 3 or 4 values, discard the highest and lowest value. When two values are left, compute their average. Transfer the value to the output of the block. • Average: compute the average of the inputs and transfer the value to the output of the block.
MIN_GOOD	Determines the minimum number of inputs needed to calculate block output.
SELECTED	This parameter is an output that indicates which input has been selected by the algorithm.
OP_SELECT	This parameter determines the selected input, regardless of the SELECT_TYPE selection.

IS block parameter name	Description
UPDATE_EVT	An alert for any change in the static data, UDATE_EVT, is included in each block. This alert can notify the interface devices that keep track of changes that one or more changes have occurred. The relative parameter index and its associated block index are included in the alert, along with the new value of ST_REV. If more than one change has been added since the last reported Update Alert, as known from the difference between the last copy of ST_REV and that in the alert, it will be necessary for the interface device to update all static data. No alert will be generated while a block is in Out of Service mode, so that downloads do not generate many update alerts. ST_REV will be incremented for each change to static data that occurs while the block is in O/S mode. On transition out of O/S mode, an update alert may be generated if the value of ST_REV for the block does not match that of the last reported alert. Update Alert has a fixed priority of 2, therefore it is auto-acknowledged (no operator intervention is required). • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been noticed. • Update State - A discrete enumeration that gives an indication of whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received – even if another change of state occurs. • Static Rev - the static revision of the block whose static parameter was changed and is being reported. It is possible for the present value of static revision to be greater than this because static can be changed at any time. • Relative Index - The OD index of the static parameter whose change caused this alert, minus the FB starting index. If the update event was caused by a write to multiple parameters at the same time, then this attribute will be zero.
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed. • Unacknowledged - A discrete enumeration which is set to Unacknowledged when an update occurs, and set to Acknowledged by a write from a human interface device or other entity which can acknowledge that the alarm has been noticed. • Update State - A discrete enumeration that gives an indication of whether the alert has been reported. • Time Stamp - The time at which evaluation of the block was started and a change in alarm/event state was detected that is not reported. The time stamp value is maintained constant until alert confirmation has been received – even if another change of state occurs. • Subcode - An enumeration specifying the cause of the alert to be reported. Enumerations are equal with the BLOCK_ERR. • Value - The value of the associated parameter at the time the alert was detected.
BLOCK_ERR_DESC_1	The BLOCK_ERR_DESC_1 parameter lists un- or misconfigured parameters of the function block.

4 LAS capability

Fieldbus communication always requires a device that can take care of communication scheduling.

Terminology definition;
- LM = Link Master. Device is able to operate as LAS or spare LAS.
- BASIC = Device that does not have LM capability
- LAS = Link Active Scheduler. LM type device that is currently taking care of the segment communication scheduling.

In a normal case, the host system or HSE linking device acts as a LAS for the segment. There may be one or more spare LAS devices.

ND9000F is delivered from the factory as a BASIC device. The customer is able to configure the ND9000F as a LM device, following which the ND9000F is able to operate as a spare LAS device.

The ND9000F device type selection between BASIC/LM can be performed from the host system. Please consult your host system manufacturer for further instructions.

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