Intelligent valve controller Neles™ NDX for FOUNDATION Fieldbus

Device Revision 1

User's guide

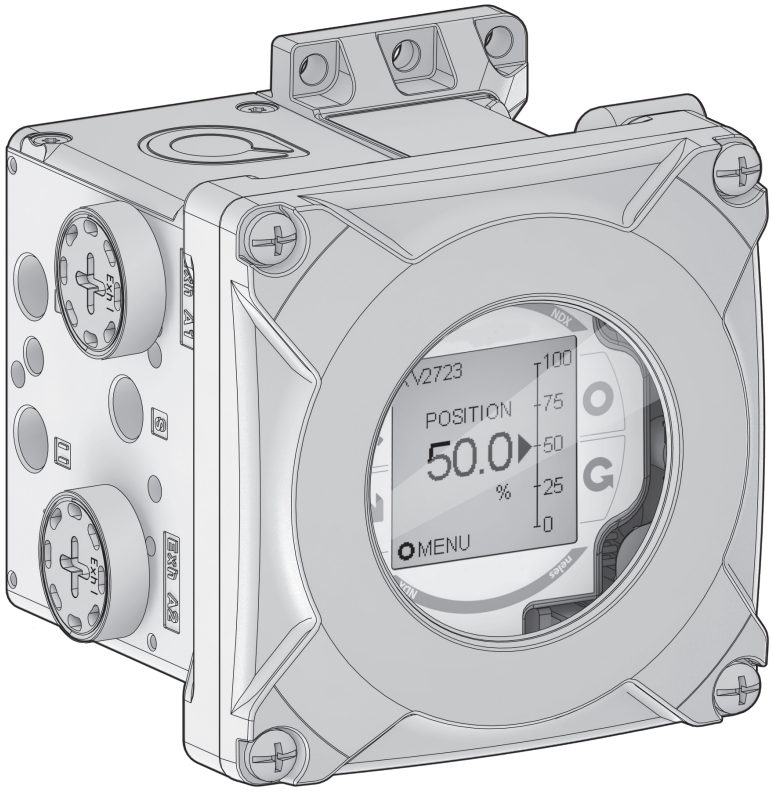

Table of Contents

1. Introduction....3
2. Device setup....3
2.1 Device description installation....3
2.2 FDI package....3
2.3 Basic setup steps....3
Settings via DTM....4
Settings via EDD in fieldbus configurator....4
2.4 Parameter settings summary....5
3. Function blocks....6
3.1 Resource block....6
Overview....6
Parameters....6
Field diagnostics....11
3.2 Transducer block....12
Overview....12
Parameters....12
3.3 SCP transducer block....22
Overview....22
Parameters....22
3.4 Diag transducer block....23
Overview....23
Parameters....23
3.5 Analog output block....24
Overview....24
Parameters....24
3.6 Analog Input function block....29
Overview....29
Parameters....29
3.7 PID function block....32
Overview....32
Parameters....33
3.8 Discrete output block....38
Overview....38
Parameters....39
3.9 Discrete input block....42
Overview....42
Parameters....43
3.10 Multiple Analog Input block....46
Overview....46
Parameters....47
3.11 Multiple discrete input block....49
Overview....49
Parameters....50
3.12 Output splitter block....52
Overview....52
Parameters....53
3.13 Input selector block....56
Overview....56
Parameters....57
4. LAS capability....60

1. Introduction

Neles™ NDX FF is a top-class intelligent valve controller for FOUNDATION Fieldbus network 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.

NDX FF contains 17 function blocks:

- Resource block – Provides options that control the behavior of all other blocks and field diagnostics compliant to Namur NE107 specification.
- NDX Transducer block - Provides valve control configuration, valve calibration and embedded valve tests.
- SCP Transducer block - Standardized Connection Point allows a control system to use the I/O functionality of a field device without first having to configure function block schedules or communication connections.
- DIAG Transducer block – Provides FF communication error and statistics counter information.
- Analog Output block - Used if NDX FF is used as the standard positioner.
- Digital Output block - Used if NDX FF is used as the on/off controller.
- Analog Input block (4 pcs) - Used to transmit analog process measurements to the field bus.
- Discrete Input blocks (2 pcs) - Used to transmit the software limit switch information (based on position sensor information) to the field bus. Two DI blocks for both limits.
- Multiple Analog Input block - Used to transmit analog process measurements to the field bus.
- Multiple Discrete Input block - Used to transmit discrete status information to the field bus.
- PID controller block - Used in distributed field control.
- Input selector block - Input signal can be selected from eight 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 DDs for most of the field devices.

If the host system's DD library does not already contain the DD for NDX FF, it can be downloaded from www.valmet.com/NDX.

The NDX FF DD4 files are: 0101.ffo, 0101.sym and 010101.cff

The NDX FF DD5 files are: 0101.ff5, 0101.sy5 and 010101.cff

The NDX FF DD6 files are: 0101.ff6, 0101.sy6 and 010101.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\00EA. If this directory does not exist in the DD library, it must be created. See your control systems manual for more information.

2.2 FDI package

NDX FF has a FDI package containing EDD (DD6) files: Valmet_Flow_Control_Oy.NDX_FF.1.0.0.FF.fdix

2.3 Basic setup steps

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

If NDX FF is supplied with valve and actuator, the tubes are mounted and NDX FF 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 NDX 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 NDX IMO for settings via Local User Interface (LUI).

Settings via DTM

1. See figure 1 for commissioning the device. Set correct assembly related parameter settings and run calibration.

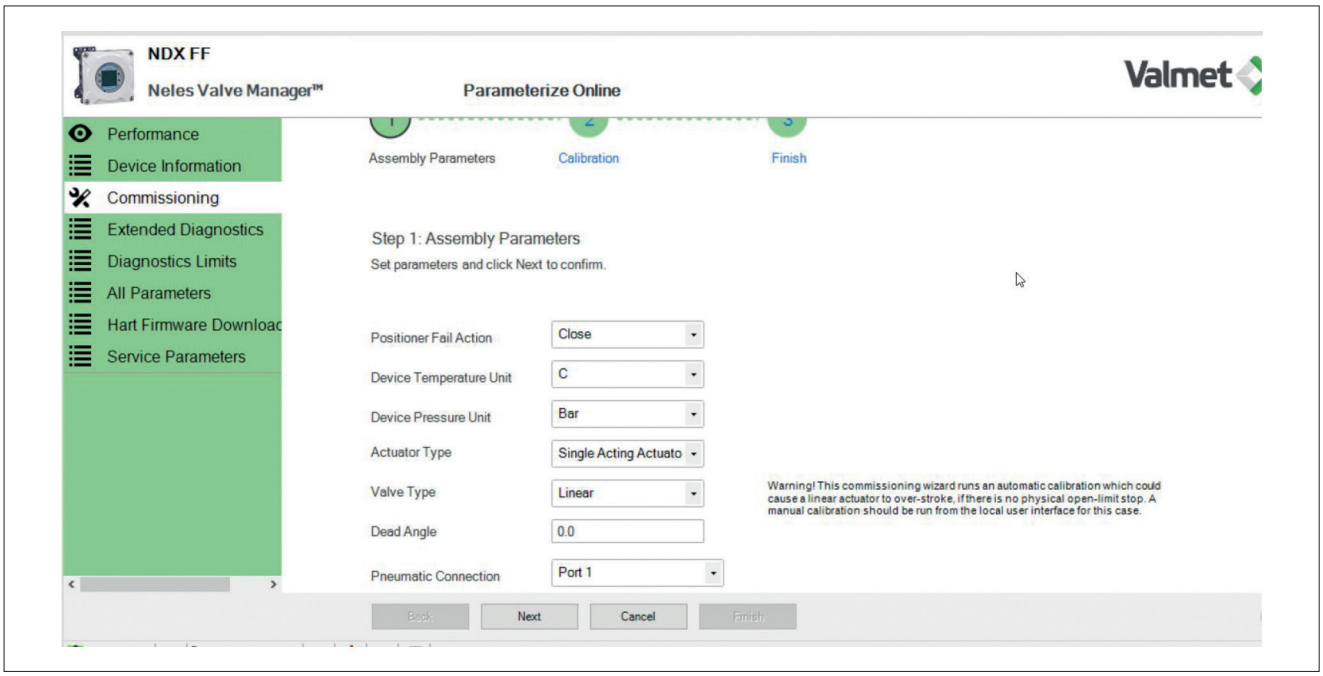

Figure 1. Assembly related parameters' setup in Neles Valve Manager™ DTM

Neles Valve Manager™ DTM Performance View and Event log are indicating any errors preventing device to operate normally.

Settings via EDD in fieldbus configurator

1. Set assembly related parameters, see chapter Transducer block parameters, assembly related section.
2. Set the Transducer block target mode to Manual.
3. Set the POSITION_CALIBRATION_SELECT parameter to value "Automatic position calibration". See Transducer block parameters, Calibration section.
4. Run the calibration by setting POSITION_CALIBRATION_START parameter to value "Start calibration".
5. Monitor the parameter POSITION_CALIBRATION_STATUS to see the calibration status. If the calibration fails, check the parameter POSITION_CALIBRATION_ERROR_CODE to find the reason for the failure, correct the setup and run the calibration again.
6. Repeat the procedure in steps 3-5 also for "Control parameter tuning" and "Magnet installation test".
7. After successful calibrations 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 has 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.

In Resource block see the standard parameters: FD_[FAIL/OFFSPEC/MAINT/CHECK]_ACTIVE and extended parameters: FD_EXTENDED_ACTIVE_ [1/2].

2.4 Parameter settings summary

Summary of commonly referred parameters and their recommended or typical settings in NDX FF 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
DEAD_ANGLE	0 [%]	According to the valve mechanical construction	
ACTUATOR_TYPE (Note 4)	Double acting	According to the valve mechanical construction	
PERFORMANCE_LEVEL	Optimum	Optimum	Optimum
PNEUMATIC_CONNECTION (Note 9)	-	According to the valve mechanical construction	

Note 1: Applicable only in cases of FF H1 Segment communication failure. One possible 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 actualposition. 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.

Note 9: For single acting actuators only. For double acting versions of NDX only. Select which pneumatic port is connected to the actuator.

3. Function blocks

3.1 Resource block

Overview

The resource block provides options that control the behavior of all other blocks. The block contains also Field diagnostics parameters (acc. Namur NE-107), 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: 00EA
DEV_REV	Manufacturer revision number associated with the resource - used by an interface device to locate the DD file for the resource. Value: 1
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
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.

Resource block parameter name	Description
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 | Soft write lock | Out Readback | Multi-bit alarm support | SCP mode
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. • Soft W Lock – This enables the use of the software 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. • SCP mode – This allows NDX to be used in SCP mode
CYCLE_TYPE	Identifies the block execution methods available for this resource.
CYCLE_SEL	Used to select the block execution method for this resource.
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 bemaintained 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.
SOFTWARE_REV	commModule software revision.
HARDWARE_REV	commModule hardware revision.
CS_SCRIPT_REV	commScripter Revision
CS_CONTENT_REV	Revision of the commScript content
APPL_TUNNEL_STATE	State of the application tunnel
APPL_TUNNEL_REQ	Request buffer of the application tunnel
APPL_TUNNEL_RES	Response buffer of the application tunnel
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.

Resource block parameter name	Description
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.
POSITIONER_SERIAL_NUMBER	Valve controller serial number.
POSITIONER_TYPE_CODE	Valve controller type code.
NDX_PCB_ITEM_NBR	Valve controller board item number.
NDX_PCB_SERIAL_NBR	Valve controller board serial number.
NDX_PCB_BATCH_NBR	Valve controller board batch number.
DEVICE_TEST_STATUS	This parameter is intended for use by Valmet personnel.
SERVICE_STATUS	This parameter is intended for use by Valmet personnel.
SERVICE_TIMESTAMP_1	This parameter is intended for use by Valmet personnel.
SERVICE_COMMENT_1	This parameter is intended for use by Valmet personnel.
SERVICE_TIMESTAMP_2	This parameter is intended for use by Valmet personnel.
SERVICE_COMMENT_2	This parameter is intended for use by Valmet personnel.
SERVICE_TIMESTAMP_3	This parameter is intended for use by Valmet personnel.
SERVICE_COMMENT_3	This parameter is intended for use by Valmet personnel.
SERVICE_TIMESTAMP_4	This parameter is intended for use by Valmet personnel.
SERVICE_COMMENT_4	This parameter is intended for use by Valmet personnel.
LOCAL_USER_INTERFACE_LOCK	Options to lock Local user interface to prevent unauthorized access. • Cover Lock (default): Detaching the main cover will unlock the for LUI editing. When the cover is re-attached, LUI is again locked to read only mode. • Pin Code: PIN code is required to unlock editing mode. PIN lock automatically re-locks after one minute of inactivity and at the same time LUI returns to monitoring view. Cover Lock and Pin: Detach the cover and after that enter the PIN code to enable the editing mode. One minute of inactivity enables PIN lock and re-attaching the cover locks the Cover lock.
PIN_CODE	Set Local User Interface PIN Code. If Local User Interface Lock option PIN Code is selected, enter PIN code to edit or start a function in Local User Interface. Deafult:1234
NDX_SOFTWARE_REV	Valve controller firmware revision.

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 and FD_EXTENDED_ ACTIVE_2.

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 2.

Table 2 Field diagnostics conditions and recommended actions

Field diagnostics condition	Default diagnostics category	Recommended action
Transducer Mode Not OK	Failure	Set transducer block into AUTO mode.
Communication loss	Failure	Replace the electronics module.
NV-RAM issue	Failure	Replace the electronics module.
Missing Position Feedback Magnet	Failure	Check magnet installation. Calibrate the device.
Electronics Problem	Failure	Replace the electronics module.
Supply Pressure Sensor Failure	Out of specification	Replace the electronics module.
Actuator Pressure Sensor Failure	Out of specification	Replace the electronics module.
Position Sensor Failure	Failure	Replace the electronics module.
Prestage Open Circuit	Failure	Replace prestage unit and calibrate device.
Calibration Required	Maintenance	Run position calibration.
Supply Pressure Too Low	Out of specification	Check supply pressure level and capacity.
Supply Pressure Too High	Out of specification	Check supply pressure level and capacity.
Temperature Too Low	Out of specification	Inspect the positioner and operating conditions.
Temperature Too High	Out of specification	Inspect the positioner and operating conditions.
Steady State Dev Lim Exceeded	Out of specification	Review performance. Check deviation limit, piping for leakages.
Low 1-Act Actuator Supply Press	Out of specification	Check supply pressure level and capacity.
Calibration Recommended	Maintenance	Run position calibration.
Operation Time Lim Exceeded	Maintenance	Review device performance. Increase limit if it is adequate.
Valve Travel Lim Exceeded	Maintenance	Review device performance. Increase limit if it is adequate.
Valve Reversals Lim Exceeded	Maintenance	Review device performance. Increase limit if it is adequate.
Min Stiction Too Low	Maintenance	Review device performance. Increase limit if it is adequate.
Load for Opening Too Low	Maintenance	Review device performance. Increase limit if it is adequate.
Valve Position Below Low Limit	Maintenance	Check valve moves in whole operating range. Calibrate if needed.
Valve Position Above High Limit	Maintenance	Check valve moves in whole operating range. Calibrate if needed.
Test Running	Function check	Wait until valve offline test is completed.
Device in Manual Mode	Function check	Set device back to auto mode from LUI.
Calibration Running	Function check	Wait until valve position calibration is completed.

3.2 Transducer block

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 other measurements and statuses to the AO, AI, MAI, DO, DI and MDI blocks. The data exchange between the transducer block and AO, AI, MAI, DO, DI and MDI blocks is configured by the CHANNEL parameter located in AO, AI, MAI, DO, DI and MDI blocks.

The transducer block provides following device functions:

- **Calibration**
- **Valve diagnostics:** travel counters, trends, histograms and online measurements.
- **Valve test:** Multipoint Step test, Valve signature test, Valve deadband test and Partial stroke test.
- **Event log**
- **Flow characterization**

Parameters

The NDX transducer block parameters are presented in table 3.

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. Valve position control through Transducer block is allowed in Man or O/S mode by writing to FINAL_VALUE or FINAL_VALUE_D parameters. Position calibration and offline tests can be started only in Manual or O/S mode. • Automatic (Auto) - Normal operation, device follows the AO.OUT signal.
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.
TRANSDUCER_TYPE_VER	Identifes the version of the transducer that follows. Format is XXYY where XX is the major spec revision and YY is the manufacturer revision.
XD_ERROR	One of the transducer error codes defined in the FF Transducer Specifications in section 4.7 Block Alarm Subcodes.
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.

Transducer block parameter name	Description
FINAL_VALUE	Setpoint for valve travel in %.
FINAL_VALUE_UNIT	Valve Position Setpoint Unit.
FINAL_VALUE_D	Valve position setpoint in discrete form.
FINAL_VALUE_CUTOFF_HI	Cut-Off Open If the FINAL_VALUE is more positive than this value, the valve is forced to its maximum high value (calibrated 100 %).
FINAL_VALUE_CUTOFF_LO	Cut-Off Close 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).
TARGET_POSITION_VALUE	Final valve setpoint (system valve setpoint after all signal modifications). This device variable is a computational value.
TARGET_POSITION_VALUE_UNIT	Target Position Unit.
FINAL_POSITION_VALUE	The measured valve position, which is fed back to AO block as AO.READBACK signal.
FINAL_POSITION_VALUE_UNIT	Valve Position Unit.
FINAL_POSITION_VALUE_D	Measured discrete valve position.
COMPENSATED_VALVE_POSITION	Compensated Valve Position %.
COMPENSATED_VALVE_POSITION_UNIT	Compensated Valve Position Unit.
CONTROLLER_PWM	Controller PWM.
CONTROLLER_PWM_UNIT	Controller PWM output Unit.
DEVIATION	Online Deviation, Difference between final valve setpoint (TARGET_POSITION_VALUE) and measured valve position (FINAL_POSITION_VALUE).
DEVIATION_UNIT	Deviation Unit.
ACTUATOR_TYPE_CODE	The actuator type code.
ACTUATOR_SERIAL_NUMBER	The actuator serial number.
VALVE_TYPE_CODE	The valve type code.
VALVE_SERIAL_NUMBER	The valve serial number.

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 NDX Installation, Maintenance and Operating Instructions for details.	
ACTUATOR_TYPE	Actuator type selection. Options: • Single acting actuator • Double acting actuator
VALVE_TYPE	Valve type selection. Options are: • Rotary • Linear • Linear long
DEAD_ANGLE	The α0 setting is designed for Metso 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 pneumatics relay feeds Port II (pneumatic connector) and releases Port I pressure. Options are: • 1 = Fail to Close • 2 = Fail to Open
PNEUMATIC_CONNECTION	For single acting actuators only. For double acting version of NDX only. Select which pneumatic port is connected to the actuator. Options: • Port 1 • Port 2
INSTRUMENTATION	Select if there are instrumentation components in use. Options: • None • Booster • QEV • Booster and QEV
Position control	
MAX_TRAVEL_SPEED_CLOSE	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.
MAX_TRAVEL_SPEED_OPEN	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: Max Stability: Slowest response to signal changes and no overshoot. Trying to keep the valve position as stable as possible. Stable: Fairly slow response to signal changes and no overshoot. Optimum (factory default): Optimum performance controlling the valve regarding response time and valve speed when signal changes. There is typically no overshoot. Fast: Fast response to signal changes but may also have small overshoot. Aggressive: Fastest possible response to signal changes and typically some overshoot. Fast Opening (FO) = The reaction time to setpoint change will be faster when recovering from the cut-off position. Max Stability FO, Stable FO, Optimum FO, Fast FO, Aggressive FO: Similar behavior than in above mentioned performance levels respectively, but always faster recovering from cut-off than above because of fast open (FO) function.
POSITION_CALIBRATION_START	Initiation or cancel of calibration procedure. During the calibration the device searches for optimum internal control parameters for the valve position control. Also, it defines open and close ends. NOTE: Writable only in Manual |OOS mode
POSITION_CALIBRATION_STATUS	POSITION_CALIBRATION_STATUS Result or status of the position calibration procedure. • Idle • Calibration running • Calibration cancelled • Calibration successful • Calibration failed
POSITION_CALIBRATION_ERROR_CODE	Position calibration error code. • No Error • Action Cancelled from LUI • Action Cancelled from HART Interface • Time Out • Another Action Already Running / Busy • Low Supply Pressure • Internal step timeout • Cannot store parameters • Cannot get channels write permission • Condition(s) not satisfied • Valve position range too small • Measurement error • Configuration error • Not implemented Cannot calculate key figure
POSITION_CALIBRATION_PROGRESS	Position calibration percentage value.
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.
Localization	
LUI_LANGUAGE	Select the desired language to be used in local user interface. Options: English Chinese Spanish Italian French Korean German Turkish Dutch Portuguese Japanese
DEVICE_TEMP_UNIT	Select the desired temperature units for various device variables. The device sends the variable's value and unit according to this selection.
DEVICE_PRESSURE_UNIT	Select the desired pressure units for various device variables. The device sends the variable's value and unit according to this selection.
Flow characterization	
CHARACTERIZATION_TYPE	Type of linearization. Options: Linear: Flow Modification is not used Shape Factor: Flow Modification is used. If you select this option, enter a Shape Factor value. User Curve: You can create a custom table. If you select this option, manually edit the Values as necessary.

SHAPE_FACTOR	Shape Factor describes the nearest approximate or the exact shape of the valve characterization transfer function based on the following hyperbolic function: f(x) = x/(S+x(1-S)) where S = Shape Factor x = normalized (0-100%) Setpoint value f(x) = an intermediate calculation of the Target Position. If Shape Factor is between 0 and 1, a quick opening transfer function is applied. If Shape Factor is 1, a linear transfer function is applied. If Shape Factor is larger than 1, an equal percentage transfer function is applied.
CHAR_USER_TABLE	If User Curve is selected. You can create a custom table. Manually edit the values as necessary.
BYPASS_SIGNAL_MODS	Defines whether Signal Modification parameters are applied or not. Options: • No (Signal modifications are applied to original setpoint, and the control module then follows the modified setpoint.) • Yes (Signal modifications are discarded.) Affects following parameters: • Setpoint Cut-Off Closed • Setpoint Cut-Off Open • Valve Position Low Limit • Valve Position High Limit • Dead angle • Split Range Low • Split Range High • Max Travel Speed Close • Max Travel Speed Open • Characterization Type • Shape Factor • Characterization user table
SYMMETRY	Symmetry factor for directions. 1 is neutral, smaller increases close direction, bigger increases to open direction
Online measurements	
PRESSURE_I	Actuator Pressure 1.
PRESSURE_I_UNIT	Pressure unit, bar or psi.
PRESSURE_II	Actuator Pressure 2.
PRESSURE_II_UNIT	Pressure unit, bar and psi.
SUPPLY_PRESSURE	Measured supply pressure value.
SUPPLY_PRESSURE_UNIT	Pressure unit, bar and psi.
TEMPERATURE	Device temperature measurement.
TEMPERATURE_UNIT	Temperature unit, deg C and deg F.
SW_LIMIT_SWITCH_CLOSED	Software Limit switch closed active.
SW_LIMIT_SWITCH_OPENED	Software Limit switch open active.
STEP_TEST_RUNNING	Multipoint step test running.
SIGNATURE_TEST_RUNNING	Valve signature test running.
DEADBAND_TEST_RUNNING	Valve dead band test running.
PST_RUNNING	Partial stroke test running.
FAIL_ACTIVE	Fail active
Counter diagnostics	
TOTAL_OPERATION_TIME	Device total operation time in hours.
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.
TRAVEL_RATIO	Ratio of Valve Travel / Valve Reversals.
CONTROL_RATIO	Ratio of Valve Reversals / Setpoint Reversals

Trends NDX FF continuously stores trend data into the device memory. The trends are used to diagnose the valve package condition over time.	
TREND_SELECT	Select trend: Supply pressure Travel ratio Control ratio Close deviation Control deviation Open deviation Supply Pressure opening Stiction Temperature Dynamic deviation
TREND_COLUMN_TIME_RESOLUTION	Select trend resolution: 1 Hour Minimum 1 Hour Maximum 1 Hour Average 14 Hours Minimum 14 Hours Maximum 14 Hours Average 196 Hours Minimum 196 Hours Maximum 196 Hours Average 2744 Hours Minimum 2744 Hours Maximum 2744 Hours Average
TREND_START_TIME_IN_HOURS	Set time range for the trend data. Give start time in operation hours. For example, trend data of last three months is given as 2160 hours.
TREND	Read trend data with selected resolution and time range: Trend ID Time resolution Start time in hours Trend unit Number of trend items Trend data
Histogram	
VALVE_POS_HISTOGRAM_ALL_TIME	Valve position histogram all time shows the valve operating areas during all operation time. Element 1: closed position; elements 2-11: operating range 0-100% divided to 10% areas; 12th element: closed position.
VALVE_POS_HISTOGRAM_THREE_MONTH	Valve position histogram three months shows the valve operating areas from last three months period. Element 1: closed position; elements 2-11: operating range 0-100% divided to 10% areas; 12th element: closed position.
Alarm settings NDX FF reports an alarm if on-line measurements, travel counters or trends exceed alarm limits. The alarm settings are defined with following parameters.	
TOTAL_OPERATION_TIME_LIM	Warning limit for total operation time.
VALVE_TRAVEL_LIM	Set the Total Valve Travel alert limit. Counter increases by 1 whenever the valve has travelled one full stroke, or 100 % of the valve movement. The valve is considered to have moved when the valve position changes +/- 0.5 % E.g. when the valve moves 10 %, the counter increases by 0.1"
VALVE_REVERSALS_LIM	Set the Total Valve Reversals alert limit. This counter increases by 1 whenever the direction of valve movement changes
ACTUATOR_TRAVEL_LIM	Set the Total Actuator Travel alert limit. Counter increases by 1 whenever the valve has travelled one full stroke, or 100 % of the valve movement. The valve is considered to have moved when the valve position changes +/- 0.5 % E.g. when the valve moves 10 %, the counter increases by 0.1
ACTUATOR_REVERSALS_LIM	Set the Total Actuator Reversals alert limit. This counter increases by 1 whenever the direction of valve movement changes.
TRAVEL_RATIO_LIM	Set travel ratio alert limit. If a value is lower than the limit, a status is activated for the device and an event is generated.
CONTROL_RATIO_LIM	Set control ratio alert limit. If a value exceeds the limit or falls below 1/limit, a status is activated for the device and an event is generated.
VALVE_POS_HIGH_LIM	Set valve position high alert limit. If a measurement exceeds the limit, a status is activated for the device and an event is generated.
VALVE_POS_LOW_LIM	Set valve position low alert limit. If a measurement goes below the limit, a status is activated for the device and an event is generated.
VALVE_POS_LATCH_TIME	Set wait time for triggering the valve position status and event in case valve position high or low limit is exceeded.

STEADY_STATE_DEV_HIGH_LIM	Set steady state deviation high alert limit. If a measurement exceeds the limit, a status is activated for the device and an event is generated.
STEADY_STATE_DEV_TIMEOUT	Deviation is evaluated if measurement is stable for the limit time.
MAX_STICTION_TOO_HIGH_LIM	Set maximum stiction high alert limit. If a measurement exceeds the limit, a status is activated for the device and an event is generated.
MAX_STICTION_TOO_LOW_LIM	Set maximum stiction low alert limit. If a measurement goes below the limit, a status is activated for the device and an event is generated.
LOAD_FOR_OPEN_TOO_HIGH_LIM	Set load for opening high alert limit. If a measurement exceeds the limit, a status is activated for the device and an event is generated.
LOAD_FOR_OPEN_TOO_LOW_LIM	Set load for opening low alert limit. If a measurement goes below the limit, a status is activated for the device and an event is generated.
TEMP_ABOVE_HIGH_LIM	Set temperature high alert limit. If a measurement exceeds the limit, a status is activated for the device and an event is generated.
TEMP_BELOW_LOW_LIM	Set temperature low alert limit. If a measurement goes below the limit, a status is activated for the device and an event is generated.
DEVICE_TEMP_LATCH_TIME	Set wait time for triggering the device temperature status and event in case device temperature high or low limit is exceeded.
SUPPLY_PRESSURE_ABOVE_HIGH_LIM	Set the supply pressure high limit at the actuator's maximum pressure rating. Since the maximum pressure rating for the NDX positioner is 8 bars this should be the highest limit if the actuator has a higher rating. If a measurement exceeds the limit, a status is activated for the device and an event is generated.
SUPPLY_PRESSURE_BELOW_LOW_LIM	For the supply pressure low limit, the spring rating of a spring return actuator can be used. For double acting actuators, the low limit can be set at the minimum air pressure that will allow the actuator to provide sufficient torque to operate the valve. If a measurement goes below the limit, a status is activated for the device and an event is generated.
SUPPLY_PRESSURE_LATCH_TIME	Set wait time for triggering the supply pressure status and event in case supply pressure high or low limit is exceeded.
VALVE_TARGET_POS_LOW_LIM	Set valve target position low limit.
VALVE_TARGET_POS_HI_LIM	Set valve target position high limit.
SW_LIMIT_SWITCH_OPEN	Set the value for limit switch open. When the set value is reached a status is generated.
SW_LIMIT_SWITCH_CLOSE	Set the value for limit switch open. When the set value is reached a status is generated.
Online Valve Signature	
ONLINE_VALVE_SIGNATURE_SELECT	Bit 0 0 = 1st to 14th elements (valid if bit 3 is not set) 1 = 15th to 20th elements and following 1st to 6th elements Bit 1 0 = Pressure up 1 = Pressure down Bit 2 0 = Pressure data 1 = Count data Bit 3 0 = See bit 0 1 = Pressure closing data and Pressure opening data (valid if bit 0 is not set)
ONLINE_VALVE_SIGNATURE_START	Start Time in Hours
ONLINE_VALVE_SIGNATURE	Read Online Valve Signature data. Online Valve Signature shows the friction of the control valve under normal process conditions whenever the valve is changing position. Online Valve Signature shows the amount of pressure required to move the valve in relation to the valve opening. The device data is continuously updated.
Event log	
EVENT_LOG_READ	Read event log
EVENT_LOG	Events and associated time stamps are saved to the device memory. The time stamp is shown in operating hours. The current operating hours are displayed in the parameter TOTAL_OPERATION_TIME.

Diagnostics reset	
RESET_DIAGNOSTICS	This parameter resets the diagnostic data. Options are: • Positioner counters • Valve counters • Actuator counters • Valve position histogram all • Valve position histogram months Trends
Off-line valve tests The off-line valve tests are used to test the valve package condition when the process is not running.	
TEST_SELECT	This parameter selects the test type to be run. Options: • None • Multipoint step test • Valve signature test • Valve deadband test • Partial stroke test
TEST_MULTIPOINT_STEP	Multipoint step test settings: Init Time (s) - the time given to the valve to reach the starting point of the test. Step Time (s) - the time between successive steps. Start Position (%) - starting valve position for the test Step 1 Target (%) - ending position of the valve after step Step 2 Target (%) Step 3 Target (%) Step 4 Target (%) Step 5 Target (%) Step 6 Target (%) Step 7 Target (%) Step 8 Target (%) Step 9 Target (%) Step 10 Target (%) Step 11 Target (%) Step 12 Target (%) Step 13 Target (%) Step 14 Target (%) Step 15 Target (%) Step 16 Target (%) Step 17 Target (%) Step 18 Target (%) Step 19 Target (%) Step 20 Target (%)
TEST_VALVE_SIGNATURE	Valve signature test settings: Init Time (s) - the time to the valve to reach the starting point of the test Start Position (%) - starting valve position for the test End Position (%)- ending position of the valve Ramp time (s) - the time to the valve to reach the end position
TEST_VALVE_DEADBAND	Valve dead band test settings: Test Init Time (s) - the time to the valve to reach the starting point of the test. Start Position (%) - starting valve position for the test Step Wait Time (s)
TEST_PARTIAL_STROKE	Partial stroke test settings: Init Time (s) - the time to the valve to reach the starting point of the test. Stroke Size (%) - size of the valve partial stroke Ramp Time (s) - the time to the valve to reach the stroke position Stay Time (s) - the time to the valve to stay in the stroke position
TEST_ACTION	This parameter is used to start the valve test. Options: • Idle • Start test • Cancel test • Read status • Reset status NOTE: Writable only in OOS mode.
TEST_STATUS	This parameter displays the status of the valve test. Displayed status values are: • Idle • Test running • Test cancelled • Test successful • Test failed

TEST_ERROR_CODE	Test error code gives more detailed information in case test start is cancelled or test is not successful. Options: • No Error • Action Cancelled from LUI • Action Cancelled from HART Interface • Time Out • Another Action Already Running / Busy • Low Supply Pressure • Internal step timeout • Cannot store parameters • Cannot get channels write permission • Dependency not satisfied • Valve position range too small • Measurement error • Configuration error • Not implemented Cannot calculate key figure
TEST_DATAL_PROGRESS	Test progress percentage value (unit code 57, 0.0-100.0)
TEST_DATA_INDEX	Selection of the test results data. Options: Multipoint step test results Time Multipoint step test results Valve Position Multipoint step test results Key Figures Valve signature test results Setpoint Valve signature test results Pressure Valve signature test results Key Figures Valve dead band test results Time Valve dead band test results Setpoint Valve dead band test results Key Figures Partial stroke test results Position Partial stroke test results Pressure Partial stroke test results Key Figures
TEST_DATAL_PART	Test data part

TEST_DATA	Test data according to the TEST_INDEX selection. Multipoint Step Test Result Time 1...250 Multipoint Step Test Result Position 1...250 Multipoint step test Key figures: Total Operating Time days part Total Operating Time seconds part Multipoint Step Test Step 1 Dead Time (td) (s) Multipoint Step Test Step 1 Step Response Time (T63) (s) Multipoint Step Test Step 1 Step Response Time (T86) (s) Multipoint Step Test Step 1 Step Response Time (T98) (s) Multipoint Step Test Step 1 Step Response Time (T100) (s) Multipoint Step Test Step 1 Maximum Overshoot (%) Multipoint Step Test Step 1 Travel Gain ... Multipoint Step Test Step 20 Dead Time (td) (s) Multipoint Step Test Step 20 Step Response Time (T63) (s) Multipoint Step Test Step 20 Step Response Time (T86) (s) Multipoint Step Test Step 20 Step Response Time (T98) (s) Multipoint Step Test Step 20 Step Response Time (T100) (s) Multipoint Step Test Step 20 Maximum Overshoot (%) Multipoint Step Test Step 20 Travel Gain Valve Signature Test Result Setpoint 1...250 Valve Signature Test Result Pressure 1...250 Valve Signature Test Result Key Figures: Total Operating Time days part Total Operating Time seconds part Maximum Friction (bar or psi) Position at Maximum Friction (%) Seat Load (bar or psi) Load for Opening (bar or psi) Pressure Open (bar or psi) Load for Close (bar or psi) Friction Average (bar or psi) Spring Rate (bar/% or psi/%) Valve Deadband Test Result Time 1...250 Valve Deadband Test Result Setpoint 1...250 Valve Deadband Test Result Key Figures: Total Operating Time days part Total Operating Time seconds part Deadband (%) Partial Stroke Test Result Position 1...250 Partial Stroke Test Result Pressure 1...250 Partial Stroke Test Result Key Figures: Total Operating Time days part Total Operating Time seconds part Load Factor (%) Breakaway Pressure (bar / psi) Minimum Pressure (bar / psi) Actual Stroke Size (%)

Service parameters Intended for more detailed trouble shooting by Valve service personnel	
DEVICE_PROPERTIES	Device properties
DEAD_ZONE_ADAPTATION	Dead zone adaptation
SIGNATURE_ADAPTATION	Signature adaptation
SIGNATURE_ADAPTATION_FACTOR	Signature adaptation factor
DEAD_ZONE_ADAPTATION_FACTOR	Dead zone adaptation factor
TOTAL_RELAY_VALVE_TRAVEL_ENV	Total relay valve travel env
TOTAL_RELAY_VALVE_TRAVEL_ENV_LIM	Total relay valve travel env limit
NOT_ACKNOWLEDGED_MESSAGES	Not acknowledged messages
COMM_ERRORS_ACKNOWLEDGED	Comm errors acknowledged
UART_ERRORS	UART errors
UART_PARITY_ERRORS	UART parity errors
UART_FRAMING_ERRORS	UART framing errors
UART_OVERRUN_ERRORS	UART overrun errors
COMM_ERRORS_IN_PREAMBLES	Comm errors in preambles
COMM_ERRORS_IN_DELIMITERS	Comm errors in delimiters
COMM_ERRORS_IN_ADDRESSES	Comm errors in addresses
COMM_ERRORS_IN_EXPANSION_BYTES	Comm errors in expansion bytes
COMM_ERRORS_IN_COMMANDS	Comm errors in commands
COMM_ERRORS_IN_BYTECOUNTERS	Comm errors in byteCounters
COMM_ERRORS_IN_DATA_BYTES	Comm errors in data bytes
COMM_ERRORS_IN_CHECK_BYTES	Comm errors in check bytes
INVALID_DELIMITERS	Invalid delimiters
TOO_FEW_PREAMBLES	Too few preambles
EXPANSION_BYTES_RECEIVED	Expansion bytes received
TOO_LONG_MESSAGES	Too long messages
INVALID_CHECKSUMS	Invalid checksums
LAST_HOUR_HUNTING	Last hour hunting
LAST_HOUR_VALVE_TRAVEL	Last hour valve travel
LAST_HOUR_VALVE_TRAVEL_LIM	Last hour valve travel limit
LAST_HOUR_VALVE_REVERSALS	Last hour valve reversals
LAST_HOUR_SETPOINT_REVERSALS	Last hour setpoint reversals
LAST_DAY_HUNTING	Last day hunting
LAST_DAY_VALVE_TRAVEL	Last day valve travel
LAST_DAY_VALVE_REVERSALS	Last day valve reversals
LAST_DAY_SETPOINT_REVERSALS	Last day setpoint reversals

3.3 SCP transducer block

Overview

The Standardized Connection Point (SCP) transducer block concept is a simplified scheme that allows a control system to use the I/O function blocks of a field device without first having to configure function block schedules or communication connections. When placed into the SCP mode of operation, a field device will automatically configure itself such that the fundamental PV(s) are published to or subscribed from profiled network addresses. This eliminates the need for control-engineer authority to integrate the device into the system.

Parameters

SCP Transducer parameters are presented in table 4.

Table 4 SCP Transducer block parameters.

SCP 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	SCP Transducer block modes are: • Out of Service (O/S) - The block is not being evaluated. • Automatic (Auto) – SCP mode is enabled by writing RB.RESTART to Restart with SCP Configuration.
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.
SCP_DIRECTORY	A directory that specifies the number and starting indices of the transducers in the transducer block.
HOST_MACROCYCLE	Macro Cycle duration
STALE_COUNT_LIMIT	Stale count
CONNECTION_TYPE_1	AI: Target pos value
IOBLK_OD_INDEX_1	OD idx of associated FB
TBLK_OD_INDEX_1	OD idx of associated TB
CONNECTION_TYPE_2	AI: Final pos value
IOBLK_OD_INDEX_2	OD idx of associated FB
TBLK_OD_INDEX_2	OD idx of associated TB
CONNECTION_TYPE_3	AI: Compensated valve pos
IOBLK_OD_INDEX_3	OD idx of associated FB
TBLK_OD_INDEX_3	OD idx of associated TB
CONNECTION_TYPE_4	AI: Controller pwm
IOBLK_OD_INDEX_4	OD idx of associated FB
TBLK_OD_INDEX_4	OD idx of associated TB

SCP transducer block parameter name	Description
CONNECTION_TYPE_5	DI: Limit switch closed
IOBLK_OD_INDEX_5	OD idx of associated FB
TBLK_OD_INDEX_5	OD idx of associated TB
CONNECTION_TYPE_6	DI: Limit switch open
IOBLK_OD_INDEX_6	OD idx of associated FB
TBLK_OD_INDEX_6	OD idx of associated TB
CONNECTION_TYPE_7	AO: Final value/Final pos value
IOBLK_OD_INDEX_7	OD idx of associated FB
TBLK_OD_INDEX_7	OD idx of associated TB

3.4 Diag transducer block

Overview

Diag TB is a custom transducer block for the fieldbus module diagnostics. It contains parameters describing e.g., condition of non-volatile memory, micro-controller temperature, current consumption, and statistics of fieldbus communication.

Parameters

Diag transducer block parameters are presented in table 5.

Table 5 Diag transducer block parameters.

Diag 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	Diag transducer block modes are: • Out of Service (O/S) - The block is not being evaluated. Automatic (Auto) – This is a normal mode for this transducer block.
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 type.
TRANSDUCER_TYPE_VER	Identifies the transducer version.
XD_ERROR	Transducer error code.
COLLECTION_DIRECTORY	Collection directory.

Diag transducer block parameter name	Description
DIAGTB_REVISION	Diag transducer block revision information.
NV_STATUS	Status of NV blocks.
NV_DIAG	NV diagnostics array.
FD_SW_REV	Revision of the field device software.
FD_HW_REV	Revision of the field device hardware.
FB_CONTROLLER	Fieldbus controller.
HW_TEST_INFO	HW test information.
TIME_SINCE_LAST_RESTART	Time since last restart – day/hour/minute/second.
FATAL_ERROR_INFO	Fatal error information – ID/reason/location/detail.
TIME_SINCE_LAST_EXCEPTION	Time since last exception – day/hour/minute/second.
EXCEPTION_INFO	Exception information – ID/reason/location/detail.
CHIP_TEMPERATURE	Chip temperature – current/min/max (0.1 C).
SHUNT_CURRENT	Shunt current – current/min/max (uA).
SHUNT_HIST	Shunt current histogram.
TIME_SINCE_LAST_DLL_RESTART	Time since last DLL restart – day/hour/second.
DLL_RESTART_INFO	DLL restart reason and DLL state.
FBC_STATISTIC_CNT	Fieldbus communication counter – transmit.
FBC_ERROR_CNT	Fieldbus error counter.
FB_EXEC_IDX	Index of Function block to be tested.
FB_EXEC_SUM	Function block execution time summary.
FB_EXEC_HIST	Function block execution histogram.
FB_EXEC_DEV_POS	Function block start deviation – delayed.
FB_EXEC_DEV_NEG	Function block start deviation – too early.

3.5 Analog output block

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.

Parameters

The AO block parameters are described in the table 6.

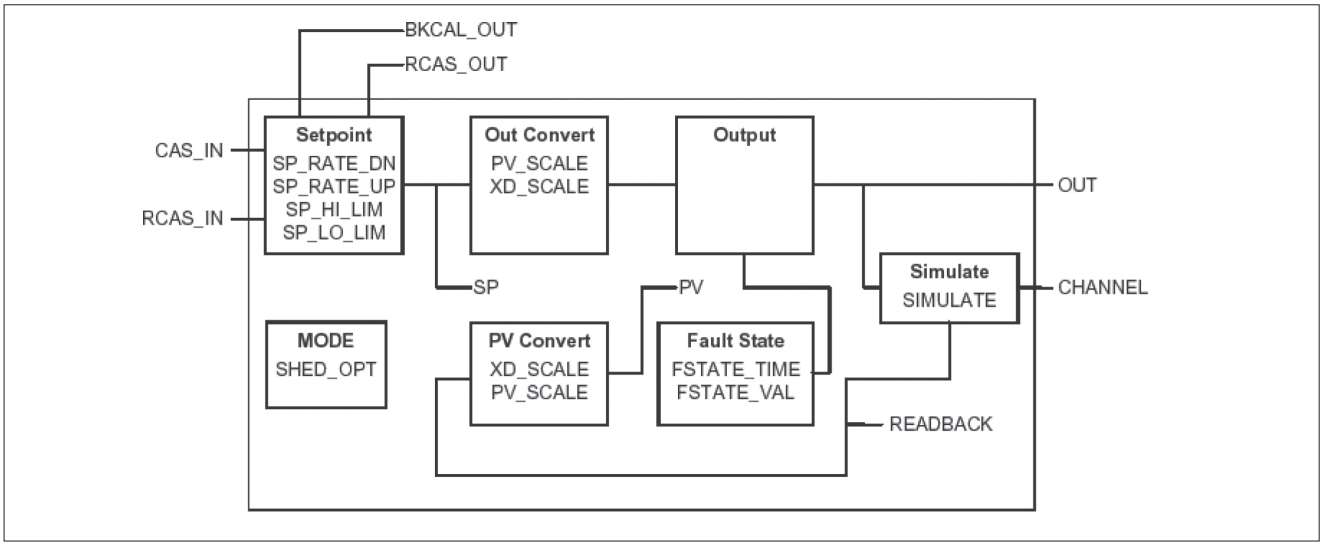

Figure 2. AO block schematic.

Table 6 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. • Initialization 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 initializes so that no bump is experienced when the mode switches from LO back to the target mode. The setpoint may be maintained or optionally initialized 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 initializes so that no bump is experienced when the mode switches. The setpoint may be maintained or optionally initialized 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.
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 fault state active. • DeviceFaultstate - Device fault state 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.

AO block parameter name	Description
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. Note: Simulate must be enabled locally from LUI parameters before this parameter can be used.
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.
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.

AO block parameter name	Description
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.
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 initialized 1 = AO: Position SP, Measured pos (Setpoint for valve travel in %, Measured valve position %) 3 = AO: Position SP, Compensated pos (Setpoint for valve travel in %, Compensated valve position %) 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 –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- The 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 Analog Input function block

Overview

Analog Input block (AI) takes the measured measured process variable from the Transducer block and makes it accessible through its OUT parameter. The CHANNEL parameters define, which process measurements are transferred.

The AI block schematic is presented in Figure 3.

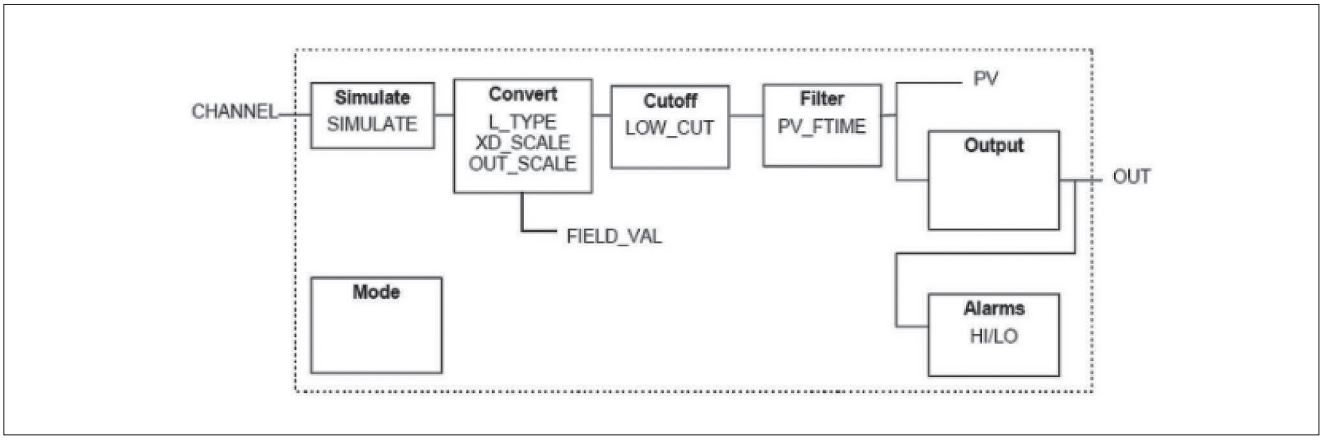

Figure 3. AI block schematic.

Parameters

Table 7 Analog input block 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.
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).

AI block parameter name	Description
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.
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 determine 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 initialized • 30 = AI: Target position • Final valve setpoint (system valve setpoint after all signal modifications). This device variable is a computational value. • 31 = AI: Valve position • The measured valve position, which is fed back to AO block as AO.READBACK signal. • 32 = AI: Compensated Valve Position • 33 = AI: Controller PWM • 34 =AI: Supply Pressure • Measured supply pressure value. • 35 = AI: Actuator Pressure 1 • 36 = AI: Actuator Pressure 2 • 37 = AI: Online Deviation • Difference between Target Position and Position. • 38 = AI: Temperature

AI block parameter name	Description
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.
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.

3.7 PID function block

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 minimizes.

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 initialize to the value of OUT. When a block is in Cas mode, on transition out of bypass the upstream block is requested to initialize 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 4.

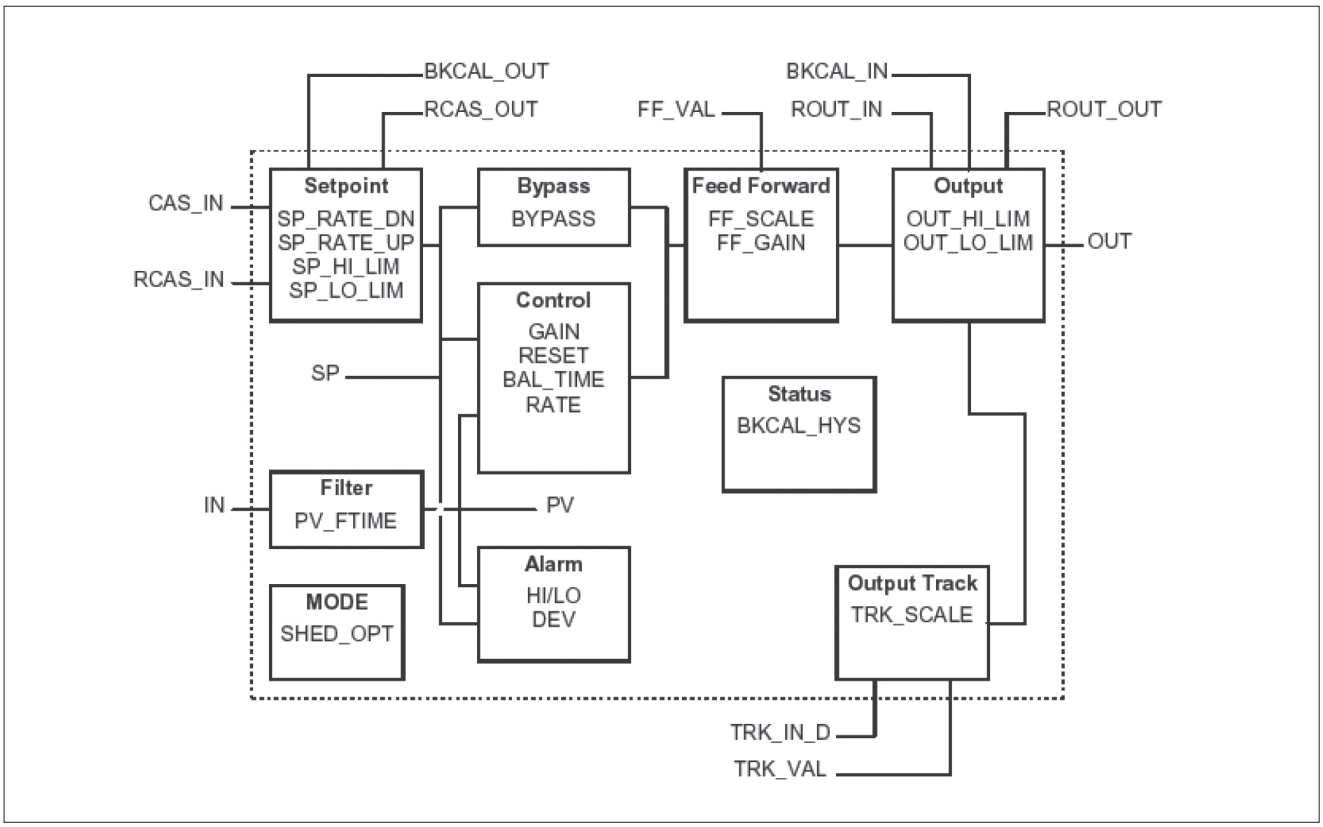

Figure 4. PID block schematic.

Parameters

The PID block parameters are presented in table 5.

Table 8 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. • Initialization 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 initializes 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 initialize so that no bump is experienced when the mode switches from LO back to the target mode. The setpoint may be maintained or optionally initialized 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 initializes so that no bump is experienced when the mode switches. The setpoint may be maintained or optionally initialized 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 initialization 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 initialize so that no bump is experienced when the mode switches. A remote output out parameter is maintained by the block to support initialization of the control application when the block mode is not remote-output. The setpoint may be maintained or optionally initialized to the process variable value.
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.

PID block parameter name	Description
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.
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 initialized 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 initialize 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.
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 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 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.

PID block parameter name	Description
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.
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.
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.

PID block parameter name	Description
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 HI_HI_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 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.

3.8 Discrete output block

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 5.

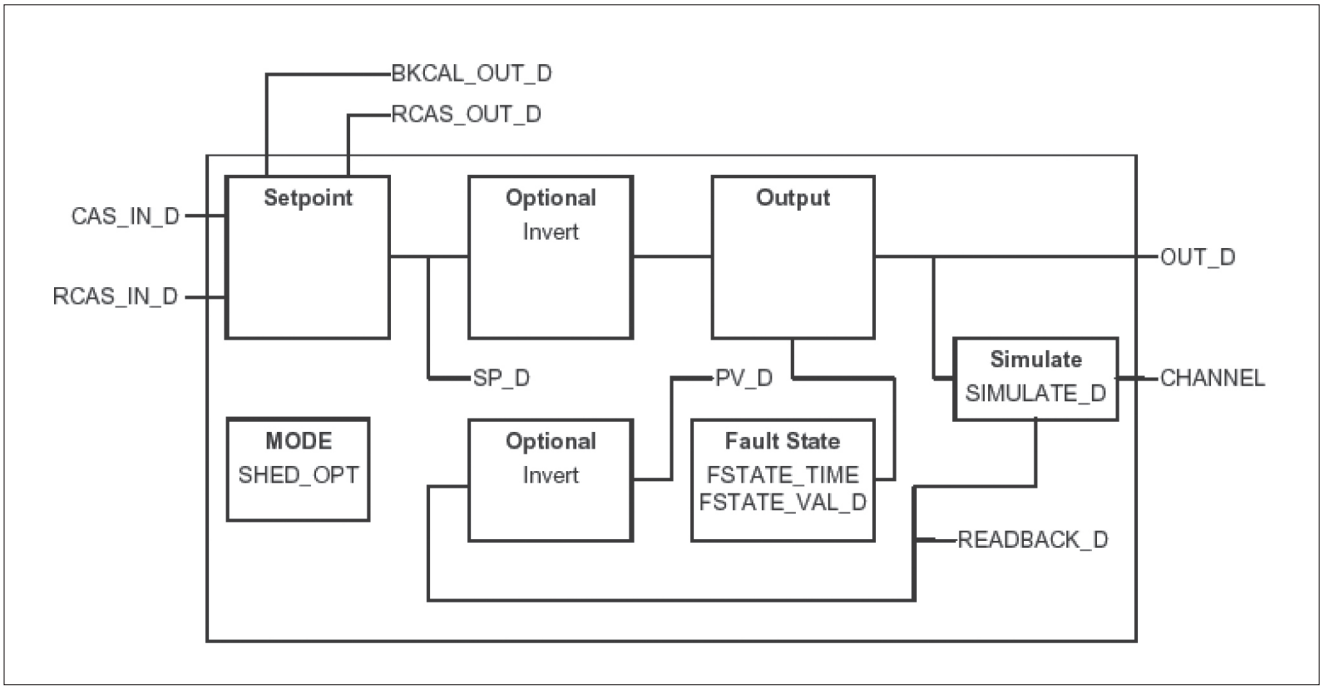

Figure 5. DO block schematic.

Parameters

The DO block parameters are presented in table 5.

Table 9 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. • Initialization 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 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_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 initialization 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.
PV_D	Valve position measurement in discrete form. Either copied from OUT_D or calculated from READBACK_D. See FEATURE_SEL. 0=Closed, 1=Open, 2=Intermediate 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.

DO block parameter name	Description
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.
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. 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 initialized • 11 = Valve Position Setpoint Discrete Valve position setpoint in discrete form.
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.

DO block parameter name	Description
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. 0=Closed, 1=Open, 2=Intermediate See NOTE 1.
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 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_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.
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 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 the direction. The limits are classified as: Not Limited, High Limited, Low Limited, Constant.

3.9 Discrete input block

Overview

The DI block is used to transmit the 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 6.

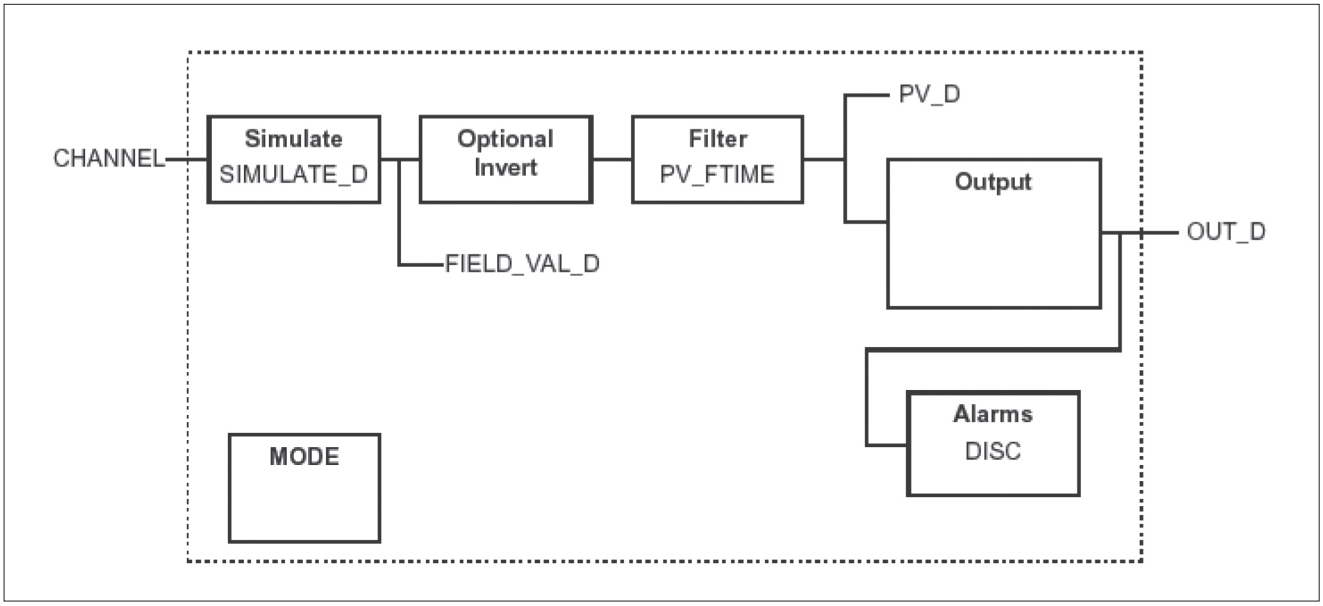

Figure 6. DI block schematic.

Parameters

The DI block parameters are presented in the table 7.

Table 10 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.
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.

DI block parameter name	Data type
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 initialized • 21 = Software Limit switch closed • 22 = Software Limit switch open
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.

DI block parameter name	Data type
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.
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 initialize 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.

3.10 Multiple Analog Input block

Overview

Multiple Analog Input block (MAI) takes the measured analog process values from the Transducer block and makes it accessible through its OUT_1…OUT_8 parameters. The CHANNEL parameter defines, which process values are presented in the OUT parameters.

CHANNEL selection 'Device output variables – normal':

- OUT_1: Target position value
- OUT_2: Final position value
- OUT_3: Compensated valve position
- OUT_4: Supply pressure
- OUT_5: Pressure I (actuator port I)
- OUT_6: Pressure II (actuator port II)
- OUT_7: Deviation
- OUT_8: Temperature

CHANNEL selection 'Device output variables – service':

- OUT_1: Target position value
- OUT_2: Final position value
- OUT_3: Compensated valve position
- OUT_4: Supply pressure
- OUT_5: Pressure I (actuator port I)
- OUT_6: Pressure II (actuator port II)
- OUT_7: Deviation
- OUT_8: Controller PWM

The MAI block schematic is presented in Figure 7.

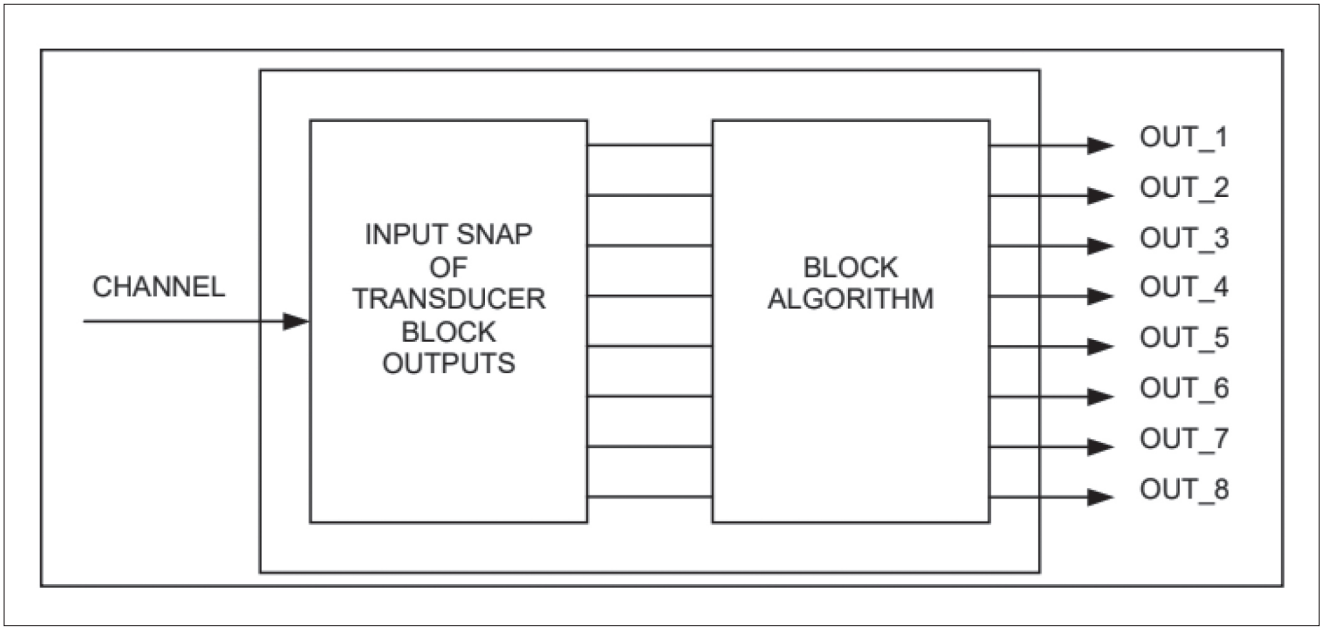

Figure 7. MAI block schematic.

Parameters

The MAI block parameters are presented in the table 8.

Table 11 Multiple analog input block parameters.

MAI 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. MAI 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. • 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.
CHANNEL	This parameter defines the signal configuration between the MAI block and transducer block. 0 = Not initialized 257 = Device output variables - normal Device output variables OUT_1 - OUT_8: OUT_1: TARGET_POSITION_VALUE OUT_2: FINAL_POSITION_VALUE OUT_3: COMPENSATED_VALVE_POSITION OUT_4: SUPPLY_PRESSURE OUT_5: PRESSURE_I OUT_6: PRESSURE_II OUT_7: DEVIATION OUT_8: TEMPERATURE 258 = Device output variables – service Device output variables OUT_1 - OUT_8: OUT_1: TARGET_POSITION_VALUE OUT_2: FINAL_POSITION_VALUE OUT_3: COMPENSATED_VALVE_POSITION OUT_4: SUPPLY_PRESSURE OUT_5: PRESSURE_I OUT_6: PRESSURE_II OUT_7: DEVIATION OUT_8: CONTROLLER_PWM
OUT_1	The MAI block output 1 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Target position value* See NOTE 1.

MAI block parameter name	Data type
OUT_2	The MAI block output 2 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Final position value* See NOTE 1.
OUT_3	The MAI block output 3 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Compensated valve position* See NOTE 1.
OUT_4	The MAI block output 4 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Supply pressure* See NOTE 1.
OUT_5	The MAI block output 5 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Pressure I* See NOTE 1.
OUT_6	The MAI block output 6 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Pressure II* See NOTE 1.
OUT_7	The MAI block output 7 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Deviation* See NOTE 1.
OUT_8	The MAI block output 8 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Temperature (channel sel Normal) or Controller PWM (channel sel Service)* See NOTE 1.
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.
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 initialize 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.

3.11 Multiple discrete input block

Overview

Multiple Discrete Input block (MDI) takes the status information values from the Transducer block and makes them accessible through its OUT_D1…OUT_D8 parameters. The CHANNEL parameter defines, which statuses are presented in the OUT_D parameters.

CHANNEL selection 'Device status outputs':

OUT_D1: SW limit switch Closed
OUT_D2: SW limit switch Open
OUT_D3: Step test running
OUT_D4: Signature test running
OUT_D5: Dead band test running
OUT_D6: Partial stroke test running
OUT_D7: Failure active
OUT_D8: Not in use

The MDI block schematic is presented in Figure 8.

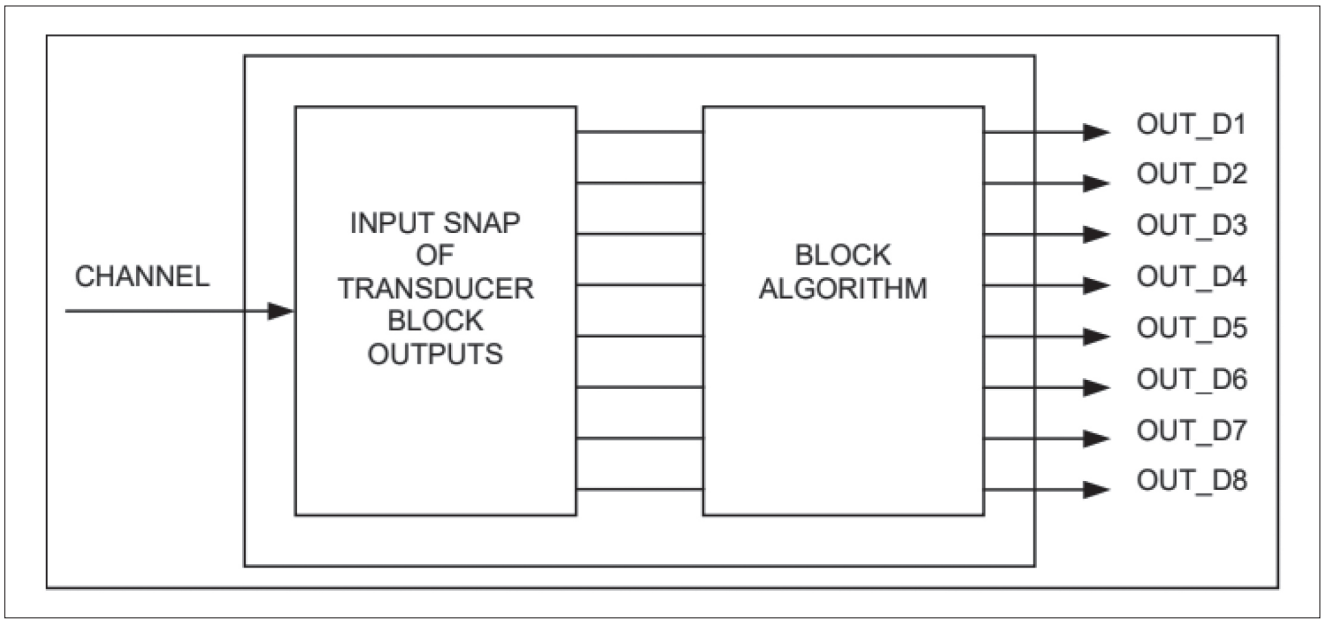

Figure 8. MDI block schematic.

Parameters

The MDI block parameters are presented in the table 9.

Table 12 Multiple discrete input block parameters.

MDI 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. • 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.
CHANNEL	This parameter defines the signal configuration between the MAI block and transducer block. 0 = Not initialized 268 = Device status outputs OUT_D1: SW_LIMIT_SWITCH_CLOSED OUT_D2: SW_LIMIT_SWITCH_OPEN OUT_D3: STEP_TEST_RUNNING OUT_D4: SIGNATURE_TEST_RUNNING OUT_D5: DEADBAND_TEST_RUNNING OUT_D6: PST_RUNNING OUT_D7: FAIL_ACTIVE
OUT_D1	The MDI block output 1 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *SW limit switch Closed* See NOTE 1.
OUT_D2	The MDI block output 2 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *SW limit switch Open* See NOTE 1.
OUT_D3	The MDI block output 3 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Step test running* See NOTE 1.
OUT_D4	The MDI block output 4 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Signature test running* See NOTE 1.
OUT_D5	The MDI block output 5 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Dead band test running* See NOTE 1.

MDI block parameter name	Data type
OUT_D6	The MDI block output 6 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Partial stroke test running* See NOTE 1.
OUT_D7	The MDI block output 7 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Fail status (Namur NE-107) active* See NOTE 1.
OUT_D8	The MDI block output 8 received from the Transducer block (Auto mode) or entered by the user (Manual mode). *Not in use* See NOTE 1.
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.
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 initialize 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.

3.12 Output splitter block

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 initialization 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 initialization information back to the upstream block.

The OS block schematic is presented in Figure 9.

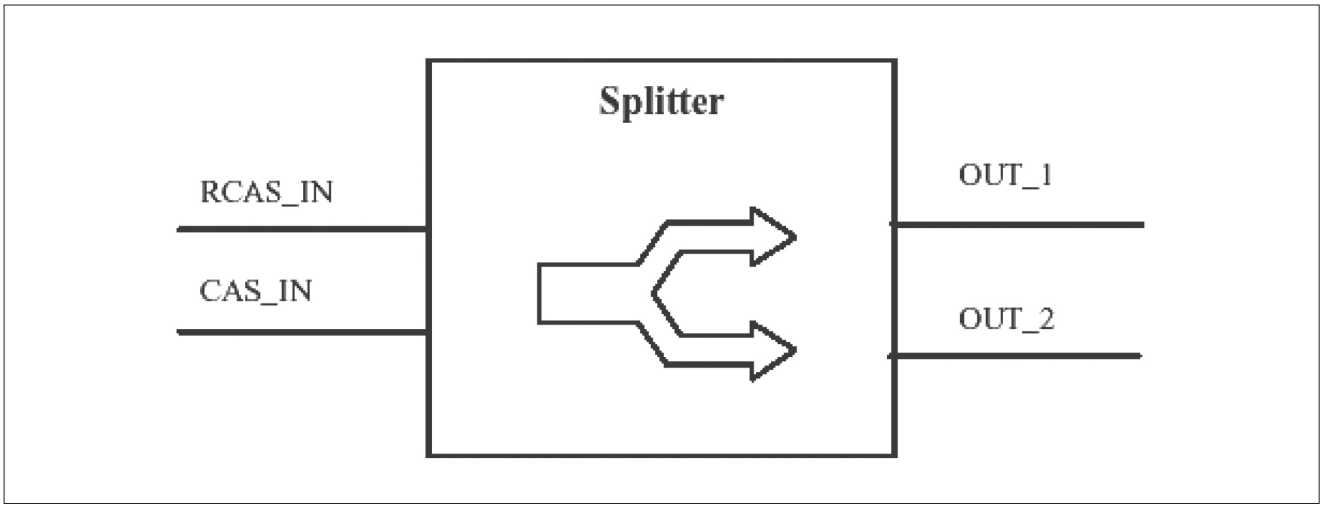

Figure 9. OS block schematic.

Parameters

The OS block parameters are presented in the table 13.

Table 13

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. • Initialization 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 initialize a lower cascade 1.
BKCAL_IN_2	The back calculated input required to initialize 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.
HYSTVAL	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.
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.

OS 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 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.

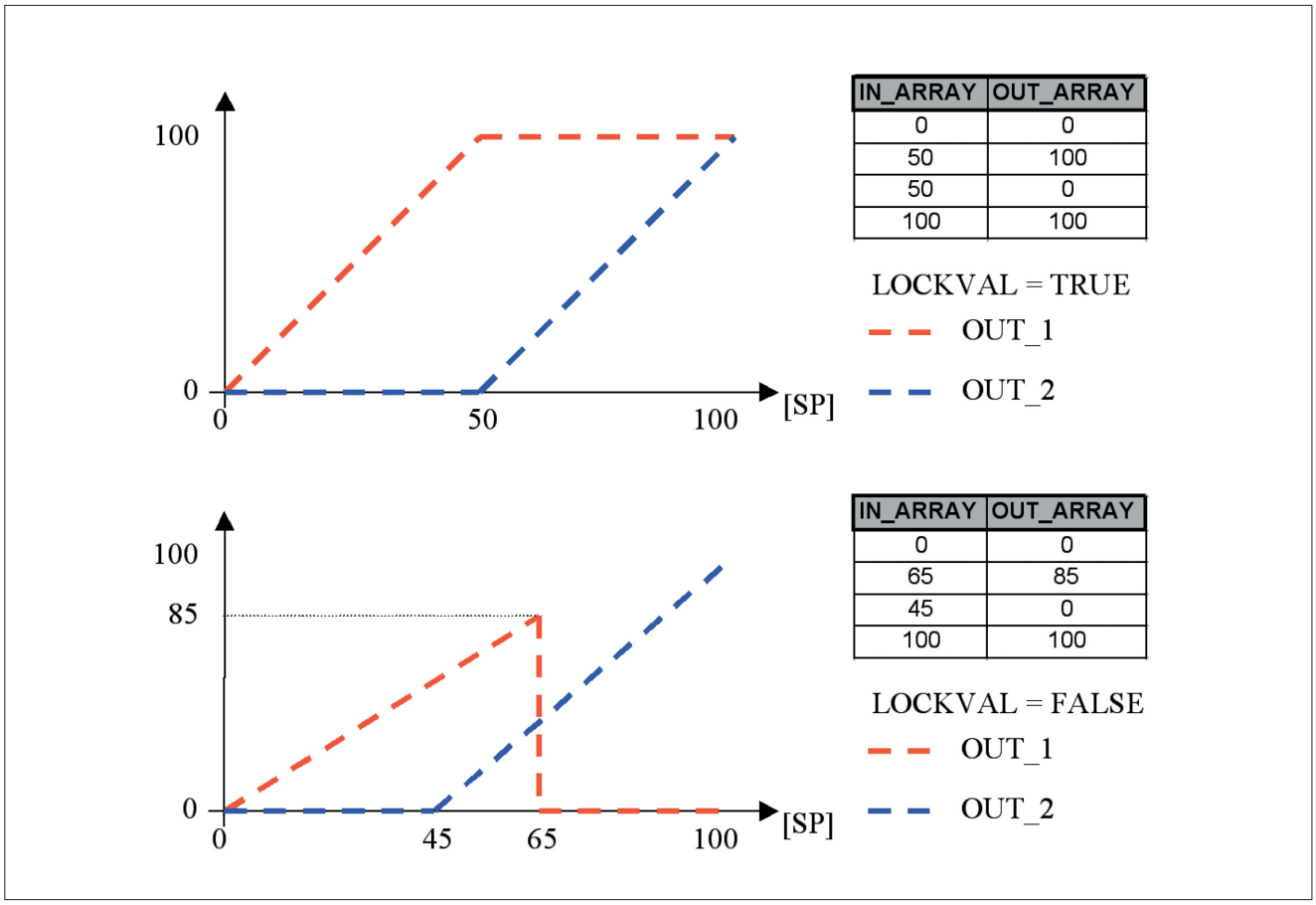

Figure 10. Function of IN_ARRAY, OUT_ARRAY and LOCKVAL.

3.13 Input selector block

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 11.

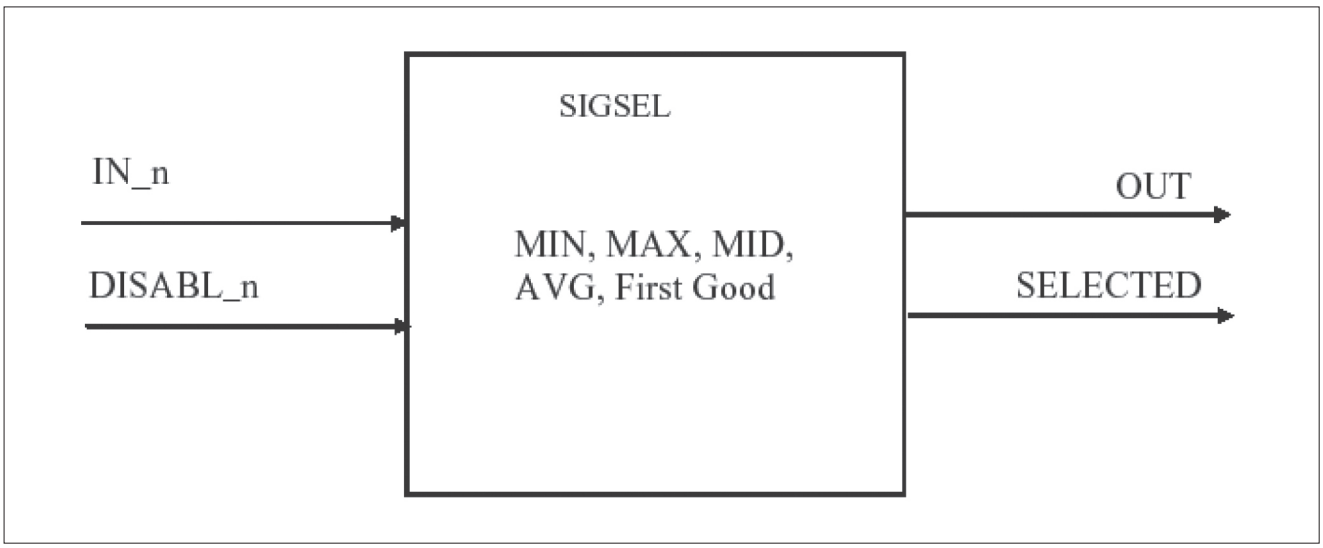

Figure 11. IS block schematic.

Parameters

The IS block parameters are presented in the table 14.

Table 14

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.
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.

IS 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 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 capable 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 linking device acts as a LAS for the segment. There may be one or more spare LAS devices.

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

The NDX FF 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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