FIELDBUS - smar

First in Fieldbus

Function Blocks Instruction Manual

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INTRODUCTION

Fieldbus is not a replacement for 4-20 mA or Intelligent/Smart Transmitter Protocols, it provides much more. Fieldbus is a complete Control System Architecture enabling distribution of the control function to equipment in the field; therefore it is a replacement for the DCS Architecture of the 1970s.

To achieve the desired control the devices must be configured. That includes calibration but also building of a control strategy. The latter is covered in this manual.

One of the major advantages of Fieldbus is interoperability. Some blocks described in this manual are used not only by Smar devices, but other Foundation Fieldbus devices too. No particular configuration tool is addressed in this manual, because the devices are independent of configuration tool due to the DD technology.

Get the best results of the Fieldbus System by carefully reading these instructions.

This manual presents the necessary background knowledge to understand the programming language of Function Blocks diagram focusing on Foundation Fieldbus technology.

Besides that, it is explained in details blocks supported by the following devices:

- LD292/LD302
- TT302
- IF302
- TP302
- FY302
- FP302
- FI302
- FB-700
- DC302
- DFI302
- HI302 (all types)
- DT302
- FR302

Other Smar devices, that are members of System302, may not be covered by this manual, because they have specific manuals.

TABLE OF CONTENTS

DEFINITIONS

Term	Description
Alarm	Detection when the block leaves a particular status and when it returns to this status.
Alert	Alarms and Events.
Critical Alert	Alert object with priority from 8 to 15.
Algorithm	Rule set for problem solution following some steps
Application	Software functional unit which consists of a set of interconnected function blocks, events and objects, that can be distributed, have interfaces with their applications and posses other applications.
Array	Array with all elements that are of the same type and each one can be uniquely referenced by a subscript reference.
Attribute	Property or characteristic of an entity for instantiation. Value and status are attributes for an output parameter.
Bitstring	Data type which consists of a bit array. Each bit corresponds to a specific characteristic that is allowed to the user make a composition of some bits (some characteristics at the same time).
Function Block	Block which consists of one or more input or output parameters.
Block or block instantiation	Software logic processing unit which consists of a single copy named of the block and of the specific parameters associated by the block type, it can have several PID block instantiations, for example.
Transducer Block	Block which consists of internal parameters that provide an interface for one or more function abilities for a resource.
Bypass	This parameter indicates a deviation, normally from the input to the block output, without passing through the algorithm. In the PID block, for example, it means the SP goes to the output.
Configuration (of a system or device)	Steps for a system: selecting function units, indicating their positions and identifiers, and defining their interconnections.
Constant status	Status attribute which has both the indications for high and low limits, used to indicate the lower block can not respond to the output of the higher block.
Dd Item Id	A unique number which identifies the description of the object class associated, that is developed as part of the Equipment Description.
Dd member Id	A unique number which identifies the function of the object class associated, that is developed as part of the Equipment Description.
Device	Physical entity able to perform one ou more specific functions into a particular context and delimited for its interfaces.

Term	Description
Download	Function which consists of loading data from the client to the server.
Primary Input	Input parameter which is critical for the operation of the control or calculation function block. The value of the primary input can be reflected in the parameter of the process variable.
Schedule	Order of the function block execution.
Data Structure	A set, whose elements need to be of the same data type and each one can be referenced uniquely by an identification
Event	Instantaneous occurrence that is important to schedule the algorithm execution.
Execution	Process of executing an operation sequence for an algorithm.
Feed forward	Process antecipation.
Interface	Limit shared between two function units, defined by the function characteristics, common physic interconnection characteristics, signal characteristics, and other adequated characteristics
Interoperability	Capacity to operate multiple equipment, regardless of the manufacturer, in the same system, without losing the functionality.
Invocation	Process of starting the sequence execution od specific operations for an algorithm.
Link	Connection between two devices.
Target Mode	Mode reached by user for the block acts.
Multi-Variable Container (MVC)	Object in the Function Block Application Process refered to a group of Function Block parameters defined by user, that can be one or more function blocks in the equipment.
Action Object (action)	Object that supports object instantiation and exclusion (blocks or links) in the resource.
Input Parameter	Block parameter that has data structure of value and status elements that can be updated through link for the output parameter.
Output Parameter	Block parameter which has data structure of value and status elements that can be updated through the block algorithm.
Container Parameter	Block parameter that is accessible in the communication network but can not be connected to the input or output parameter. The value of the parameter can be used in the block algorithm or written by the block algorithm.
Resource	Internal function unit of the equipment that has the control, independent of the operation, and provides characteristics needed for scheduling and execution of application algorithms (resource).
Resource block	Block which consists of internal parameters that provide the interface for common resource characteristics or information.

Term	Description
Primary Output	Output parameter which depends on the mode parameter, reflects the results of the block algoritm execution or the input value given by user.
Shedding	The shedding occurs when one or other non fieldbus interface provides data periodically for the algorithm.
Time stamp	Date and time register (hour:minute:milisecond) for the alert occurrence.
Block Type	Common qualities for all type instantiations. The PID block is a block type, for example.
Data Type	Value set for a set of allowed operations.
Engineering Unit	Terms of data measuring, such as Celsius degrees, Pound, grams and others.
Upload	This function allows transmit data from server to client.
View	Data structure with the maping associtated to the sub set of block parameters. It is used for optimization of reading parameters.
BLOCK.PARAMETER	Definition used to indicate the block and the parameter associated, for example: DIAG.BEHAVIOR.

Table 1 – Definitions Table

ABREVIATIONS

- AI (Analog Input)
- AO (Analog Output)
- Cas (Cascade Mode)
- DCS (Distributed Control System)
- DD (Device Description)
- DI (Discrete Input)
- DO (Discrete Output)
- DS (Data Structure)
- EU (Engineering Unit)
- FB (Function Block)
- FF: Fieldbus Foundation
- IA (Initialization Acknowledge): status when the block is in Cascade mode
- IMan (Initialization Manual): status when the block is in Cascade mode
- IR (Initialization Request): status when the block is in Cascade mode
- LO (Local Override)
- NI (Not invited)
- RCas (Remote Cascade Mode): status when the block is in Cascade mode
- Rout (Remote Output Mode): status when the block is in Cascade mode

Chapter 1

INTRODUCTION TO FUNCTION BLOCK APPLICATION

Overview

Function block applications are defined as plant or factory applications that perform one or more automatic monitoring and control functions.

Function Block

Function blocks represent the basic automation functions performed by the function block application. Each function block processes input parameters according to a specified algorithm and an internal set of control parameters. They produce output parameters that are available for use within the same function block application or by other function block applications.

Transducer Block

Transducer blocks insulate function blocks from the specifics of I/O devices, such as sensors, actuators, and switches. Transducer blocks control access to I/O devices through a device independent interface defined for use by function blocks. Transducer blocks also perform functions, such as calibration and linearization, on I/O data to convert it to a device independent representation. Their interface to function blocks is defined as one or more implementation independent I/O channels.

Resource Block

Resource blocks are used to define hardware specific characteristics of function block applications. Similar to transducer blocks, they insulate function blocks from the physical hardware by containing a set of implementation independent hardware parameters.

Function Block Definitions

Function blocks are defined by their inputs, outputs, control parameters, and by the algorithm that operates on these parameters. Function blocks are identified using a name (Tag) and a numeric index.

Tags provide a symbolic reference to function blocks. They are unambiguous within the scope of a Fieldbus system. Numeric indices are numbers assigned to optimize access to function blocks. As opposed to function block tags, which are global, numeric indices have meaning only within the application that contains the function block.

Function block parameters define the inputs, outputs, and the data used to control function block operation. They are visible and accessible over the network. Additional parameters, called “contained within” parameters are used to define the private data of a function block. Although visible over the network, they may not participate in function block linkages.

Function Block Linkages

Function block outputs may be linked to inputs of other function blocks. Each linkage indicates that an input parameter of one function block obtains its value from specific output parameters of another function block. While function block “pull” their values from upstream blocks, which block controls the “pulling” depends on the characteristics of the underlying communications.

Two function blocks linked together may exist in the same function block application, or in separate applications, either in the same device or in different devices.

To transfer the data for a function block link, the communication channel must be known, that provide the transfer of parameter data (and other types of data) between applications.

Link with Function Block executing in DFI302

Any function block executing in DFI302 may be linked to any other function block being executed in other device connected to any of four H1 channels available.

Information Access

Function block information may be grouped for access depending on how it is to be used. The following four groups are defined for access purposes:

1) Dynamic operation data;
2) Static operation data;
3) All dynamic data, and
4) Other static data.

To support access of operator interface information during function block execution, two levels of network access are defined, one for operational traffic and one for background traffic. Operator interface traffic is transferred as background traffic to prevent it from interfering with the operation of time-critical function blocks.

Function Block Application Structure

Function block applications are modeled as a set of function blocks coordinated to execute a related set of operations. This set of operations collectively provides a single, higher level control function.

Function block model is real-time algorithm that transforms input parameters into output parameters. Their operation is controlled through the setting of control parameters.

Interoperation between function blocks is modeled by linking an input parameter of one function block to an output parameter of another. Function blocks can be bound together within and across devices. Interfaces between function blocks located in the same function block application are locally defined. Those interfaces between function blocks in different devices use the communication services.

To support function block operation, the function block architecture also provides transducer and resource blocks, and display objects.

Function Block Application Process represents the function block application as an integrated set of these components accessed to its network interface.

Block Object

A block object represents a logical processing unit composed of a set of input, processing, and control parameters and an associated algorithm.

Each block is identified by its Tag which is defined to be unique throughout the control system at one plant site. Block tags are defined as strings with a maximum length of 32 characters.

During system operation, a short hand reference, known as a numeric index is used for block access purposes. A block’s numeric index is unique only within the function block application where it exists.

The algorithm of a block is identified by its type and the revision level of its type. This information indicates how the execution of the algorithm is affected by control parameters.

Block Parameters

Parameters define the inputs, outputs, and control data for a block. Their relationship to each other and to the block algorithm is shown below.

Parameter Identifiers

Parameter names are unique within a block. Within a system, a parameter can be unambiguously identified by qualifying its name with the tag of its block. This construction is referred to as "Tag.Parameter".

The Tag.Parameter construct is used to obtain the index of a parameter. This is the second way of identifying a parameter.

Parameter Storage

Parameter attributes may be classified as dynamic, static, or non-volatile. The value of parameter attributes may need to be restored after a power failure based on its classification:

Dynamic - a parameter attribute whose value is calculated by the block algorithm and therefore does not need to be restored after a power failure.

Static - a parameter attribute which has a specific configured value that must be restored by a device after power failure. An Interface or temporary devices may write to static parameter attributes on an infrequent basis. Static parameter attribute values are normally tracked by a configuration device. To support tracking changes in static parameter attributes, the associated block's static revision parameter will be incremented and an update event will be generated each time a static parameter attribute value is modified.

Non-volatile - a parameter attribute whose value is written on a frequent basis and the last saved value must be restored by the device after a power failure. Since the values of these parameter attributes are constantly changing, they are not normally tracked by a configuration device.

The classification of a parameter attribute will determine the manner is which the attribute value is stored within a device.

Parameter Usage

Parameters are defined for a block for a specific purpose. Each is defined for use as an input, an output, or a control parameter. Control parameters are also referred to as "contained" parameters because they may not be linked with parameters in other blocks. Each type of usage is defined as follows:

Contained

A contained parameter is a parameter whose value is configured, set by an operator, higher level device, or calculated. It may not be linked to another function block input or output. The mode parameter is an example of a contained parameter common to all blocks.

Output

An output parameter is a parameter that may be linked to an input parameter of another function block. Output parameters contain status. The output status indicates the quality of the parameter value and the mode of the block when it was generated.

The value of an output parameter may not be obtained from a source external to the block. It may be generated by the block algorithm, but does not have to be.

The values of certain output parameters are dependent on the value of the mode parameter of the block. These output parameters may be referred to as mode-controlled output parameters.

Blocks whose purpose is to generate a single output contain one parameter designed as the primary output parameter. Primary outputs are used by other blocks for control or calculation purposes. These blocks also contain secondary output parameters such as alarm and event parameters that play a supporting role to the primary output parameter.

Input

An input parameter obtains its value from a source external to the block. An input parameter may be linked to an output parameter of another function block. Its value may be used by the algorithm of the block.

Input parameter values are accompanied by status. When an input parameter is linked to an output parameter, the status will be provided as the status of the output parameter. When it is not linked to an output parameter, the status will indicate that the value was not provided by an output parameter.

When an expected input parameter value is not received, the function block supported services responsible for delivering the data will set the status of the input parameter to indicate the failure.

If an input parameter is not linked to an output parameter, then it will be treated as a constant value by the function block application. The difference between unlinked input parameters and contained parameters is that input parameters have the capability to support a linkage and contained parameters do not.

Blocks whose purpose is to transform or operate on a single input will contain one parameter designed as the primary input parameter. One input parameter of some types of blocks is designated as the primary input parameter. Primary inputs are used for control or calculation purposes. These blocks may also contain secondary input parameters that support processing done on the primary input parameter.

Parameter Relationships

The execution of a block involves the inputs, outputs, contained parameters, and the algorithm of the block. The execution time for a block's algorithm is defined as a parameter of the block. Its value is dependent on how the block was implemented.

The input parameters are used by the algorithm in conjunction with the state of the function block application containing the block to determine if the algorithm can achieve the target mode established for it. The target mode is the part of the mode parameter that indicates what mode of operation is desired for the block. It is normally set by a control device or the operator.

Under certain operating condition a block may not be able to function in the requested mode. In such cases, the actual mode reflects the mode it is able to achieve. Comparison of the actual against the target indicates whether the target was achieved.

The values for the mode parameter for a block are defined by the Permitted Mode parameter. Thus, the modes available for controlling a block may vary with each block.

The values assigned to the Permitted Mode are selected from those defined by the block designer. They are assigned during block configuration for the specific use of the function block application.

Once the actual mode is determined, the block execution progresses and the outputs are generated.

Parameter Status

All input and output parameters are structures composed of status and value, but some contained parameter (internal parameter, not accessible by other blocks) have also that 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 – It 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 less than normal, but the value may still be useful.
Bad – The value is not useful.

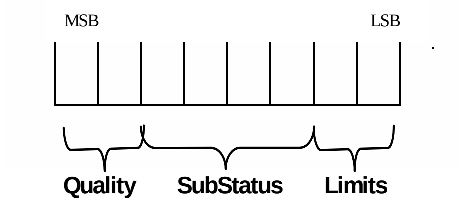
Sub-Status – The sub-status is a complement of the quality status and takes information to initialize or break a cascade control, alarms and others. There are different sets of sub-status for each quality.

Limits – It 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, and Constant.

When an input parameter is linked to an output parameter through the link object, the whole structure (status and value) is copied (local link) or received from the bus (external link). If the input is not linked, then the status may be set manually by the user, as well the value.

Composition of Status

The Status has the following composition:



The quality, sub-status, and limit components of status are defined as follows:

Quality - The quality used will be determined by the highest priority condition:
0 = Bad
1 = Uncertain
2 = Good (Non-cascade)
3 = Good (Cascade)

Sub status - Sub-status values in the status attribute are defined as shown in the following table.

Limit - The following limit conditions will be always available in the status attribute.
0 = Not limited
1 = Low limited
2 = High limited
3 = Constant

Examples:

0xC1 (in hexadecimal) is “Good-Cascade Non Specific and Low Limited” status
0xCF (in hexadecimal) is “Good-Cascade Not invited and Constant” status
0x4E (in hexadecimal) is “Uncertain Initial Value and High Limited” status

In the table below, status is shown in lowest (GoodNC - Non-specific) to highest priority (Bad - Out of Service). When multiple conditions exist which may impact status, the condition having the highest priority will determine the parameter status.

	Quality	Sub-status	Hex value	Not in cascade	Forward path of cascade	Backward path of cascade
lowest priority	Good (NC)	0 = Non-specific	0x80	X	X	
	Good (NC)	1 = Active Block Alarm	0x84	X		
	Good (NC)	2 = Active Advisory Alarm	0x88	X		
	Good (NC)	3 = Active Critical Alarm	0x8c	X		
	Good (NC)	4 = Unacknowledged Block Alarm	0x90	X		
	Good (NC)	5 = Unacknowledged Advisory Alarm	0x94	X		
	Good (NC)	6 = Unacknowledged Critical Alarm	0x98	X		
	Uncertain	0 = Non-specific	0x40	X		
	Uncertain	1 = Last Usable Value	0x44	X		
	Uncertain	2 = Substitute	0x48	X		
	Uncertain	3 = Initial Value	0x4c	X		
	Uncertain	4 = Sensor Conversion not Accurate	0x50	X		
	Uncertain	5 = Engineering Unit Range Violation	0x54	X		
	Uncertain	6 = Sub-normal	0x58	X		
	Good (C)	0 = Non-specific	0xc0		X	X
	Good (C)	1 = Initialization Acknowledge(IA)	0xc4		X	
	Good (C)	2 = Initialization Request(IR)	0xc8			X
	Good (C)	3 = Not Invited (NI)	0xcc			X
	Good (C)	4 = Not Selected(NS)	0xd0			X

	Quality	Sub-status	Hex value	Not in cascade	Forward path of cascade	Backward path of cascade
	Good (C)	6 = Local Override(LO)	0xd8			X
	Good (C)	7 = Fault State Active(FSA)	0xdc			X
	Good (C)	8 = Initiate Fault State (IFS)	0xe0		X	
	Bad	0 = Non-specific	0x00	X	X	X
	Bad	1 = Configuration Error	0x04	X	X	X
	Bad	2 = Not Connected	0x08			
	Bad	3 = Device Failure	0x0c	X	X	X
	Bad	4 = Sensor Failure	0x10	X	X	X
	Bad	5 = No Communication, with last usable value	0x14			
	Bad	6 = No Communication, with no usable value	0x18			
highest priority	Bad	7 = Out of Service	0x1c	I	I	I
X = Permitted Status; I = Initial status, (NC) = (Non-cascade), (C) = (Cascade)						

Table 1.1 – Status Composition

Example: Conversion from the Enumerations to Number

The following formula is used to obtain the enumeration number of a determinate status attribute:

Decimal Value Status = 64*Quality + 4* Sub-Status + Limit

For example, considering the following status:

"Uncertain - Initial Value - High Limited"
Where:
Quality = "uncertain" = 1
Sub-Status = "Initial Value" = 3
Limit = "High Limited "= 2
Applying the formula:
Decimal Value Status = 64 * 1 + 4 * 3 + 2 = 78 (in decimal) or 0x4E (in Hexadecimal)

Example: Conversion from Number to Enumerations

There are many forms to convert the enumerate number to the status string. Below is shown two forms to do this.

The number is expressed in binary as:
Hex Value Status = 78 = 0x4E = 01001110 (in binary)
Dividing this binary number in quality, sub-status and limit fields:
Quality = 01 = 1 = "Uncertain"
Sub-Status = 0011 = 3 = "Initial Value"
Limit = 10 = 2 = "High Limited"

The corresponding status is "Uncertain - Initial Value - High Limited".

The user must use the value of status in decimal format.
Decimal Value Status = 78

Divide the number by 64. The quotient will be the Quality and save the remainder:
Quality = 78 / 64 = 1
Remainder = 14

The remainder should be divided by 4. The quotient will be the Sub-Status and the remainder will be the limit:
SubStatus = 14 / 4 = 3
Limit = 2

Process Variable Calculation

The process variable (PV) parameter reflects the value and status of the primary input value or calculated value based on multiple inputs. The PV parameter is the IN parameter after filtering (PID and AALM), or it reflects the value from the transducer after filtering (AI and AO-readback), or the combination of two input parameters for range extension (ARTH).

The PV parameter has a status, although it is a contained parameter. This status is a copy of the primary input status or the worst status when the PV is based on multiple inputs. The PV value reflects the value of the calculated input regardless the mode of the block, unless this input is not usable, then the PV holds the last usable value.

Optionally, a filter may be applied in the process value signal, whose time constant is PV_FTIME. Considering a step change to the input, this is the time in seconds to the PV reaches 63,2% of the final value. If the PV_FTIME value is zero, the filter is disabled.

Setpoint Calculation

a) SP limits: SP_HI_LIM and SP_LO_LIM

At first, the SP will be limited to a range specified by the SP_HI_LIM and SP_LO_LIM parameters **only in Auto mode**. However in the PID block, if the bit “Obey SP limits if Cas or Rcas” in CONTROL_OPTS parameter is true, then the setpoint value will be also restricted to setpoint limits in Cas and RCas mode.

b) SP rate limits: SP_RATE_UP and SP_RATE_DN

These parameters avoid bump in SP change, and they depend on the block type as well the mode to be effective. The SP rate limits are applied for the PID block in Auto mode, and AO block in Auto, Cas or Rcas modes.

When the block is in Auto mode and the user change the SP to a value greater than the current value, then the SP value ramps upward based on the SP_RATE_UP parameter. If the new setpoint is less than the current value, the SP value ramps downward based on the SP_RATE_DN. When the SP_RATE_DN and/or SP_RATE_UP is zero the rate limiting is disabled.

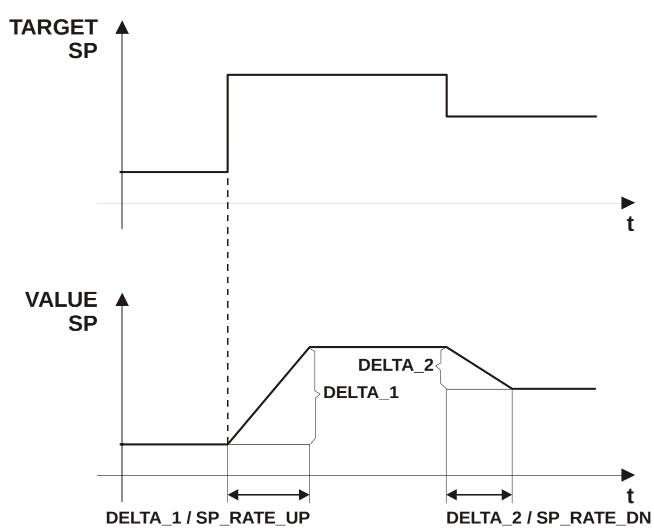


Figure 1.1 – Example SP Rate Limits

The below table summarizes the conditions for SP limits and SP rate limits.

Block type	Mode	Required configuration for SP limits (SP_HI_LIM/SP_LO_LIM)	Required configuration for SP rate limits (SP_RATE_UP/SP_RATE_DN)
PID	Auto	None	SP_RATE_UP / SP_RATE_DN different of zero
	Cas/Rcas	CONTROL_OPTS.“Obey SP limits if Cas or Rcas” is true	Not apply
AO	Auto	None	SP_RATE_UP / SP_RATE_DN different of zero
	Cas/Rcas	Not apply	SP_RATE_UP / SP_RATE_DN different of zero.

Table 1.2 – Summary Conditions for SP Limits and Rate Limits

c) SP tracking PV

Some control strategies require that the transition from a “manual” mode (Rout, Man, LO and Iman) to an “auto” mode (Auto, Cas, Rcas) must be done with error equals to zero, therefore SP must be equal to PV.
The CONTROL_OPTS of the PID block and the IO_OPTS of the AO block may be configured for SP tracking PV when the block is in a “manual” mode.

This option is summarized in the following table:

Bitstring	CONTROL_OPTS (PID)	IO_OPTS (AO)	Meaning
SP-PV Track in Man	X	X	The SP tracks the PV when the target mode is Man.
SP-PV Track in Rout	X		The SP tracks the PV when the actual mode is Rout.
SP-PV Track in LO or Iman	X	X	The SP tracks the PV when the actual mode is LO or Iman.

Table 1.3 – Summary Conditions for SP Tracking PV

Output Calculation

When the actual mode is AUTO, CAS or RCAS, the normal algorithm is executed. This calculation is specific for each function block type. If the mode is a “manual” mode, the output is just following a value provided by another block (LO, Iman), the user (Man) or a Control Application running on an interface device (Rout).

The output value is limited high and low by the OUT_HI_LIM and OUT_LO_LIM parameters in PID and ARTH blocks for all modes.
It is possible to disable the output limits in Manual mode in the PID block by setting “No OUT limits in Manual” bit in CONTROL_OPTS.

Cascade Control

There is a linked output and input pair involved in each of the different forms of cascade, as shown in the following table.

Mode	Forward	Backward
Cas	CAS_IN	BKCAL_OUT
RCas	RCAS_IN	RCAS_OUT
ROut	ROUT_IN	ROUT_OUT

Table 1.4 – Parameter Pairs

In a cascade, the upper control block provides an output value and status, which becomes the cascade input to the lower block.

The lower block in the cascade provides an output value, which is communicated to the upper block as back-calculation input.

Based on the following example, which is the most common form of cascade, it will be shown the process of cascade initialization.

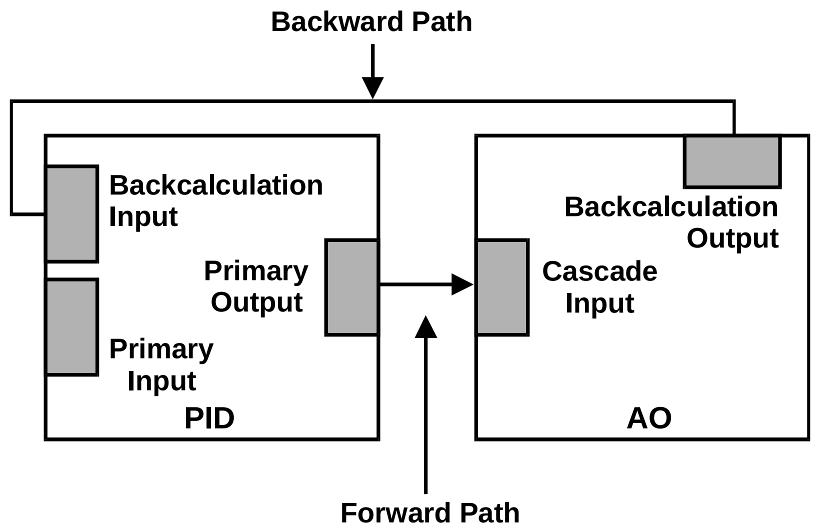


Figure 1.2 – Cascade Common Form

There are four steps to complete a cascade initialization:
1. Not cascade mode – As the AO block is in Auto mode, the PID block is not calculating the output (OUT), it is just following the backward value (AO.BKCAL_OUT -> PID.BKCAL_IN).

PID
MODE_BLK.Target = Auto
MODE_BLK.Actual = IMan
OUT.Status = GoodC-Non-specific

AO
MODE_BLK.Target = Auto
MODE_BLK.Actual = Auto
BKCAL_OUT.Status = GoodC-Not Invited

2. Initialize – The user changes the target mode of AO block to Cas, then the AO block sets GoodC-IR in BKCAL_OUT. The value of BKCAL_OUT is the initial value for the PID starts to calculate.
The AO block waits for the PID to set GoodC-IA in OUT, which is linked to AO.CAS_IN (PID.OUT -> AO.CAS_IN).

PID
MODE_BLK.Target = Auto
MODE_BLK.Actual = IMan
OUT.Status = GoodC-Non-specific

AO
MODE_BLK.Target = Cas
MODE_BLK.Actual = Auto
BKCAL_OUT.Status = GoodC-Initialization Request (IR)

3. Initialization complete – The AO block goes to Cas, because the PID block sent GoodC-IA.

PID
MODE_BLK.Target = Auto
MODE_BLK.Actual = IMan
OUT.Status = GoodC- Initialization Acknowledge (IA)
AO

MODE_BLK.Target = Cas
MODE_BLK.Actual = Cas
BKCAL_OUT.Status = GoodC- Non-specific

4. Cascade complete – The PID block changes the status of OUT from GoodC-IA to GoodC-NS.

PID
MODE_BLK.Target = Auto
MODE_BLK.Actual = Auto
OUT.Status = GoodC- Non-specific

AO
MODE_BLK.Target = Cas
MODE_BLK.Actual = Cas
BKCAL_OUT.Status = GoodC- Non-specific

Notes:

- The remote cascade modes (Rcas and Rout) have a similar mechanism to the process of cascade initialization.
- The function blocks prepared to work as the upper block in the cascade have the BKCAL_IN parameter, as PID, SPLT, SPG and OSDL
- The function blocks prepared to work as the lower block in the cascade have the BKCAL_OUT parameter, as PID, AO, SPLT and OSDL.
- The upper blocks will be in Iman mode when the lower block is not in cascade, whose main reasons are:
  - Link failure in backward path (lower.BKCAL_OUT -> upper.BKCAL_IN)
  - Lower block can not execute in Cas: the target mode of lower block is not Cas, or there is any condition forcing the lower block to a higher priority mode as fault state (AO in LO), link failure in the forward path (OUT -> CAS_IN).
  - Tracking (PID in LO), link failure in the primary input (PID in Man), and others. (See details in the section Mode Parameter).
  - Control Application running on as interface device works similarly an upper block in the remote cascade modes (Rcas and Rout).

Mode Parameter

a) Mode types

The operation of the block is summarized for each mode type as follows:

Out of Service (O/S):
The block is not being evaluated. The output is maintained at last value or, in the case of output class function blocks, the output may be maintained at an assigned Fault State value – last value or configured Fault State value. Setpoint is maintained at last value.

Initialization Manual (IMan):
This mode means that the downstream block is not in cascade (Cas mode), therefore the normal algorithm must not be executed and the block output will just follow an external tracking signal (BKCAL_IN) coming from the downstream block. This mode cannot be requested through the target mode.

Local Override (LO):
It applies to control block that supports a track input parameter, when the control block is LO, its output is tracking the TRK_VAL input parameter.
The LO mode also applies to output block when it is in fault state. This mode cannot be requested through the target mode.

Manual (Man):
The block output is not being calculated, although it may be limited. The operator may set directly the outputs of the block.

Automatic (Auto):
The normal algorithm calculates the block output. If the block has a setpoint, it will be used a local value that may be written by an operator through an interface device.

Cascade (Cas):
The setpoint comes from another block over a link (CAS_IN), therefore the operator cannot change the setpoint. The normal algorithm calculates the block output based on that setpoint. In order to achieve this mode, the algorithm uses the CAS_IN input and BKCAL_OUT output to establish the cascade with the upstream block in a bumpless way.

Remote Cascade (RCas):
The block setpoint is being set by a Control Application running on an interface device to the RCAS_IN parameter. The normal algorithm calculates the block output based on that setpoint, so the block running in Rcas works similarly a "lower block" in cascade. In order to achieve this mode, the block algorithm uses the RCAS_IN and RCAS_OUT to **establish a relation like a cascade** with the interface device in a bumpless way. Therefore the Control Application works **similarly as an "upper block"**, but its algorithm is not synchronized to the schedule and neither does it use a link to transfer the setpoint to the block.

Remote Output (ROut):
The block output is being set by a Control Application running on an interface Device to the ROUT_IN parameter. In order to achieve this mode, the block algorithm uses the ROUT_IN and ROUT_OUT to **establish a relation like a cascade** with the interface device in a bumpless way. Therefore the Control Application works **similarly as an "upper block"**, but its algorithm is not synchronized to the schedule and neither does it use a link to transfer the output to the block. The block running in ROut works similarly a "lower block" in cascade.

Auto, Cas, and RCas are the "automatic" modes, which calculate the primary output using the normal algorithm. The "manual" modes are IMan, LO, Man, and ROut.

Mode type	Source of SP	Source of OUT
O/S	User	User
Iman	User	Other function block – following BKCAL_IN parameter
LO	PID / EPID / APID : User AO / DO : Fault state (last value or FSTATE_VAL)	PID / EPID / APID : Other function block – following TRK_VAL parameter AO / DO :Fault state (last value or FSTATE_VAL)
Man	User	User
Auto	User	Block algorithm
Cas	Other function block – following CAS_IN parameter	Block algorithm
Rcas	Control Application running on an interface device	Block algorithm
Rout	Block keeps last value	Control Application running on an interface device

Table 1.5 – Mode Types

b) Elements of MODE_BLK

The mode parameter (MODE_BLK) is defined in every function block. It is defined as having four elements:

1) **Target** - This is the mode requested by the operator. Only one mode from those allowed by the permitted mode parameter may be requested, that check will be done by the device.

2) **Actual** - This is the current mode of the block, which may differ from the target based on operating conditions and block configuration, as input parameter status and bypass configuration, for example. Its value is *always* calculated as part of block execution, therefore the user can not write in this attribute.

3) **Permitted** – It defines the modes that are allowed for an instance of the block. The permitted mode is configured based on the application requirement. For example, if a PID block does not have link for CAS_IN, the Cas mode should not be permitted for that block. It is like a list of mode types selected from the supported modes.

4) Normal - This is the mode which the block should be set to during normal operating conditions. The normal attribute is used as a *reminder*. It does not affect the algorithm calculation.
Execution of a function or transducer block will be controlled through the mode parameter. The user sets the target mode, which indicates what mode of operation is desired for the block. Then, the algorithm evaluates if the block can be executed in the *requested mode* (target mode) *or the nearest higher priority mode possible*. The actual mode reflects the mode of block operation.

Other concepts of mode:

Retained target: When the target mode is O/S, MAN, RCAS or ROUT the target mode attribute may retain information about the previous target mode. This information may be used by the block in mode shedding and setpoint tracking. This feature is optional and the interface device is responsible to implement it.

Supported mode: Each *block type* has a set of mode types supported, it means that *the block definition specifies* in which modes the block may operate.

c) Priority of mode

The concept of priority is used when the block calculates the actual mode, and when determining if write access is allowed for a particular mode or other of higher priority.

Mode	Description	Priority
O/S	Out of Service	7 – highest
IMan	Initialization Manual	6
LO	Local Override	5
Man	Manual	4
Auto	Automatic	3
Cas	Cascade	2
Rcas	Remote Cascade	1
Rout	Remote Output	0 - lowest

Table 1.6 – Priority of the Mode

d) Mode shedding

Interface devices such as a host computer, distributed control system (DCS) controller, or programmable logic controller (PLC) may exist which not support the function blocks application architecture but have proprietary control applications running on them.

Such applications may adjust the values of the block setpoint (RCas mode) and/or primary output (ROut mode) parameters in a function block. When doing so, they provide the value of each parameter along with its status.

If a new value is not received by the function block within a specified “update time” (defined by SHED_RCAS and SHED_ROUT parameters of the Resource block), or a bad status is received, then the function block mode will be changed to a non-remote mode of higher priority.

The SHED_OPT parameter configures the desired behavior when shedding from a remote mode (Rcas and Rout); therefore **it does not include the Cas mode**. Also, it determines if the shed mode is maintained once the RCAS_IN or ROUT_IN parameter updating is recovered (no return – target mode receives the shed mode) or original mode will be restored when the cause of shedding has cleared (normal return – no change in target mode).

The shed option has the following enumeration:

0 = Undefined – Invalid
1 = 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.

2 = Normal shed, no return – Target mode changes to the next lowest priority non-remote mode permitted. The target remote mode is lost, so there is no return to it.
3 = Shed to Auto, normal return.
4 = Shed to Auto, no return – Target mode changes to Auto on detection of a shed condition.
5 = Shed to Manual, normal return.
6 = Shed to Manual, no return – Target mode changes to Man on detection of a shed condition.
7 = Shed to Retained target, normal return.
8 = Shed to Retained target, no return (change target to retained target).

e) Mode calculation

The actual mode will be calculated based on the following:

Each mode type has some conditions that force the actual mode to be of higher priority than the target mode.

Starting from the highest priority mode (O/S), it is analyzed its corresponding conditions. If they are present, then the actual mode will be this one, otherwise it is necessary to check the conditions for the next lower priority mode (Iman, LO, Man, Auto, Cas, Rcas and Rout) till the target mode, exclusive. For instance, if the target mode is Cas, it is necessary to check the conditions for O/S, IMan, LO, Man and Auto, in this order. If all those conditions are false, the actual mode will be the target mode.

Mode	Conditions
O/S	Resource block is in O/S (resource state is Standby) - Enumerated parameter has an invalid value
IMan	BKCAL_IN.status is Bad BKCAL_IN.status is Good – Fault State Active, Not Invited or Initialization Request.
LO	Fault state is active (in an output function block) CONTROL_OPTS.Track Enable active and TRK_IN_D is active. If target is Man, then the CONTROL_OPTS.Track in Manual must be active.
Man	Target mode has just changed from O/S (Status attribute of primary input parameter (IN parameter) is Bad or Uncertain with option to treat Uncertain as Bad) and (Bypass not set). Target mode is RCas or ROut, and SHED_OPT=shed to Manual or shed to next
Auto	Target mode is Cas and (CAS_IN.status=Bad or cascade initialization not completed) Target mode is RCas and RCAS_IN.status=Bad and SHED_OPT=shed to Auto or shed to next Target mode is ROut and ROUT_IN.status=Bad and SHED_OPT = shed to Auto or shed to next.
Cas	Actual mode last execution was Cas. Target mode is Cas and cascade initialization has just completed Target mode is RCas and RCAS_IN.status=Bad and SHED_OPT=shed to next and cascade initialization has just completed Target mode is ROut and ROUT_IN.status=Bad and SHED_OPT=shed to next and cascade initialization has just completed
RCas	RCas cascade initialization has just completed or actual mode last execution was RCas.
ROut	ROut cascade initialization has just completed or actual mode last execution was ROut.

Table 1.7 – Mode Conditions

When the actual mode is different from the target, a good suggestion to find the cause is an analysis of the corresponding conditions for the actual mode. The most frequent causes are shown below.

Mode	Frequent cause
O/S	Check the Resource block mode and all enumerated parameters
Iman	Check the BKCAL_IN.status: Bad – No Comm : link failure in backward path (BKCAL_OUT -> BKCAL_IN) NI : lower block can not execute in Cas (check the target mode of lower block as well fault state condition) or link failure in forward path (OUT -> CAS_IN)
LO	Check : Value and status of TRK_IN_D, TRK_VAL and CONTROL_OPTS (Track Enable, Track in Manual) Output block : status of CAS_IN and the delay time for fault state established by FSTATE_TIME
Man	Status of IN If the target is Cas, check the links with the upper block in backward path (BKCAL_OUT -> BKCAL_IN) and forward path (OUT -> CAS_IN) If the block is not reaching the target mode Rcas or Rout, compare the updating rate of RCAS_IN and ROUT_IN by a Control Application to SHED_RCAS and SHED_ROUT.
Auto	If the target is Cas, check the links with the upper block in backward path (BKCAL_OUT -> BKCAL_IN) and forward path (OUT -> CAS_IN) If the block is not reaching the target mode Rcas or Rout, compare the updating rate of RCAS_IN and ROUT_IN by a Control Application to SHED_RCAS and SHED_ROUT.
Cas	If the block is not reaching the target mode Rcas or Rout, compare the updating rate of RCAS_IN and ROUT_IN by a Control Application to SHED_RCAS and SHED_ROUT.

Table 1.8 – Frequent Causes

f) Cascade initialization

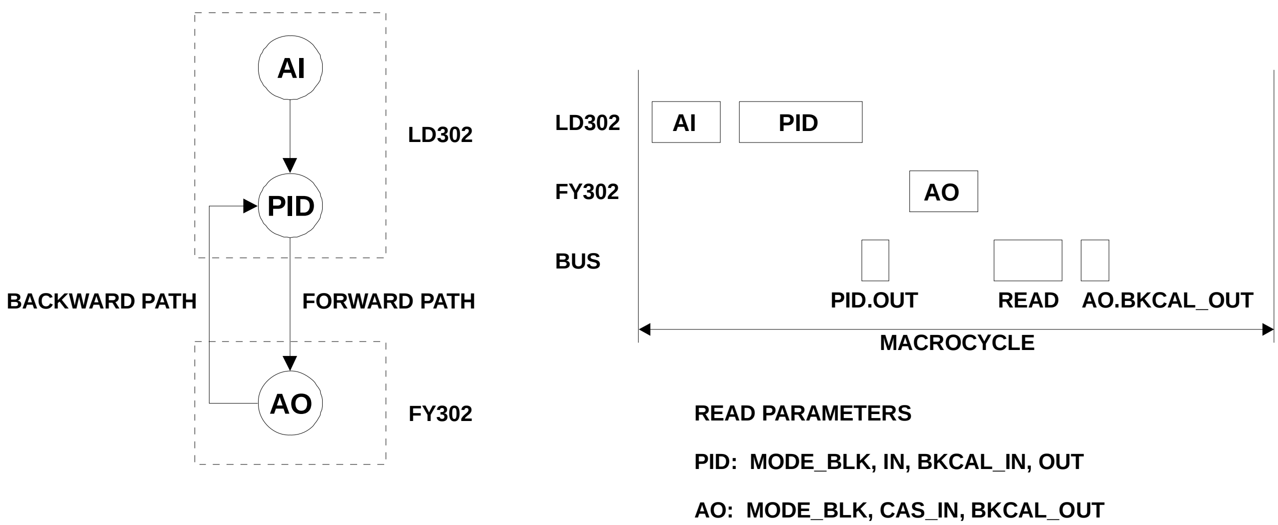


Figure 1.3 – Example of Cascade Initialization

The following table shows the sequence of status exchange between the PID and AO blocks for cascade initialization, and a link failure between PID.OUT and AO.CAS_IN (forward path) after execution 8.

PID parameters

Execution	1	2	3	4	5	6	7	8	9	10	11
Target	O/S	Auto									
IN	Bad	GNC	GNC	GNC	GNC	GNC	GNC	GNC	GNC	GNC	GNC
BKCAL_IN	Bad	Bad-O/S	NI	IR	GC	GC	GC	GC	NI	NI	NI
Actual	O/S	Iman	IMan	IMan	Auto	Auto	Auto	Auto	IMan	IMan	IMan
OUT	Bad-O/S	GC	GC	IA	GC	GC	GC	GC	GC	GC	GC

Table 1.9 – Sequence of PID execution

AO parameters

Execution	1	2	3	4	5	6	7	8	9	10	11
Target	O/S	Cas									
CAS_IN	Bad	GC	GC	IA	GC	GC	GC	Bad	Bad	Bad	Bad
Actual	O/S	Man	Auto	Cas	Cas	Cas	Cas	LO	LO	LO	LO
BKCAL_OUT	Bad-O/S	NI	IR	GC	GC	GC	GC	NI	NI	NI	NI

Table 1.10 – Sequence of AO execution

Meaning of status:
GNC – Good Non-Cascade – Non Specific
GC - Good Cascade – Non Specific
IA - Good Cascade – Initialization Acknowledge
IR - Good Cascade – Initialization Request
NI - Good Cascade – Not Invited
Bad – Bad – any sub-status

The above sequence for cascade initialization applies not only for the Cas mode, but also for Rcas and Rout modes.

g) Example

The mode configuration for the control loop of the Figure 1.3.

	Supported	Target	Actual	Permitted	Normal
AI	O/S,Man,Auto	Auto	-	O/S,Auto	Auto
PID	O/S,Iman,LO,Man,Auto,Cas,Rcas,Rout	Auto	-	O/S,Man,Auto	Auto
AO	O/S,Iman,LO,Man,Auto,Cas,Rcas	Cas	-	O/S,Man,Auto,Cas	Cas

Table 1.11 – Example of Mode Configuration

h) Specific information for driver developers

Internally, the each mode attribute is assigned within the bitstring in the following manner:

	Hex value	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
O/S	0x80	1	0	0	X	X	X	X	X
Iman & LO	-	Not Valid Target Modes							
Man	0x10	0	0	0	1	0	X	X	X
Auto	0x08	0	0	0	0	1	0	0	0
Cas	0x0c	0	0	0	0	1	1	0	0
Rcas	0x0a	0	0	0	0	1	X	1	0
Rout	0x09	0	0	0	0	1	X	0	1

***Table 1.12* – Target and Normal Mode Bitstring**

Where: X = indicates the bit setting is retained from the previous target mode.

	Hex value	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
O/S	0x80	1	0	0	0	0	0	0	0
Iman	0x40	0	1	0	0	0	0	0	0
LO	0x20	0	0	1	0	0	0	0	0
Man	0x10	0	0	0	1	0	0	0	0
Auto	0x08	0	0	0	0	1	0	0	0
Cas	0x04	0	0	0	0	0	1	0	0
Rcas	0x02	0	0	0	0	0	0	1	0
Rout	0x01	0	0	0	0	0	0	0	1

Table 1.13 – Actual Mode Bitstring

Block	Permitted modes	Hex value	O/S	-	-	Man	Auto	Cas	Rcas	Rout
AI	O/S,Auto	0x88	1	0	0	0	1	0	0	0
PID	O/S,Man, Auto	0x98	1	0	0	1	1	0	0	0
AO	O/S,Man, Auto,Cas	0x9c	1	0	0	1	1	1	0	0

Table 1.14 – Permitted Mode Bitstring

(Example for the loop control in the previous figure)

The retained target mechanism is suitable to work with toggle switch in the interface device following the rules:
A/M toggle switch:
“Automatic mode” → Man mode: Bit #4 <- 1 and Bit #3 ← 0
Man mode → “automatic mode”: Bit #4 <- 0 and Bit #3 ← 1

Cascade/Local toggle switch:

Cascade → Local: Bit #2 ←0
Local → Cascade: Bit #2 ←1

Remote/Non-remote setpoint toggle switch:
Remote → Non-remote: Bit #1 ←0 and Bit #0 ←0
Non-remote → Remote: Bit #1 ←1 and Bit #0 ←0

Remote/Non-remote output toggle switch:
Remote → Non-remote: Bit #1 ←0 and Bit #0 ←0
Non-remote → Remote: Bit #1 ←0 and Bit #0 ←1

Target mode	Rule for toggle	Value retained	Possible retained modes	Target + Retained modes
O/S : 100xxxxx	Bit #7 ←0	000xxxxx	00010000 (0x10) : Man 00001000 (0x08) : Auto 00001100 (0x0c) : Cas 00001010 (0x0a) : Rcas 00001001 (0x09) : Rout	10010000 (0x90) : Man 10001000 (0x88) : Auto 10001100 (0x8c) : Cas 10001010 (0x8a) : Rcas 10001001 (0x89) : Rout
Man: 00010xxx	Bit #4 ←0 and Bit #3 ←1	00001xxx	00001000 (0x08) : Auto 00001100 (0x0c) : Cas 00001010 (0x0a) : Rcas 00001001 (0x09) : Rout	00010000 (0x10) : Auto 00010100 (0x14) : Cas 00010010 (0x12) : Rcas 00010001 (0x11) : Rout
Rcas: 00001x10	Bit #1 ←0 and Bit #0 ←0	00001x00	00001000 (0x08) : Auto 00001100 (0x0c) : Cas	00001010 (0x0a) : Auto 00001110 (0x0e) : Cas
Rout: 00001x01	Bit #1 ←0 and Bit #0 ←0	00001x00	00001000 (0x08) : Auto 00001100 (0x0c) : Cas	00001001 (0x09) : Auto 00001101 (0x0d) : Cas

Table 1.15 – Retained Target Summary

Scaling Parameters

The scaling parameter defines the operating range and the engineering units associated with a parameter. It also defines the number of digits to the right of the decimal point, which should be used by an interface device in displaying that parameter.

Scaling information is used for two purposes. Display devices need to know the range for bar graphs and trending, as well as the units code. Control blocks need to know the range to use internally as percent of span, so that the tuning constants may remain dimensionless.

The PID blocks take the error and convert it to percent of span using the PV_SCALE. The algorithm operates on percent of span to produce an output in that form. This is converted back to a number with engineering units by using the range of OUT_SCALE.

The AI block has the XD_SCALE parameter to define the engineering units expected from the transducer.

The AO block uses the XD_SCALE to convert the SP value to the engineering unit expected by the output transducer block, which is also the engineering unit of the readback value.

The following fields form the scale:

- Engineering Units at 100% of scale - The value that represents the upper end of range in engineering unit;
- Engineering Units at 0% of scale - The value that represents the lower end of range in engineering unit;
- Units Index - Device Description units code index for the engineering unit.
- Decimal Point - The number of digits to the right of the decimal point which should be used by an interface device in displaying the specified parameter.

Example Using Scale Parameter

The PID algorithm works internally with values in percent of span. Therefore the PID block converts the error to percentage (PV_SCALE), it calculates the output in percentage, and then it converts to engineering unit of output (OUT_SCALE).

1. The PID takes the input IN and SP and converts to percentage of the PV_SCALE:

VALUE% = (VALUE – EU_0) * 100/ (EU_100 – EU_0)   [PV_SCALE]

PV_SCALE:

EU at 100% = 20
EU at 0% = 4
Units Index = mA
Decimal point = 2

SP = 15 mA
PV = 10 mA

The values of SP and PV in percentage are:
SP% = (15 – 4) * 100/(20 – 4) = 68.75%

PV% = (10 – 4) * 100/(20 – 4) = 37.50%

2. The PID algorithm calculates the error in percentage. If it is configured the reverse action, the error is the difference between SP% and PV%.
Error% = SP% - PV % = 31.25%

3. The PID algorithm applies the Error% to the calculation of the P, I and D terms. If only the proportional term is enabled, the value of the output is:
GAIN = 1.0
RESET = +INF
RATE = 0.0
OUT% = 31.25%

4. The output value is converted from percentage to engineering units of the OUT_SCALE:
OUT = OUT% /100 * (EU_100 – EU_0) + EU_0 [OUT_SCALE]

OUT_SCALE:
EU at 100% = 15
EU at 0% = 3
Units Index = psi
Decimal point = 2

The output value of this example is:
OUT = 31.25/100 * (15 – 3) + 3 = 6.75 psi

Modbus Scale Conversion

The Modbus function blocks can read and write digital and analogical data of other Modbus slave or master devices. For each configured analogical point, which for Modbus reading or writing, it is associated a scale conversion parameter. The parameters and blocks which have Modbus conversion scale are: MBCM.IN_x, MBCS.IN_x, MBCS_OUT.x, MBSM.PVALUE_x, which x=1, 2, until the point limit of that block.

The scale conversion for the Modbus protocol has two purposes:

- Conversion from the Fieldbus analogical value to Modbus value expressed in Engineering Units.
- Conversion from the Modbus analogical value to the Fieldbus value in Engineering Units.

The scale parameters are defined in the data structures DS_256, DS_257, DS_258, and DS_259 (see the item “Data Structure”) and they are composed by the following fields:

- FROM_EU_100% - defines the higher input unit value (actual data unit).
- FROM_EU_0% - defines the lower input unit value (actual data unit).
- TO_EU_100% - defines the higher output unit value (desired data unit).
- TO_EU_0% - defines the lower output unit value (desired data unit).
- Data Type – data type which it desires to convert from or to Modbus (in the Fieldbus the data always will be float). The table with the supported data type is below:

Number of Data Type	Data Type
1	Float
2	Unsigned8
3	Unsigned16
4	Unsigned32
5	Integer8
6	Integer16
7	Integer32
8	Swapped.Float
9	Swapped.Unsigned8
10	Swapped.Unsigned16
11	Swapped.Unsigned32
12	Swapped.Integer8
13	Swapped.Integer16
14	Swapped.Integer32

Table 1.16 – Data Type

Note
In despite of there are different data structures which have scale conversion, they follow the same conversion procedure.

Procedure to handle the conversion from FF parameter to Modbus variable

- Load INx_VALUE.
- Calculate Y = (A * INx_VALUE + B).
- Convert Y to DATA_TYPE_IN, generating MOD_VAR_IN.
- Write MOD_VAR_IN.

Procedure to handle the conversion from Modbus variable to FF parameter:

- Read MOD_VAR_OUT.
- Convert MOD_VAR_OUT to float, generating Y
- Calculate OUTx_VALUE = (A * Y + B).
- Store OUTx_VALUE.

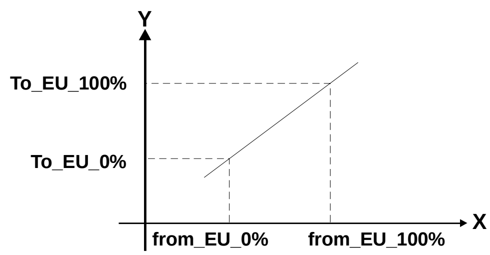


Figura 1.4 – Scale Conversion

Where:
A = (To_EU_100% - To_EU_0%)/(From_EU_100% - From_EU_0%)
B = To_EU_0% - A*From_EU_0%;
IN_VALUE, OUT_VALUE: FF parameters
MOD_VAR_IN, MOD_VAR_OUT: Modbus variables
Y: auxiliary float variable

Below, there are examples using the Modbus scale conversion.

1) Conversion from Modbus to Fieldbus

It considers a Modbus Slave device which has an analogical value of temperature in percentage (0-10000) with the data type Integer 2 bytes. It desired to use the value in Fieldbus in Celsius degree (0-500). It uses the Master Control Block Modbus (MBCM).

A) In the MBCM block, the scale is configured (OUT_1.SCALE_LOC_OUT_1) of the following form:

- FROM_EU_100% = 10000
- FROM_0% = 0
- TO_EU_100% = 500

- TO_EU_0% = 0
- DATATYPE = Integer16

B) The MBCM block reads the Modbus data from the slave and stores in MOD_VAR_OUT. Thus, it converts the Y value. For last, it calculates the OUT output using the equation OUT = A*Y+B. Using the values from the example above and considering the actual value of temperature is 6000, it has:

MOD_VAR_OUT = 6000 (value read from Modbus)

And following the equations showed above:

A = (TO_EU_100% - TO_EU_0%) / (From_EU_100% - From_EU_0%)
A = (500 – 0) / (10000 – 0) = 0.05

B = TO_EU_0% - A * From_EU_0%
B = 0 – (0.02 * 0) = 0

OUT = A * Y + B
OUT = 0.05 * Y
OUT = 0.05 * 6000 = 300

The OUT output value for this example will be:

OUT = 300 [^{o}C]

2) Conversion from Fieldbus to Modbus
It considers the DFI is the Modbus slave equipment and it desires to become available one temperature analogical value from one TT302, range 0-500 [ºC] for a Modbus master in the range 4-20 [mA] with the data type integer 2 bytes. Using the Modbus Block Control Slave (MBCS).

A) In the MBCS block, the scale is configured (IN_1.SCALE_CONV_IN_1) of the following form:

- FROM_EU_100% = 500
- FROM_0% = 0
- TO_EU_100% = 20
- TO_EU_0% = 4
- DATATYPE = Integer16

B) The MBCS block reads the data from the Fieldbus in the IN input and stores in IN_VALUE. It calculates the Y value following the equation Y = A * IN_VALUE + B. Thus, it converts the value to the DATATYPE specified and saves in MOD_VAR_IN which it will be the value to be sent to the Modbus.

Using the values from the example above and considering the actual value of temperature is 300, it has:

IN_VALUE = 300 (value read from TT302)

And following the equations showed above:
A = (TO_EU_100% - TO_EU_0%) / (From_EU_100% - From_EU_0%)
A = (20 – 4) / (500 – 0) = **0,032**

B = TO_EU_0% - A * From_EU_0%
B = 4 – (0,032 * 0) = **4**

MOD_VAR_IN = A * IN_VALUE + B
MOD_VAR_IN = 0.032 * 300 + 4
MOD_VAR_IN = 13.6

The value of the Modbus variable read (after the conversion to integer) for this example will be:

OUT = 14 [mA]

Fault State Handling

A) Definition
The Fault State is a special state that allows the output block to do safe action when it has been detected an abnormal situation or the user set to Fault State in the Resource block.
The abnormal situation occurs to there is an unusable input (bad sensor, for example) or the loss of the communication between function blocks longer than a specified time (FSTATE_TIME).

The blocks that support cascade control (as PID, OSDL and SPLT) propagate the fault state status forward to the output block.
When the condition that activated the Fault State is normalized, the Fault State is cleared and the block returns to the normal operation.

B) Generate the Initiate Fault State status (The fault was detected by the own block)
Blocks like PID, OSDL and SPLT may be configured to send an Initiate Fault State (IFS) status when they detect an unusable input. The bit "IFS if bad IN" and/or the bit "IFS if bad CAS_IN" in the STATUS_OPTS or OSDL_OPTS parameters must be true to generate an IFS status when the corresponding input is unusable.

C) Propagate the Initiate Fault State status (The fault occurred in the upstream block)
The blocks that support the cascade control have special handling to propagate the fault to the downstream blocks till the output block.

When the block, that is in cascade mode (Cas, RCas), receives an Initiate Fault State (IFS) status, then this status will be reported to forward path. For example, it considers a PID block that is receiving a "Good Cascade IFS" status in CAS_IN input. If the target mode of the PID is Cas, then the IFS status will be the status of OUT, replacing the normal status. Otherwise, the IFS status will not be propagated forward.

D) Using the Resource Block to activate the Fault State
The Fault State of the Resource block forces all output function blocks into the device to go immediately to the fault state condition. The Resource block has some parameters that define the fault state behavior:

- FEATURES_SEL – The "Fault State supported" bit is used to enable the Fault State characteristic into the Resource block. The default value is disabled.
- FAULT_STATE – It only indicates the Fault State in the Resource block, not in individual output block. For example, if an AO block is in Fault State because its CAS_IN input is bad, the FAULT_STATE parameter will not be active.
- SET_FSTATE – The user may force FAULT_STATE to active by setting this parameter to On.
- CLEAR_FSTATE – The user may force FAULT_STATE to clear by setting this parameter to On.

Fault State Active

When the Output Function Blocks detects an abnormal condition, the block goes to a fault state. The abnormal conditions are:
- Loss of communication to CAS_IN for a time that exceeds FSTATE_TIME;
- IFS status in the CAS_IN input when the target mode is Cas, for a time that exceeds FSTATE_TIME;
- IFS status in the RCAS_IN when the target mode is Rcas, for a time that exceeds FSTATE_TIME;
- The FAULT_STATE parameter of the Resource block is Active because the user set to on the SET_FSTATE parameter and the bit "Fault State supported" in the FEATURES_SEL is true.

When the output block is in the Fault State the output may retain the last value or goes to the preset value determined by the FSTATE_VAL. The default is retaining the last value. The output goes to the preset value if the bit "Fault State to value" in the IO_OPTS is true.

When the Fault State is active then the actual mode of the output block goes to Local Override (LO). In the backward path, the block sends the Not Invited (NI) status to indicate that the block is in "Fault State".

Optionally, the target mode of the output block will be changed to Manual by the block algorithm when the Fault State is active. In order to set this characteristic, the "Target to Man if Fault State activated" bit in IO_OPTS needs to be true.

Examples

The following control loop must be considered for the examples below. The below tables show the sequence of status exchange between the PID_1, The Master, PID_2 Slave and AO blocks are in a fault and normal condition.

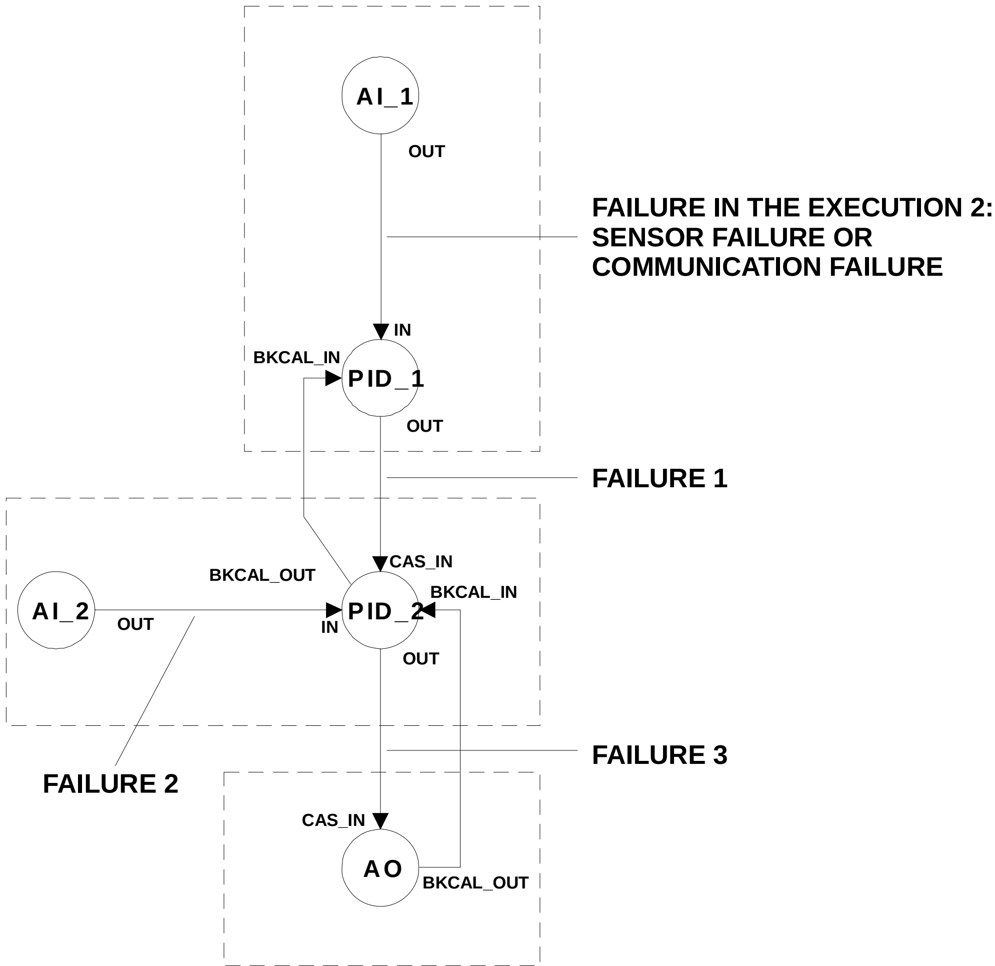


Figure 1.5 – Example of Status Propagation Failure

The status of PID_1.IN becomes bad in the execution 2, which may be due to a Bad-Sensor Failure detected by the AI_1 or a communication failure between AI_1.OUT and PID_1.IN. The PID_2 Slave only propagates the status forward. The AO block receives the IFS status and active the Fault State. In the safety condition the preset value of the FSTATE_VAL is used to the output of the AO block. After the execution 6, the bad status in the IN of the PID master is cleared and the loop returns to normal operation.

PID 1 – Master
STATUS _OPTS = “IFS if Bad IN”

Execution	1	2	…	4	5	6	7	8	9	10	11
Target	Auto										
IN	GNC	Bad	…	Bad	Bad	Bad	Bad	GNC	GNC	GNC	GNC
BKCAL_IN	GC	GC	…	GC	GC	NI	NI	NI	NI	NI	IR
Actual	Auto	Man	…	Man	Man	Iman	Iman	Iman	Iman	Iman	Iman
OUT	GC	IFS	…	IFS	IFS	IFS	IFS	GC	GC	GC	IA

PID 2 – Slave

Execution	1	2	…	4	5	6	7	8	9	10	11
Target	Cas										
CAS_IN	GC	IFS	…	IFS	IFS	IFS	GC	GC	GC	IA	GC
BKCAL_IN	GC	GC	…	GC	NI	NI	NI	IR	GC	GC	GC
Actual	Cas	Cas	…	Cas	Iman	Iman	Iman	Iman	Auto	Cas	Cas
OUT	GC	IFS	…	IFS	IFS 100	IFS 100	GC 100	IA 100	GC	GC	GC
BKCAL_OUT	GC	GC	…	GC	NI	NI	NI	NI	IR	GC	GC

AO
FSTATE_VAL = 100
FSTATE_TIME = 2 sec
IO_OPTS = “Fault State to value”
PV_SCALE (E0%-E100%)=0-100
XD_SCALE (E0%-E100%)= 4-20

2 sec
|--------------------------------|

Execution	1	2	3	4	5	6	7	8	9	10	11
Target	Cas										
CAS_IN	GC	IFS	IFS	IFS	IFS 100	IFS 100	IFS 100	GC 100	IA 100	GC	GC
BKCAL_IN	GC	GC	GC	GC 100	GC 100	GC 100	GC 100	GC 100	IA 100	GC	GC
Actual	Cas	Cas	Cas	LO	LO	LO	LO	Auto	Cas	Cas	Cas
OUT	GC	GC	GC	GC 20	GC 20	GC 20	GC 20	GC 20	GC 20	GC	GC
BKCAL_OUT	GC	GC	GC	NI	NI	NI	NI	IR	GC	GC	GC

Other link failures in the forward path could force the AO into Fault State since the configuration is as it follows:
Failure 1) **PID_1.OUT to PID_2.CAS_IN**: PID_2.STATUS_OPTS = “IFS if Bad CAS_IN”
Failure 2) AI_2.OUT to PID_2.IN: PID_2.STATUS_OPTS = “IFS if Bad IN”
Failure 3) **PID_2.OUT to AO.CAS_IN**: No configuration is required for the AO block to force it to Fault State.

Note:

- FSTATE_VAL has the same engineering unit of SP. Therefore it is using the PV_SCALE, not the XD_SCALE.
- When the Resource block forces all output blocks to Fault State, the FSTATE_TIME is not used.

Alarms and Events – Alert Processing

Alarms and events, known as alerts, represent state changes within function block applications.
In detection of a significant event, a function block may report this event to an interface device or other field devices.

Alarms refer not only to the comparison between a variable and a limit, but also what is called block alarm, that is used to report errors found in the software and/or hardware during block execution.

For alarms, both entering and exiting alarm condition are defined as an alert state, which will cause a report message to be published onto the network. The time at which the alert state was detected is included as a time stamp in the alert message. The reporting of alerts may be individually suppressed by setting the corresponding priority.

Update event is a mechanism used to inform an interface device that a static parameter was changed so the parameter is read only in this case. It is a much optimized way to keep track of such kind of parameters without doing polling, because these parameters are changed very rarely compared with dynamic parameters.

a) Alarm parameter (X_ALM parameter)

The alarm parameter is provided in a block to capture the dynamic information associated with an alarm. The information contained in the alarm parameter is transferred to an alert object when the alarm is reported. The following fields form the alarm parameter:

- Unacknowledged
- Alarm state
- Time stamp
- Subcode
- Value

Each one of these fields is explained below.

Unacknowledged

When it is detected a positive transition of alarm state (entering in alarm active), it will be set to Unacknowledged. This field is set to Acknowledged when the plant operator acknowledges the alarm through the interface device, which is responsible for alarm management.

It is possible to configure the auto-acknowledgement feature for each type of alarm for the block through the ACK_OPTION parameter. If a positive transition of alarm type happens and the corresponding bit in the ACK_OPTION is true, then it will not be required an operator plant acknowledgement.

The other form to auto-acknowledge the alarm notice is configuring the alert-priority of the respective alarm to 0, 1 or 2. The alert-priority will be discussed later.

Unacknowledged will have the following enumerations:
0 = Undefined
1 = Acknowledged
2 = Unacknowledged

Alarm state

This field gives an indication of whether the alert is active and whether it has been reported. The Alarm State will have the following bit enumeration:
1 – Clear-Reported
2 – Clear-Not Reported
3 – Active-Reported
4 – Active-Not Reported

The alarm state is cleared when the block goes to Out of service mode.

Time stamp

Time stamp is the time when the change in alarm state was detected that is unreported. This value will be maintained constant until alert confirmation has been received.

Sub code

This field contains an enumeration specifying the cause of the alert to be reported.

Value

The value of the associated parameter at the time the alert was detected.

b) Alarm limit (X_LIM parameter)

An analog alarm occurs when a value meets or exceeds a limit. For a high alarm, an alarm is true when the analog value is greater than the limit. The status of the alarm remains true until the value drops below the limit minus the alarm hysteresis.

The alarm type can be disabled setting its respective alarm limit parameter to +/- infinity, which is the default of all alarm limits.

The analog parameter compared to alarm limit depends on the block type:
PID: PV and (PV-SP), regardless of CONTROL_OPTS.Direct acting
Analog alarm: PV

AI: OUT
Setpoint generator: BKCAL_IN – OUT

c) Alarm hysteresis (ALARM_HYS parameter)

Amount the PV or OUT must return within the alarm limits before the alarm condition clears. Alarm Hysteresis is expressed as a percent of the PV/OUT span.

The span used depends on the block type:
PID: PV_SCALE
AI, Setpoint generator, Analog alarm: OUT_SCALE

d) Alert Priority (X_PRI parameter)

The alert priority is a parameter, which may be used to configure the priority value assigned to an alarm or event.

The Alert Priority can be:
0-1 – The associated alert is not sent as a notification. The priority is above 1, and then the alert must be reported. This priority is auto-acknowledged.
2 – Reserved for alerts that do not require the attention of a plant operator. Block alarm and update event have this priority. This priority is auto-acknowledged.
3-7 – Advisory Alarms. In this priority is necessary to send an acknowledged.
8-15 – Critical Alarms. In this priority is necessary to send an acknowledged.

e) Alert key (ALERT_KEY parameter)

It is an identification number of the plant unit. This information may be used in the host for sorting alarms, etc.

f) Alarm Summary (ALM_SUM parameter)

The parameter Alarm Summary summarizes the status of up to 16 process alarms of the same block. It has four attributes:

- Current Alarms - the Active status of each alarm.
- Unacknowledged - the Unacknowledged status of each alarm.
- Unreported - the Unreported status of each alarm.
- Disabled – it allows Enable/Disable each type of alarm.

Each attribute has the same bitstring described in the table 1.17.

g) ACK_OPTION parameter

Selection of whether alarms associated with the block will be automatically acknowledged.
Bit = 0 -> auto-acknowledgment disabled
Bit = 1 -> auto-acknowledgment enabled

Bit	Description	Meaning	
		Function Blocks	Resource Block
0	Unack Alarm1	Discrete alarm	Write Alm
1	Unack Alarm2	High High alarm	
2	Unack Alarm3	High alarm	
3	Unack Alarm4	Low Low alarm	
4	Unack Alarm5	Low alarm	
5	Unack Alarm6	Deviation High alarm	
6	Unack Alarm7	Deviation Low alarm	
7	Unack Alarm8	Block alarm	Block alarm
8	Unack Alarm9	Not used	
9	Unack Alarm10	Not used	
10	Unack Alarm11	Not used	
11	Unack Alarm12	Not used	
12	Unack Alarm13	Not used	
13	Unack Alarm14	Not used	
14	Unack Alarm15	Not used	
15	Unack Alarm16	Not used	

Table 1.17 – Alarm Type Bitstring Description (ACK_OPTION and ALM_SUM parameters)

The correspondent bits for each type of alarm in the ACK_OPTION are the same of that defined for ALARM_SUM except for the Resource block. The ACK_OPTION of the Resource block has a different association of bit number to alarm type from the previous table; its special meaning is described below:
Unack Alarm1 – Writes have been enabled (WRITE_ALM)
Unack Alarm8 – Block Alarm (BLOCK_ALM)

h) FEATURES_SEL parameter

It is a resource block parameter that has an element to enable/disable alert report for the whole resource, “report supported”.

i) CONFIRM_TIME parameter

A reply is required that confirms receipt of the alert notification. If the reply is not received within a time-out period (CONFIRM_TIME), the alert will be re-transmitted. It is a resource block parameter, so it is valid for all alert of that resource.

Therefore the alarm parameter is a structured object, which is defined in conjunction with other parameters:
- Enable / disable alarm evaluation:
ALARM_SUM: enable/disable each alarm type for a specific block.
X_LIM: it is possible to disable the alarm evaluation by setting the limit to +INF or –INF.

- Enable / disable alarm report:
FEATURES_SEL: setting the bit “report supported” enables alarm report for the whole resource
X_PRI: besides configuring the FEATURES_SEL, it is necessary to set the priority of alarm greater than or equal to 2 to enable the alarm report.

- Auto-acknowledgment:
X_PRI: the corresponding alarm will be auto-acknowledged if the alarm priority is 0, 1 or 2
ACK_OPTION: this parameter makes possible to enable/disable auto-acknowledgment for each alarm type, regardless the configuration of X_PRI.

The information contained in the alarm parameter is transferred to an alert object when the alarm is reported (if it is enabled) to an interface device. As an example, the following parameters are used to configure the Low Low Alarm of the PID block: LO_LO_PRI (alarm priority), LO_LO_LIM (limit parameter) and LO_LO_ALM (alarm parameter), ALARM_SUM, ACK_OPTION.

Summarizing, the function block detects the alarm condition. The communication stack is responsible to send the alert report to the interface device, which must reply to device, otherwise the alert report will be re-transmitted after a timeout defined by CONFIRM_TIME. The alarm configuration (ACK_OPTION and priority) may require that a plant operator acknowledge it even though the condition has cleared.

j) Example of analog alarm

It follows an example of AI block alarm configuration, which illustrates how is the alarm processing as well the corresponding alert report.

RS parameter:
FEATURES_SEL = Reports supported
CONFIRM_TIME = 640 000 (20 seconds, multiple of 1/32 milliseconds)

AI parameters:
ALERT_KEY = 12 (this value could be related to a boiler, for example, therefore any alert received by interface device with this alert key means an alert in that boiler)
OUT_SCALE.EU at 100% = 200
OUT_SCALE.EU at 0% = 0
HI_LIM = 190
HI_PRI = 4
ALARM_HYS = 5%
ALARM_SUM.DISABLED = Discrete, HiHi, LoLo, Lo, DevHi, DevLo, BlockAlm
ACK_OPTION = 0x00

Only the high alarm is enabled in ALARM_SUM.DISABLED and it is disabled the auto-acknowledgement (HI_PRI=4 and bit reset in ACK_OPTION), therefore it is necessary an operator plant intervention.

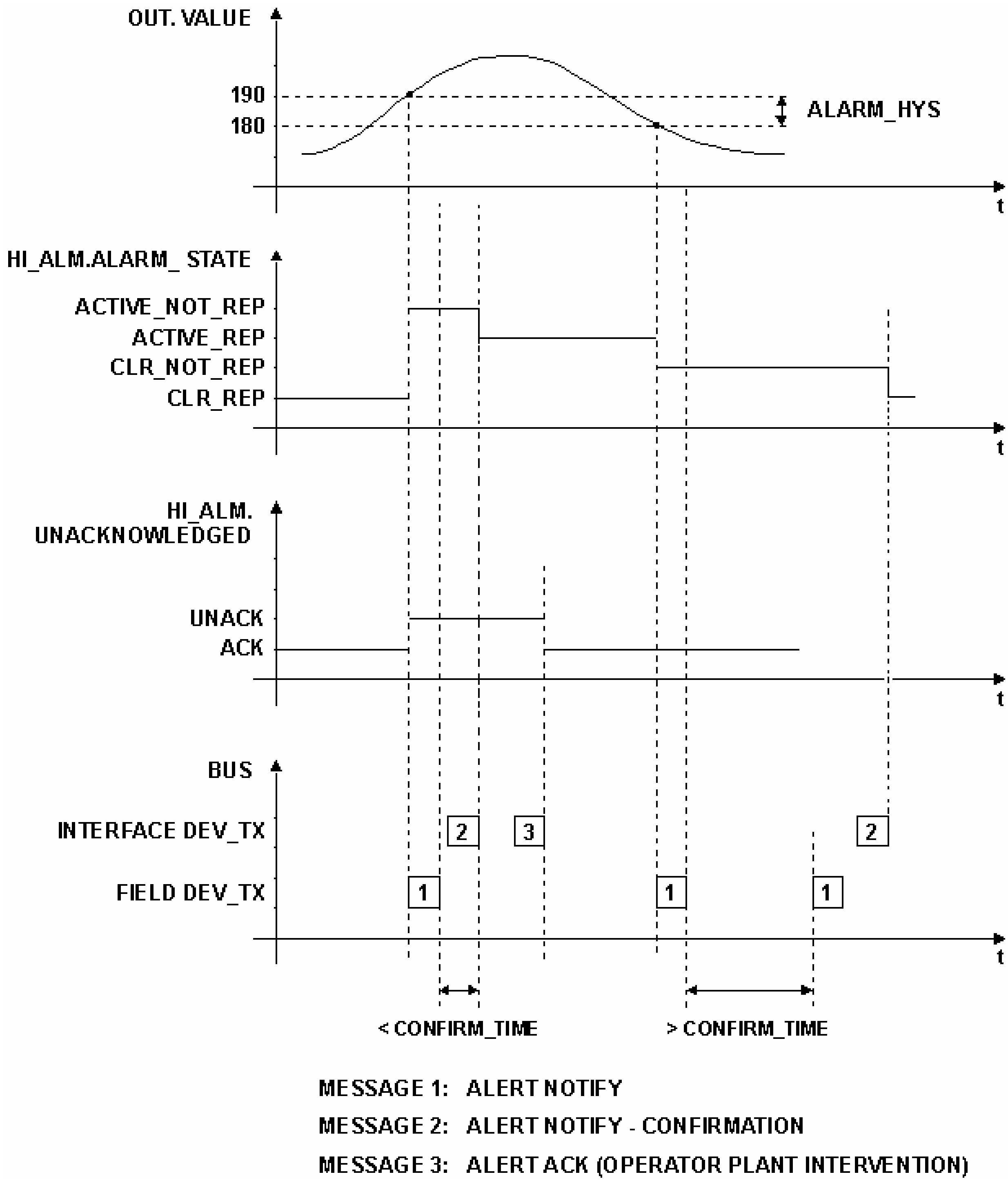


Figura 1.6 – Alert Processing

k) Block alarm (BLOCK_ALM parameter)

The block alarm is used for all configuration, hardware, connection failure or system problems in the block. These problems detected by the block algorithm are registered in the BLOCK_ERR parameter, which is a bit string, so that multiple errors may be shown.

Block error conditions is defined (0= inactive, 1 = active) as follows:

Bit	Description
0	Other (LSB)
1	Block Configuration Error
2	Link Configuration Error
3	Simulate Active
4	Local Override
5	Device Fail Safe Set
6	Device Needs Maintenance Soon
7	Input Failure/ process variable has BAD status
8	Output Failure
9	Memory Failure
10	Lost Static Data
11	Lost NV Data
12	Readback Check Failed
13	Device Needs Maintenance Now
14	Power-up
15	Out-of-Service (MSB)

Table 1.18 – Block_Err Bitstring Description

The cause of the alert is entered in the Subcode field of BLOCK_ALM, for example, value 3 means Simulate Active. The first condition to become active will set to Active the Alarm State attribute, if other conditions also become active, no alert will be sent. When all conditions become inactive, then an alert with Clear will be reported.

Block alarm has a fixed priority of 2, therefore it is auto-acknowledged (no operator plant intervention is required).

l) Update Event (UPDATE_EVT parameter)

The update event parameter is provided in a block to capture the dynamic information associated with a write to a static parameter within the block. An update alert object transfers the information contained in the update event parameter when the alert is reported.

The index of the changed parameter (relative to the start of the function block in the OD) and the new static revision level (ST_REV) are also included in the alert message.

Update event has a fixed priority of 2, therefore it is auto-acknowledged (no operator plant intervention is required).

Simulation

All input and output class function blocks have a SIMULATE or SIMULATE_D or SIMULATE_P parameter, which has a pair of status and values, and an enable switch. This parameter acts as a switch at the interface between the I/O function block and the associated transducer block or hardware channel.

Enable simulation
The simulate jumper must be ON to enable simulation in the SIMULATE (SIMULATE_D or SIMULATE_P) parameter.

The BLOCK_ALM and BLOCK_ERR parameters will show the simulation condition (enable or disable). Such parameters in the Resource Block (RS) will indicate the condition of simulate jumper, while in the Input/Output Function Blocks they will indicate the enable switch condition in the SIMULATE (SIMULATE_D or SIMULATE_P) parameter.

Simulation disabled
When disabled, the SIMULATE. Simulate Value and Status will track SIMULATE. Transducer Value and Status in order to provide a bumpless transfer from disabled to enabled. The parameter will always initialize to disabled and will be stored in dynamic memory.

Input Function Block (AI, DI, PUL)
The SIMULATE. Transducer Status and SIMULATE.Transducer Value come from the transducer block or input channel, and contain what will be sent to the input block if the switch is off (disabled). The SIMULATE.Simulate Value and SIMULATE.Simulate Status are presented to the input block when the enable switch is on, and the transducer block or input channel is ignored. The status can be used to simulate transducer faults. The transducer value and status will always be written with transducer data at each evaluation of the input function block.

Simulation Condition	Action
Enable	SIMULATE.Simulate Value and Status -> PV (after scaling, linearization and filtering)
Disable	SIMULATE.Transducer Value and Status -> PV (after scaling, linearization and filtering) and SIMULATE.Simulate Value and Status

Table 1.19 – Summary of Simulate Actions for Input Blocks

Output Function Block (AO, DO)
The SIMULATE.Simulate Value and SIMULATE.Simulate status become the READBACK value and status when the enable switch is on, 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 and the transducer maintains last output and ignores the OUT of the Output block.

Simulation Condition	Action
Enable	SIMULATE.Simulate Value and Status -> READBACK
Disable	SIMULATE.Transducer Value and Status -> READBACK and SIMULATE.Simulate Value and Status

Table 1.20 - Summary of Simulate Actions for Output Blocks

CHANNEL Configuration

The CHANNEL parameter configuration depends on the device features as it follows:

a) Fixed I/O device: This type of device has a fixed number of I/O. All Smar field devices belong to this class.
The channel is numbered from 1 to the maximum number of I/O.

The DC302 has specific rules to set the CHANNEL parameter as it follows:
- DI and DO Blocks: group A has inputs numbered from 1 to 8 and group B has inputs numbered from 9 to 16.

- MDI and MDO Blocks: the whole group A is selected setting CHANNEL to 1, and group B to 2.

b) Configurable I/O device: The user may configure the number of I/O modules as well the I/O type (input or output, discrete, analog, pulse…). The DFI302 is the only device classified as a configurable I/O device.
All I/O modules have the I/O points arranged as it follows:

- Point (P): Ordinal number of I/O point in a group, it is numbered from 0 (first point) to 7(last point in the group), and 9 means the whole group of points. The whole group may have 4 or 8 points of I/O.

- Group (G): Ordinal number of group in the specified I/O module, it is numbered from 0 (first group) till number of groups minus 1. The I/O points are arranged in groups of 8 points, regardless how they are grouped for electrical isolation.
If the I/O type is “8- discrete input/4- discrete output”, the inputs belong to the group 0 and the

outputs belong to the group 1.

- Slot (S): One slot supports one I/O module, and it is numbered from 0 (first slot in the rack) till 3 (last slot in the rack).

- Rack (R): Each rack has four slots. The rack is numbered from 0 (first rack) till 14 (last rack).

Therefore a single I/O point in the DFI302 may be identified by specifying the rack (R), slot (S), group (G) and point (P). As the CHANNEL parameter in the multiple I/O blocks (MIO) must specify the whole group (8 points), the point must be 9, which mean the whole group.

The value in the CHANNEL parameter is composed by those elements in the following form: RRSGP.

For example, a CHANNEL parameter equals to 1203, it means rack 1, slot 2, group 0 and point 3. If CHANNEL parameter of a MAI block is 10119, it means rack 10, slot 1, group 1 and point 9 (whole group).

Before setting the CHANNEL parameter, it is recommended to configure the hardware in the HC block. Because the write check will verify if the I/O type configured in the HC block is suitable for block type. Therefore setting the CHANNEL parameter of AI block to access an I/O type different of analog input will be rejected.

Block Instantiation

Before explaining block instantiation it is better to clarify some concepts:

Block type: It is an algorithm to process the input parameters based on the configuration in the contained parameters, then it generates the outputs. It includes also method to write/read the parameters, DD and others. Indeed all this information are stored in Flash memory of device, therefore one device type has a predefined set of block type available in its firmware.

Block (block instance): It is a block type associated to a database where the block parameters are stored (RAM and non-volatile memory).

Action Object: Through the action object, a block may be instantiated (created) or deleted. Before instanting a block, it will be checked if the device supports the specified block type as well if there is available RAM and non-volatile memory to store the parameters.

All Smar devices support block instantiation and the Block Library (set of block type) for each type of device is shown in the item “Block type availability and initial block set”.

Order of Parameters during Download

Some block parameters have a write check based on the value of others parameters. Such relationships are shown in the block parameter table of each block type in the columns “Valid Range” and “Store/Mode”.

It follows the most common parameter relationship used in write check:
- It is required a mode to write the parameter.
- The valid range depends on a scale parameter
- For configurable I/O device, the CHANNEL parameter depends on the hardware configuration in the HC block.

Due to these relationships between parameters in the write check, some times it is necessary to take care about the order of parameters during a download of configuration.

The Smar configuration tool Syscon always sends the command to write in the MODE_BLK parameter as last one for that block, it is enough to avoid a lot of problems in the download. The user must observe the other cases and may change the parameter order easily using drag and drop in Syscon.

Data Type and Data Structure Definition

In this section are defined every data structure and data types used in the system.

Object Index	Data Type	Description
1	Boolean	True or false
2	Integer8	1 byte
3	Integer16	2 bytes
4	Integer32	4 bytes
5	Unsigned8	1 byte
6	Unsigned16	2 bytes
7	Unsigned32	4 bytes
8	FloatingPoint	*
9	VisibleString	They are one byte per character, and include the 7 bit ASCII character set.
10	OctetString	Octet strings are binary.
11	Date	Date and hour – 7 bytes
12	TimeofDay	Time in millisecond elapsed in the day – 6 bytes
13	TimeDifference	Time difference – 6 bytes
14	BitString	*
21	TimeValue	Integer – 8 bytes It represents the date/hour to synchronize the clock.

Table 1.21 – Data Type and Data Structure Definition

- Date:
  - Date (3 bytes) – Format#Year#Month#(Week Day and Month Day)
  - Hour (4 bytes) – Format: HH#MM#MSEG

- TimeofDay:
  - Time (4 bytes) – It counted in milliseconds from the Zero hour of the day.
  - Date (3 bytes) – It counted in days related to the January, 1, 1984.

- TimeDifference: The structure is the same of the TimeofDay.
- TimeValue: It used to represent Date and Hour to synchronize the clock. It is an integer with 8 bytes in the base of 1/32 milliseconds.

Block Structure – DS-64

This data structure consists of the attributes of a block.

E	Element Name	Data Type	Size
1	Block Tag	VisibleString	32
2	DD MemberId	Unsigned32	4
3	DD ItemId	Unsigned32	4
4	DD Revision	Unsigned16	2
5	Profile	Unsigned16	2
6	Profile Revision	Unsigned16	2
7	Execution Time	Unsigned32	4

E	Element Name	Data Type	Size
8	Period of Execution	Unsigned32	4
9	Number of Parameters	Unsigned16	2
10	Next FB to Execute	Unsigned16	2
11	Starting Index of Views	Unsigned16	2
12	NumberofVIEW_3	Unsigned8	1
13	NumberofVIEW_4	Unsigned8	1

Value & Status - Floating Point Structure – DS-65

This data structure consists of the value and status of floating point parameters that are Inputs or Outputs.

E	Element Name	Data Type	Size
1	Status	Unsigned8	1
2	Value	Float	4

Value & Status - Discrete Structure – DS-66

This data structure consists of the value and status of discrete value parameters.

E	Element Name	Data Type	Size
1	Status	Unsigned8	1
2	Value	Unsigned8	1

Scaling Structure – DS-68

This data structure consists of the static data used to scale floating point values for display purposes.

E	Element Name	Data Type	Size
1	EU at 100%	Float	4
2	EU at 0%	Float	4
3	Units Index	Unsigned16	2
4	Decimal Point	Integer8	1

Mode Structure – DS-69

This data structure consists of bit strings for target, actual, permitted, and normal modes.

E	Element Name	Data Type	Size
1	Target	Bitstring	1
2	Actual	Bitstring	1
3	Permitted	Bitstring	1
4	Normal	Bitstring	1

Access Permissions – DS-70

This data structure consists of access control flags for access to block parameters.

E	Element Name	Data Type	Size
1	Grant	Bit String	1
2	Deny	Bit String	1

Alarm Float Structure – DS-71

This data structure consists of data that describes floating point alarms.

E	Element Name	Data Type	Size
1	Unacknowledged	Unsigned8	1
2	Alarm State	Unsigned8	1
3	Time Stamp	Time Value	8
4	Subcode	Unsigned16	2
5	Value	Float	4

Alarm Discrete Structure – DS-72

This data structure consists of data that describes discrete alarms.

E	Element Name	Data Type	Size
1	Unacknowledged	Unsigned8	1
2	Alarm State	Unsigned8	1
3	Time Stamp	Time Value	8
4	Subcode	Unsigned16	2
5	Value	Unsigned8	1

Event Update Structure – DS-73

This data structure consists of data that describes a static revision alarm.

E	Element Name	Data Type	Size
1	Unacknowledged	Unsigned8	1
2	Update State	Unsigned8	1
3	Time Stamp	Time Value	8
4	Static Revision	Unsigned16	2
5	Relative Index	Unsigned16	2

Alarm Summary Structure – DS-74

This data structure consists of data that summarizes 16 alerts.

E	Element Name	Data Type	Size
1	Current	Bit String	2
2	Unacknowledged	Bit String	2
3	Unreported	Bit String	2
4	Disabled	Bit String	2

Simulate - Floating Point Structure – DS-82

This data structure consists of simulate and transducer floating point value and status and a simulate enable/disable discrete.

E	Element Name	Data Type	Size
1	Simulate Status	Unsigned8	1
2	Simulate Value	Float	4
3	Transducer Status	Unsigned8	1

E	Element Name	Data Type	Size
4	Transducer Value	Float	4
5	Simulate En/Disable	Unsigned8	1

Simulate - Discrete Structure – DS-83

This data structure consists of a simulator, and discrete value and status transducer, and a discrete enable/disable simulator.

E	Element Name	Data Type	Size
1	Simulate Status	Unsigned8	1
2	Simulate Value	Unsigned8	4
3	Transducer Status	Unsigned8	1
4	Transducer Value	Unsigned8	4
5	Simulate En/Disable	Unsigned8	1

Test Structure – DS-85

This data structure consists of function block test read/write data.

E	ElementName	DataType	Size
1	Value1	Boolean	1
2	Value2	Integer8	1
3	Value3	Integer16	2
4	Value4	Integer32	4
5	Value5	Unsigned8	1
6	Value6	Unsigned16	2
7	Value7	Unsigned32	4
8	Value8	FloatingPoint	4
9	Value9	VisibleString	32
10	Value10	OctetString	32
11	Value11	Date	7
12	Value12	Time of Day	6
13	Value13	Time Difference	6
14	Value14	Bitstring	2
15	Value15	Time Value	8

Discrete Structure – DS-159

This data structure consists of one status and eight discrete value parameters.

E	Element Name	Data Type	Size
1	Status	Unsigned8	1
2	Value1	Unsigned8	1
3	Value2	Unsigned8	1
4	Value3	Unsigned8	1
5	Value4	Unsigned8	1
6	Value5	Unsigned8	1
7	Value6	Unsigned8	1

E	Element Name	Data Type	Size
8	Value7	Unsigned8	1
9	Value8	Unsigned8	1

Discrete Structure – DS-160

This data structure consists of one status and sixteen discrete value parameters.

E	Element Name	Data Type	Size
1	Status	Unsigned8	1
2	Value1	Unsigned8	1
3	Value2	Unsigned8	1
4	Value3	Unsigned8	1
5	Value4	Unsigned8	1
6	Value5	Unsigned8	1
7	Value6	Unsigned8	1
8	Value7	Unsigned8	1
9	Value8	Unsigned8	1
10	Value9	Unsigned8	1
11	Value10	Unsigned8	1
12	Value11	Unsigned8	1
13	Value12	Unsigned8	1
14	Value13	Unsigned8	1
15	Value14	Unsigned8	1
16	Value15	Unsigned8	1
17	Value16	Unsigned8	1

Manufacturer Specific Data Structure

In this section are defined manufacturer specific data structure used in the system.

Scaling Conversion Structure - DS-256

This data structure consists of data used to generate constants A and B in equation Y= A*X + B.

E	Element Name	Data Type	Size
1	From EU 0%	Float	4
2	From EU 100%	Float	4
3	To EU 0%	Float	4
4	To EU 100%	Float	4
5	Data Type	Unsigned8	1

Scaling Conversion Structure with Status - DS-257

This data structure consists of data used to generate constants A and B in equation Y= A*X + B plus the output status.

E	Element Name	Data Type	Size
1	From EU 0%	Float	4
2	From EU 100%	Float	4
3	To EU 0%	Float	4
4	To EU 100%	Float	4
5	Data Type	Unsigned8	1
6	Output Status	Unsigned8	1

- Ouput Status: This status can be set in two ways: by Modbus Master (default) or by user. Example for output status set by user: For OUT_1.Status, LOCAL_MOD_MAP equals to 0, the address will be 40021.

Scaling Locator Structure - DS-258

This data structure consists of data used to generate constants A and B in equation Y= A*X + B plus the addresses in a slave device.

E	Element Name	Data Type	Size
1	From EU 0%	Float	4
2	From EU 100%	Float	4
3	To EU 0%	Float	4
4	To EU 100%	Float	4
5	Data Type	Unsigned8	1
6	Slave Address	Unsigned8	1
7	Modbus Address of Value	Unsigned16	2

- Slave Address: It informs the slave address which is required to reference to the PVALUEn parameter. For example, it suppose there is one LC700 with device address equal 3 and In this equipment is required to monitor one specific variable. Thus, this Slave Address is 3.
- Modbus Address of Value: It informs the Modbus address of variable which it will be monitored. In the example of the last element, it supposes the Modbus address of the monitored variable was 40032. Thus, element must receive this address.

Scaling Locator Structure with Status- DS-259

This data structure consists of data used to generate constants A and B in equation Y= A*X + B plus the addresses in a slave device.

E	Element Name	Data Type	Size
1	From EU 0%	Float	4
2	From EU 100%	Float	4
3	To EU 0%	Float	4
4	To EU 100%	Float	4
5	Data Type	Unsigned8	1
6	Slave Address	Unsigned8	1
7	Modbus Address of Value	Unsigned16	2
8	Modbus Address of Status	Unsigned16	2

- Slave Address: It informs the slave address which is required to reference to the PVALUEn parameter. For example, it suppose there is one LC700 with device address equal 3 and In this equipment is required to monitor one specific variable. Thus, this Slave Address is 3;
- Modbus Address of Value: It informs the Modbus address of variable which it will be monitored. In the example of the last element, it supposes the Modbus address of the monitored variable was 40032. Thus, element must receive this address.

- Modbus Address of Status: In this parameter, the user informs the Modbus address which the status will be read or write. Each input and output has one correspondent status. The status interpretation follows the Foundation Fieldbus Default (See the item "Parameter Status" for more details).

Modbus Variable Locator Structure - DS-260

This data structure consists of data indicating the addresses in a slave device.

E	Element Name	Data Type	Size
1	Slave Address	Unsigned8	1
2	Modbus Address of Value	Unsigned16	2

- Slave Address: It indicates the Slave Address which the required variable to be monitored is located. For example, if in an application one LC700 was adjusted with Device Address 1, the Slave Address must be 1.

- Modbus Address Value: It writes the Modbus address of the variable which will be monitored in the MBSM block. It supposes the user needs to monitor the variable with MODBUS Address 40001 located in one Slave I/O module with Device Address 1. Thus, the Modbus Address of Value must be 40001.

Modbus Variable Locator Structure with Status- DS-261

This data structure consists of data indicating the addresses in a slave device.

E	Element Name	Data Type	Size
1	Slave Address	Unsigned8	1
2	Modbus Address of Value	Unsigned16	2
3	Modbus Address of Status	Unsigned16	2

FF Parameter ID Structure - DS-262

This data structure consists of data informing the position of the FF parameter requested.

E	Element Name	Data Type	Size
1	Block Tag	VisibleString(32)	32
2	Relative Index	Unsigned16	2
3	Sub Index	Unsigned8	1

- Block Tag: It informs the Block Tag that contains the variable which is required to visualization. For example, the user needs to monitor the gain value from the PID block. Thus, it inserts the PID Tag Block which contained the gain parameter required to be visualized in the Modbus Master.

- Relative Index: It is the parameter index of a function block which it desired to monitor. (See the function block parameter tables). Thus, it inserts the relative index to the desired parameter to be monitored. In the case above, to monitor the gain parameter from the ID relative block, the relative index is 23.

- Sub Index: The Sub Index is used for parameters which posses structure. In this case, it is necessary to indicate which structure element is being referred.

Slave Address Structure - DS-263

This data structure consists of data informing the IP address and the Modbus address of the slaves.

E	Element Name	Data Type	Size
1	IP Slave1	VisibleString(16)	16
2	IP Slave2	VisibleString(16)	16
3	IP Slave3	VisibleString(16)	16
4	IP Slave4	VisibleString(16)	16
5	IP Slave5	VisibleString(16)	16
6	IP Slave6	VisibleString(16)	16
7	IP Slave7	VisibleString(16)	16
8	IP Slave8	VisibleString(16)	16
9	Slave Address1	Unsigned8	1
10	Slave Address2	Unsigned8	1
11	Slave Address3	Unsigned8	1
12	Slave Address4	Unsigned8	1
13	Slave Address5	Unsigned8	1
14	Slave Address6	Unsigned8	1
15	Slave Address7	Unsigned8	1
16	Slave Address8	Unsigned8	1

Chapter 2

BLOCK LIBRARY

Description of Block Types

RESOURCE	DESCRIPTION
RS	**RESOURCE** – This block contains data that is specific to the hardware that is associated with the resource.

TRANSDUCER BLOCKS	DESCRIPTION
DIAG	**DIAGNOSTICS TRANSDUCER** – It provides online measurement of block execution time, check of links between blocks and other features
DSP	**DISPLAY TRANSDUCER** – This block supported by devices with LCD display can be used to monitor and actuate in local parameters of blocks.
HC	**HARDWARE CONFIGURATION TRANSDUCER** – It configures the module type for each slot in the DFI302.
IDSHELL	This transducer block provides configuration of the initial settings of the system and device and block online diagnostics.

INPUT TRANSUCER BLOCKS	DESCRIPTION
LD292/LD302	**PRESSURE TRANSDUCER** – This is the transducer block for LD292/LD302, a pressure transmitter.
TT302	**TEMPERATURE TRANSDUCER –** This is the transducer block for TT302, a temperature transmitter.
IF302	**CURRENT FIELDBUS TRANSDUCER –** This is the transducer block for IF302, a Current to Fieldbus Transmitter.
TP302	**POSITION FIELDBUS TRANSDUCER –** This is the transducer block for TP302, a Position Fieldbus Transmitter.
TEMP	**DF-45 TEMPERATURE TRANSDUCER** – This is the transducer block for the module DF-45, an eight low signal input module for RTD, TC, mV, Ohm.
DT302	**CONCENTRATION/DENSITY TRANSDUCER –** This is the transducer block for the DT302, a concentration/density transmitter.

OUTPUT TRANSUCER BLOCKS	DESCRIPTION
FY302	**FIELDBUS POSITIONER TRANSDUCER -** This is the transducer block for FY302, a Fieldbus Positioner.
FP302	**FIELDBUS PRESSURE TRANSDUCER -** This is the transducer block for FP302, a Fieldbus to Pressure Converter.
FI302	**FIELDBUS CURRENT TRANSDUCER -** This is the transducer block for IF302, a Fieldbus to Current Converter.
FR302	**FIELDBUS RELAY TRANSDUCER –** This is the transducer block for the FR302, a Fieldbus relay transmitter.

INPUT FUNCTION BLOCKS	DESCRIPTION
AI	**ANALOG INPUT** – This block takes the analog input data from the analog input signal and it makes available to other function blocks. It has scaling conversion, filtering, square root, low cut and alarm processing.
DI	**DISCRETE INPUT** – This block takes the discrete input data from the discrete input signal, and it makes available to other function blocks. It has option to invert, filtering and alarm processing.
MAI	**MULTIPLE ANALOG INPUT**– It provides a way to receive 8 analog variables from other modules or physical inputs.
MDI	**MULTIPLE DISCRETE INPUT**– It provides a way to receive 8 discrete variables from other modules or physical inputs.
PUL	**PULSE INPUT** – It provides an analog value that represents a totalization of pulses in a physical discrete input.

CONTROL AND CALCULATION FUNCTION BLOCKS	DESCRIPTION
PID	**PID CONTROL** – This standard block has a lot of valuables features as setpoint treatment (value and rate limiting), filtering and alarm on PV, feedforward, output tracking and others.
EPID	**ENHANCED PID** – It has all the standard features plus: bumpless or hard transfer from a “manual” mode to an “automatic” mode and bias.
APID	**ADVANCED PID** – It has all the standard features plus: bumpless or hard transfer from a “manual” mode to an “automatic” mode, bias. Adaptative gain, PI sampling, dead band for error, special treatment for error, ISA or parallel algorithm.
ARTH	**ARITHMETIC** – This calculation block provides some pre-defined equations ready for use in applications as flow compensation, HTG, ratio control and others.
SPLT	**SPLITTER** – This block is used in two typical applications: split ranging and sequencing. It receives the output of PID block, which is processed according to the selected algorithm, and then it generates the values for the two analog output blocks.
CHAR	**SIGNAL CHARACTERIZER** – It has capability for two signal characterization based on the same curve. The second input has an option for swapping “x” to “y”, providing an easy way to use the inverse function, which may be used in signal characterization of readback variables.
INTG	**INTEGRATOR** – It integrates a variable in function of the time. There is a second flow input that may be used for the following applications: net flow totalization, volume/mass variation in vessels and precise flow ratio control.
AALM	**ANALOG ALARM** – This alarm block has dynamic or static alarm limits, hysteresis, and temporary expansion of alarm limits on step setpoint changes to avoid nuisance alarms, two levels of alarm limits and delay for alarm detection.
ISEL	**INPUT SELECTOR** – This block has four analog inputs that may be selected by an input parameter or according to a criterion as first good, maximum, minimum, middle and average.
SPG	**SETPOINT RAMP GENERATOR** – This block generates setpoint following a profile in function of the time. Typical applications are temperature control, batch reactors, etc.
ESPG	**ENHANCED SETPOINT RAMP GENERATOR –** It has an extra parameter to identify the step or segment of the profile in the float format.
TIME	**TIMER and Logic** – This block has four discrete inputs that are processed by combination logic. The selected timer processing type operates on the combined input signal to produce a measurement, delay, extension, pulse or debounce.
LLAG	**LEAD-LAG** – This block provides dynamic compensation of a variable. It is used normally in a feedforward control.
OSDL	**OUTPUT SELECTOR / DYNAMIC LIMITER** – It has two algorithms: Output selector – selection of output by a discrete input Dynamic limiter – this algorithm was developed specially for double cross limit in combustion control.
DENS	**DENSITY** – This block has a special algorithm to calculate the density in different types of engineering units: plato degree, INPM and others.
CT	**CONSTANT** – It provides analog and discrete output parameters with constant values.
FFET	**FLIP-FLOP AND EDGE TRIGGER** – It can be configured to work as SR flip-flop, RS flip-flop, D-LATCH and EDGE TRIGGER (rising, falling or bi-directional)
AEQU	**ADVANCED EQUATIONS -** This block was specially designed to support specific calculations.
PRED	**SMITH PREDITOR–**This block becomes available the following functions as Delay, Bypass and Smith Predictor.
TF	**TRANSFER FUNCTION –** This block is intended to represent systems up to 2nd order, using the coefficients A, B, C, D, E and F.
LCF	**LIQUID CORRECTION FACTORS –** This block calculates the correction factors (CTL, CPL and BSW in operation temperature) for liquid measurement.

MODBUS FUNCTION BLOCKS	DESCRIPTION
MBCF	**MODBUS CONFIGURATION** – This transducer block is used to configure general features related to Modbus gateway.
MBCS	**MODBUS CONTROL SLAVE** – When the device is working as gateway between Foundation Fieldbus and Modbus (slave device), this block may be used to exchange control data between both protocols.
MBSS	**MODBUS SUPERVISION SLAVE** – When the device is working as gateway between Foundation Fieldbus and Modbus (slave device), this block may be used to convert Foundation Fieldbus parameters into Modbus variables. Such variables will be available to the supervisory with a Modbus driver.

MODBUS FUNCTION BLOCKS	DESCRIPTION
MBCM	**MODBUS CONTROL MASTER** – When the device is working as gateway between Foundation Fieldbus and Modbus (master device), this block may be used to exchange control data between both protocols.
MBSM	**MODBUS SUPERVISION MASTER** – When the device is working as gateway between Foundation Fieldbus and Modbus (master device), this block may be used to convert Modbus variables into Foundation Fieldbus parameters. Such parameters will be available to the supervisory with a Foundation Fieldbus driver (OPC).

OUTPUT FUNCTION BLOCKS	DESCRIPTION
AO	**ANALOG OUTPUT** – The AO block provides an analog value to generate an analog output signal. It provides value and rate limiting, scaling conversion, fault state mechanism and other features.
DO	**DISCRETE OUTPUT** – The DO block provides a discrete value to generate a discrete output signal. There is option to invert the discrete value, fault state mechanism and other features.
MAO	**MULTIPLE ANALOG OUTPUT** – It provides a way to send 8 analog variables to other modules or physical outputs.
MDO	**MULTIPLE DISCRETE OUTPUT** – It provides a way to send 8 discrete variables to other modules or physical outputs.
STEP	**STEP OUTPUT PID** – It is used when the final control element has an actuator driven by an electric motor.

FLEXIBLE FUNCTION BLOCK	DESCRIPTION
FFB	**Flexible Function Block -** The FFB block provides logic such as AND, OR, XOR and NOT and functions such as Timer On-Delay, Timer Off-Delay, Timer Pulse, Pulse Counter Down (CTD), Pulse Counter Up(CTU), RS Flip-Flop and SR Flip-Flop. The logic is done using the eight discrete variables available for the FF network (OUT_Dx), the eight input parameters from the FF network (IN_Dx), the sixteen input discrete variables from DC302 hardware(HIN), the eight output discrete variables from DC302 hardware(HOUT), failsafe(FSx) values and auxiliary bit variables(AUX's).

HART FUNCTION BLOCKS	DESCRIPTION
HCFG	**HART Configuration & Diagnostic** – Concentrates general configuration parameters for module working, in addition to parameters on HART Communication performance and diagnostic.
HIRT	**HART Information & Dynamic Data** – This block contains the main parameters, i.e., most commonly used, besides dynamic variables. All parameters related to universal commands and some main "Common Practice" commands are found here. There should be one HIRT block for each HART device installed, up to 32 blocks. In normal operation, the HIRT block parameters show the HART device variables, since there are mechanisms to keep the HI302 database updated. See the A Appendix or the Function Blocks handbook for details.
HVT	**HART Variable Template** – This block is a large collection of variables for general use arranged in arrays. It is now possible to access any HART instrument parameter. To this effect, the module should get a configuration (HCD and HWPC blocks) to define the specific instrument one wants to access, and how these commands will relate to each parameter on the block. There is just one HVT block that should be shared among the devices when accessing them through the HART_TAG. This configuration is already configured in the Smar device's memory.
HCD	**HART Commands Definition** – It contains the HART command description for each device type or version. This description stores information needed by the module to communicate and the data read on the HIRT or HTV blocks. The HCD blocks defining the universal and the common practice commands, as well as all commands specific to Smar instruments, are already stored in the equipment's memory and do not require any configuration from the user. See the Appendix B for details.
HWPC	**HART Write Parameter Configuration** – This block stores information about all parameters to be written on the instrument and mapped on the HVT block.
HBC	**HART Bypass Communication –** This block allows HART messages are sent to any equipment through written in the block parameter.

Block Type Availability and Initial Block Set

The table below shows how powerful and flexible the Smar devices are. For example, the user may instantiate up to 20 blocks selected from 17 block types (algorithms) in a field device as LD302. Indeed it means that almost all control strategy may be implemented using only the Smar field devices.

Read carefully the notes in order to fully understand the information in this table.

Block type	LD292/ LD302	TT302	IF302	TP302	FY302	FP302	FI302	FB700	DC302	DFI302	FR302	DT302	HI302-O	HI302-N	HI302-I
RS (1)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DIAG (1)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DSP (1)	1	1	1	1	1	1	1				1	1			
HC (1)										0					
IDSH(1)										1					
TRD-LD (1)	1														
TRD-TT (2)		2													
TRD-IF (3)			3												
TRD-TP(1)				1											
TEMP										0					
TRD-FI (3)							3								
TRD-FP (1)						1									
TRD-FY (1)					1										
AI (*)	1	2	3	1						0		1			
DI(*)									0	0					
MAI								2		0			0		1
MDI								3	0	0			0		0
PUL										0					
PID	1	1	1	1	1	1	1	1	1	0	1	1			
EPID		0	0	0	0	0	0	0		0					
APID	0				0	0	0			0		0			
ARTH	1	1	1	1	1	1	1	0	0	0		1	1		
SPLT		0	0	0	0	0	1	0		0					
CHAR	1	1	1	1	1	1	1	0		0			1		
INTG	1	0	1	1		0	1	0		0			1		
AALM	1	2	1	1	1	1	1	1	0	0		1	1		
ISEL	0	1	0	0	1	1	0	0	1	0		1	0		
SPG		1	1	1	0	0	0	0							
ESPG										0					
TIME	1	0	0	0	0	0	0	0	1	0	1	1			
LLAG	1	0	0	0	0	0	0	0		0		1			
OSDL	0	0	0	0	0	0	0	0		0		0			
DENS	0									0		0			
CT	0	0	0	0	0	0	0	0		0		0			

Block type	LD292/ LD302	TT302	IF302	TP302	FY302	FP302	FI302	FB700	DC302	DFI302	FR302	DT302	HI302-O	HI302-N	HI302-I
FFET									1	0	1				
AEQU										0					
PRED										0					
TF										0					
LCF										0					
MBCF(1)										0					
MBCS(16)										0					
MBSS(16)										0					
MBCM(16)										0					
MBSM(16)										0					
MDO								4	0	0			0		0
STEP									0	0	1				
HCFG													1	1	1
HIRT													8	8	8
HVT													1	1	1
HCD													0	0	0
HWPC													0	0	0
HBC													0	0	0

Note 1 – The column “Block type” indicates which block type is available for each type of device.
Note 2 – The number associated to the block type and the device type is the number of instantiated blocks during the factory initialization.
Note 3 – If the function block type is not available to the device type, it will be indicated by blank space.
Note 4 – Field devices and FB700 have a capability of 20 blocks, including resource, transducers and function blocks.
Note 5 – DFI302 has a capability of 100 blocks, including resource, transducers and function blocks.
Note 6 – The column Block type shows the mnemonics, if it is followed by a number between Parentheses, it indicates the maximum number of block instances. If it is followed by “*”, it indicates the maximum number depends on the device type.
Note 7 – The blocks PRED, TF and LCF are available only in DFI302 with DD 0704 or higher.

Resource

RS – Resource Block

Description
This block contains data that is specific to the hardware that is associated with the resource. All data is modeled as Contained, so there are no links to this block. The data is not processed in the way that a function block processes data, so there is no function schematic.

This parameter set is intended to be the minimum required for the Function Block Application associated with the resource in which it resides. Some parameters that could be in the set, like calibration data and ambient temperature, are more part of their respective transducer blocks.

The mode is used to control major states of the resource. O/S mode stops all function block execution. The actual mode of the function blocks will be changed to O/S, but the target mode will not be changed. Auto mode allows normal operation of the resource. IMan shows that the resource is initializing or receiving a software download.

Parameters MANUFAC_ID, DEV_TYPE, DEV_REV, DD_REV, and DD_RESOURCE are required to identify and locate the DD so that Device Description Services can select the correct DD for use with the resource.

The parameter HARD_TYPES is a read only BitString that indicates the types of hardware that are available to this resource. If an I/O block is configured that requires a type of hardware that is not available, the result will be a block alarm for a configuration error.

The RS_STATE parameter contains the operational state of the Function Block Application for the resource containing this resource block.

RESTART parameter
The RESTART parameter allows degrees of initialization of the resource. They are:
1 - Run: it is the passive state of the parameter
2 - Restart resource: it is intended to clear up problems like garbage collection
3 - Restart with defaults: it is intended to wipe configuration memory; it works like a factory initialization.
4 - Restart processor: it provides a way to hit the reset button on the processor associated with the resource
This parameter does not appear in a view because it returns to 1 shortly after being written.

Non-volatile parameters
The Smar devices do not support cyclic saving of non-volatile parameters to a non-volatile memory, therefore NV_CYCLE_T parameter will always be zero, which means not supported feature.

On the other hand, the Smar devices have a mechanism to save non-volatile parameters into a non-volatile memory during the power down, and they will be recovered in the power up.

Timeout for remote cascade modes
SHED_RCAS and SHED_ROUT set the time limit for loss of communication from a remote device. These constants are used by all function blocks that support a remote cascade mode. The effect of a timeout is described in Mode Calculation. Shedding from RCAS/ROUT shall not happen when SHED_RCAS or SHED_ROUT is set to zero.

Alert Notification
The MAX_NOTIFY parameter value is the maximum number of alert reports that this resource can have sent without getting a confirmation, corresponding to the amount of buffer space available for alert messages. A user can set the number lower than that, to control alert flooding, by adjusting the LIM_NOTIFY parameter value. If LIM_NOTIFY is set to zero, then no alerts are reported. The CONFIRM_TIME parameter is the time for the resource to wait for confirmation of receipt of a report before trying again. If the CONFIRM_TIME = 0 the device shall not retry.

FEATURES / FEATURE_SEL parameters
The bit strings FEATURES and FEATURE_SEL determine optional behavior of the resource. The first defines the available features, and is read only. The second is used to turn on an available

feature by configuration. If a bit is set in FEATURE_SEL that is not set in FEATURES, the result will be a block alarm for a configuration error.

Smar devices support the following features: Reports supported, Fault State supported, Soft Write lock supported.

Fault state for the whole resource
If the user sets the SET_FSTATE parameter, the FAULT_STATE parameter will indicate active and it will cause **all output function blocks** in the resource to go immediately to the condition chosen by the fault state Type I/O option. It may be cleared by setting the CLR_FSTATE parameter. The set and clear parameters do not appear in a view because they are momentary.

Write lock by software
The WRITE_LOCK parameter, if set, will prevent any external change to the static or nonvolatile data base in the Function Block Application of the resource. Block connections and calculation results will proceed normally, but the configuration will be locked. It is set and cleared by writing to the WRITE_LOCK parameter. Clearing WRITE_LOCK will generate the discrete alert WRITE_ALM, at the WRITE_PRI priority. Setting WRITE_LOCK will clear the alert, if it exists.
Before setting WRITE_LOCK parameter to *Locked*, it is necessary to select the “Soft Write lock supported” option in FEATURE_SEL.

Features being implemented
The parameter CYCLE_TYPE is a BitString that defines the types of cycles that this resource can do. CYCLE_SEL allows the configurator chooses one of them. If CYCLE_SEL contains more than one bit, or the bit set is not set in CYCLE_TYPE, the result will be a block alarm for a configuration error. MIN_CYCLE_T is the manufacturer specified minimum time to execute a cycle. It puts a lower limit on the scheduling of the resource.

MEMORY_SIZE declares the size of the resource for configuration of function blocks, in kilobytes.
The parameter FREE_SPACE shows the percentage of configuration memory that is still available. FREE_TIME shows the approximate percentage of time that the resource has left for processing new function blocks, should they be configured.

BLOCK_ERR
The BLOCK_ERR of the resource block will reflect the following causes:

- Device Fault State Set – When FAULT_STATE is active.
- Simulate Active – When the Simulate jumper is ON.
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S, IMAN and AUTO

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	RS_STATE	Unsigned8			E	D / RO	State of the function block application state machine.
8	TEST_RW	DS-85			None	D	Read/write test parameter - used only for conformance testing.
9	DD_RESOURCE	VisibletString (32)		Spaces	Na	S / RO	String identifying the tag of the resource which contains the Device Description for this resource.
10	**MANUFAC_ID**	**Unsigned32**	**Enumeration; controlled by FF**	**0x00000302**	**None**	**S / RO**	**Manufacturer identification number - used by an interface device to locate the DD file for the resource.**
11	**DEV_TYPE**	**Unsigned16**	**Set by mfgr**		**None**	**S / RO**	**Manufacturer’s model number associated with the resource - used by interface devices to locate the DD file for the resource.**
12	**DEV_REV**	**Unsigned8**	**Set by mfgr**		**None**	**S / RO**	**Manufacturer revision number associated with the resource - used by an interface device to locate the DD file for the resource.**

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
13	**DD_REV**	**Unsigned8**	**Set by mfgr**		**None**	**S / RO**	**Revision of the DD associated with the resource - used by an interface device to locate the DD file for the resource.**
14	GRANT_DENY	DS-70	See Block Options	0	Na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
15	HARD_TYPES	Bitstring(2)	Set by mfgr		Na	S / RO	The types of hardware available as channel numbers.
16	**RESTART**	**Unsigned8**	**1: Run, 2: Restart resource, 3: Restart with defaults, 4: Restart processor**		**E**	**D**	**Allows a manual restart to be initiated. Several degrees of restart are possible.**
17	FEATURES	Bitstring(2)	Set by mfgr		Na	S / RO	Used to show supported resource block options.
18	**FEATURE_SEL**	**Bitstring(2)**		**0**	**Na**	**S**	**Used to select resource block options.**
19	CYCLE_TYPE	Bitstring(2)	Set by mfgr		Na	S / RO	Identifies the block execution methods available for this resource.
20	CYCLE_SEL	Bitstring(2)		0	Na	S	Used to select the block execution method for this resource.
21	MIN_CYCLE_T	Unsigned32	Set by mfgr		1/32 millisec	S / RO	Time duration of the shortest cycle interval of which the resource is capable.
22	MEMORY_SIZE	Unsigned16	Set by mfgr		kbytes	S / RO	Available configuration memory in the empty resource. To be checked before attempting a download.
23	NV_CYCLE_T	Unsigned32			1/32 millisec	S / RO	Interval between writing copies of NV parameters to non-volatile memory. Zero means never.
24	FREE_SPACE	Float	0 to 100 %		%	D / RO	Percent of memory available for further configuration. Zero in a preconfigured resource.
25	FREE_TIME	Float	0 to 100%		%	D / RO	Percent of the block processing time that is free to process additional blocks.
26	SHED_RCAS	Unsigned32		640000	1/32millisec	S	Time duration at which to give up on computer writes to function block RCas locations.
27	SHED_ROUT	Unsigned32		640000	1/32 millisec	S	Time duration at which to give up on computer writes to function block ROut locations.
28	FAULT_STATE	Unsigned8	1: Clear, 2: Active		E	D	Condition set by loss of communication to an output block, failure promoted to an output block or a physical contact. When Fault State condition is set, and then output function blocks will perform their FSAFE actions.
29	SET_FSTATE	Unsigned8	1: Off, 2: Set	1	E	D	Allows the fault state condition to be manually initiated by selecting Set.
30	CLR_FSTATE	Unsigned8	1: Off, 2: Clear	1	E	D	Writing a Clear to this parameter will clear the device fault state if the field condition, if any, has cleared.
31	MAX_NOTIFY	Unsigned8	Set by mfgr		None	S / RO	Maximum number of unconfirmed notifies messages possible.
32	LIM_NOTIFY	Unsigned8	0 to MAX_ NOTIFY	MAX_ NOTIFY	None	S	Maximum number of unconfirmed alert notifies messages allowed.
33	CONFIRM_TIME	Unsigned32		640000	1/32 millisec	S	The minimum time between retries of alert reports.
34	WRITE_LOCK	Unsigned8	1:Unlocked, 2:Locked	1	E	S	If set, no writes from anywhere are allowed, except to clear WRITE_LOCK. Block inputs will continue to be updated.
35	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
36	BLOCK_ALM	DS-72			Na	D	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.
37	ALARM_SUM	DS-74			Na	S	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
38	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged.
39	WRITE_PRI	Unsigned8	0 to 15	0	None	S	Priority of the alarm generated by clearing the write lock.
40	WRITE_ALM	DS-72			None	D	This alert is generated if the write lock parameter is cleared.
41	**ITK_VER**	**Unsigned16**			**Na**	**S/RO**	**This parameter informs which ITK version is the device (only for certified devices).**

Legend: ***E – Enumerated Parameter; Na – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile; S – Static.***

Gray Background Line: Default Parameters in Syscon

Transducer Blocks

DIAG – Diagnostics Transducer Block

Description

This transducer block provides the following features:

- Online measurement of block execution time
- Hardware revision
- Firmware revision
- Serial number of device
- Serial number of main board

The parameter BEHAVIOR will define which initial values for parameters will be used after a block instantiation. The option *Adapted* selects a more suitable initial value set; it will avoid invalid values for parameters. It is still possible to have the initial values defined by specification by selecting the option *Spec*.

Supported modes

O/S and AUTO.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter.**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	**EXE_TIME_TAG**	**Visible String (32)**		**spaces**	**Na**	**D**	**Block tag of the selected block to measure the execution time.**
8	MIN_EXE_TIME	Float		+INF	ms	D / RO	Minimum execution time of the selected block.
9	**CUR_EXE_TIME**	**Float**		**0**	**ms**	**D / RO**	**Current execution time of the selected block.**
10	MAX_EXE_TIME	Float		0	ms	D / RO	Maximum execution time of the selected block.
11	**HW_REV**	**Visible String(5)**				**S / RO**	**Hardware revision.**
12	FIRMWARE_REV	**Visible String(5)**				**S / RO**	**Firmware revision.**
13	DEV_SN	**Unsigned32**				**S / RO**	**Device serial number.**
14	MAIN_BOARD_SN	Unsigned32				S / RO	Main board serial number.
15	BEHAVIOR	**Unsigned8**	**0:Adapted 1:Spec**	**0**	**E**	**S**	**Select the initial values for parameters, there are two options Adapted and Spec.**
16	PUB_SUB_STATUS	Unsigned8	0-good 1-bad		E	D / RO	Indicate if all external links is good or if at least one is bad.
17	LINK_SELECTION	Unsigned8	0-first 1-next 2-previous	0	E	D	Select an external link.
18	LINK_NUMBER	Unsigned16				D / RO	Number of the external link selected.
19	LINK_STATUS	Unsigned8				D / RO	Status of the external link selected (see table below)
20	LINK_RECOVER	Unsigned8	0-no action 1-action	No action	E	D	Command a recovery process to the external link selected.
21	BLOCK_ALM	DS-72			Na	D	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.
22	SAVING_CONFIG	Unsigned 8	0 – NOT SAVING 1 - SAVING	0	E	D	It indicates if the device is saving the configuration in a non-volatile memory.

***Legend:* E – Enumerated Parameter; Na – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile; S – Static.**
Gray Background Line: Default Parameters in Syscon

Description of the values given by the LINK_STATUS parameter

Link Status	General Status	Publisher/ Subscriber	Connection Status	Sending/Receiving	Block Update
0X00	Good	Publisher			
0X40	Good	Subscriber			
0X84	Bad	Publisher	Established	Sending/Receiving	Not updating
0X88	Bad	Publisher	Established	Not sending/receiving	Updating
0X8C	Bad	Publisher	Established	Not sending/receiving	Not updating
0X98	Bad	Publisher	Not established	Not sending/receiving	Updating
0X9C	Bad	Publisher	Not established	Not sending/receiving	Not updating
0XA8	Bad	Publisher	Pending	Not sending/receiving	Updating
0XAC	Bad	Publisher	Pending	Not sending/receiving	Not updating
0XBC	Bad	Publisher	Not configured	Not sending/receiving	Not updating
0XC4	Bad	Subscriber	Established	Sending/Receiving	Not updating
0XCC	Bad	Subscriber	Established	Not sending/receiving	Not updating
0XDC	Bad	Subscriber	Not established	Not sending/receiving	Not updating
0XEC	Bad	Subscriber	Pending	Not sending/receiving	Not updating
0XFC	Bad	Subscriber	Not configured	Not sending/receiving	Not updating

DSP - Display Transducer

Description

The display transducer is responsible to show on the LCD screen, one chose variable when it is in monitoring mode or a configured menu when in local adjustment mode. The display transducer is completely configured via SYSCON. It means the user can select the best options to fit his application. Among the possibilities, the following options can be emphasized: Mode block, Outputs monitoring, Tag visualization and Tuning Parameters setting. The user, when configuring, may select up to seven parameters of any block, executing in the local device. It means that the device itself is executing that Display Transducer Block.

Supported Modes

OOS and AUTO.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store	Description
7	BLOCK_TAG_PARAM	VisibleString			None	S	This is a tag of the block to which the parameter belongs to use up to a maximum of 32 characters.
8	INDEX_RELATIVE	Unsigned16	0-65535		None	S	This is the index related to the parameter to be actuated or viewed (1, 2...).
9	SUB_INDEX	Unsigned8	1-255		None	S	To visualize a certain tag, opt for the index relative equal to zero, and for the sub-index equal to one.
10	MNEMONIC	VisibleString			None	S	This is the mnemonic for the parameter identification (maximum of 16 characters). Choose the mnemonic, preferably with no more than 5 characters because, this way, it will not necessary to rotate it on display.
11	INC_DEC	Float			None	S	It is the increment and decrement in decimal units when the parameter is Float or Float Status time, or integer, when the parameter is in whole units.
12	DECIMAL_POINT_NUMBER	Unsigned8	0-4		None	S	This is the number of digits after the decimal point (0 to 3 decimal digits)
13	ACCESS	Unsigned8	Monit/Action		None		The access allows the user to read, in the case of the "Monitoring" option, and to write when "action" option is selected, and then the display will show the increment and decrement arrows.
14	ALPHA_NUM	Unsigned8	Mnem/Value		None	S	These parameters include two options: value and mnemonic. In option value it is possible to display data both in the alphanumeric and in the numeric fields, this way, in the case of a data higher than 10000, it will be shown in the alphanumeric field.
63	DISPLAY_REFLESH	Unsigned8	1		None	D	

Legend: *E – Enumerated Parameter; Na – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile; S – Static.*

Gray Background Line: Default Parameters in Syscon

HC – Hardware Configuration Transducer

Overview

It configures the module type for each slot in the **DFI302.**

Description

The following table shows the available module types.

Code	Description	I/O Type
	Available slot	No I/O
DF51	DFI302 Processor 1x10Mbps, 4xH1	No I/O
DF50	Power Supply 90-264VAC	No I/O
DF56	Power Supply for Backplane 20-30VDC	No I/O
DF52	Power Supply for Fieldbus	No I/O
DF49	2-channel Power Supply Impedance	No I/O
DF53	4-channel Power Supply Impedance	No I/O
DF11	2 Groups of 8 24VDC Inputs (Isolated)	16-discrete input
DF12	2 Groups of 8 48VDC Inputs (Isolated)	16- discrete input
DF13	2 Groups of 8 60VDC Inputs (Isolated)	16- discrete input
DF14	2 Groups of 8 125VDC Inputs (Isolated)	16- discrete input
DF15	2 Groups of 8 24VDC Inputs (Sink)(Isolated)	16- discrete input
DF16	2 Groups of 4 120VAC Inputs (Isolated)	8- discrete input
DF17	2 Groups of 4 240VAC Inputs (Isolated)	8- discrete input
DF18	2 Groups of 8 120VAC Inputs (Isolated)	16- discrete input
DF19	2 Groups of 8 240VAC Inputs (Isolated)	16- discrete input
DF20	1 Group of 8 On/Off Switches	8- discrete input
DF21	1 Group of 16 Open Collector Outputs	16- discrete output
DF22	2 Group of 8 Transistor Outputs (source) (Isolated)	16- discrete output
DF23	2 Groups of 4 120/240VAC Outputs	8- discrete output
DF24	2 Groups of 8 120/240VAC Outputs	16- discrete output
DF25	2 Groups of 4 NO Relays Outputs	8- discrete output
DF26	2 Groups of 4 NC Relays Outputs	8- discrete output
DF27	1 Group of 4 NO and 4 NC Relay Outputs	8- discrete output
DF28	2 Groups of 8 NO Relays Outputs	16- discrete output
DF29	2 Groups of 4 NO Relays Outputs (W/o RC)	8- discrete output
DF30	2 Groups of 4 NC Relays Outputs (W/o RC)	8- discrete output
DF31	1 Group of 4 NO and 4 NC Relay Outputs (W/o RC)	8- discrete output
DF32	1 Group of 8 24VDC Inputs and 1 Group of 4 NO Relays	8- discrete input/4- discrete output
DF33	1 Group of 8 48VDC Inputs and 1 Group of 4 NO Relays	8- discrete input/4- discrete output
DF34	1 Group of 8 60VDC Inputs and 1 Group of 4 NO Relays	8- discrete input/4- discrete output
DF35	1 Group of 8 24VDC Inputs and 1 Group of 4 NC Relays	8- discrete input/4- discrete output
DF36	1 Group of 8 48VDC Inputs and 1 Group of 4 NC Relays	8- discrete input/4- discrete output
DF37	1 Group of 8 60VDC Inputs and 1 Group of 4 NC Relays	8- discrete input/4- discrete output
DF38	1 Group of 8 24VDC Inputs ,1 Group of 2 NO and 2 NC Relays	8- discrete input/4- discrete output
DF39	1 Group of 8 48VDC Inputs , 1 Group of 2 NO and 2 NC Relays	8- discrete input/4- discrete output
DF40	1 Group of 8 60VDC Inputs , 1 Group of 2 NO and 2 NC Relays	8- discrete input/4- discrete output
DF41	2 Groups of 8 pulse inputs – low frequency	16-pulse input
DF42	2 Groups of 8 pulse inputs – high frequency	16-pulse input
DF43	1 Group of 8 analog Inputs	8-analog input
DF44	1 Group of 8 analog inputs with shunt resistors	8-analog input

Code	Description	I/O Type
DF57	1 Group of 8 differential analog inputs with shunt resistors	8-analog input
DF45	1 Group of 8 temperature Inputs	8-temperature
DF46	1 Group of 4 analog output	4-analog output

The execution method of this transducer block will write to all output modules and it will read all the input modules. If any I/O module has failed in this scan, it will be indicated in BLOCK_ERR as well in the MODULE_STATUS_x. It makes easy to find the module in failure or even the sensor.
All the I/O modules in the previous table may be accessed directly using Input/Output Function Blocks without a transducer block, except for the DF-45 that requires the TEMP block.

IMPORTANT
In order to have a safe startup, is necessary to set in Offline mode the MODE_BLK parameter to OOS to download the configuration. Change the MODE_BLK parameter to Auto, only after the download finished.

BLOCK_ERR
The BLOCK_ERR of the HC block will reflect the following causes:

- Lost static data – Low battery voltage indication
- Device needs maintenance now – High temperature in the CPU
- Input Failure – a physical input point in failure
- Output Failure – a physical output point in failure
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S and AUTO.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	REMOTE_IO	Unsigned8	0 : Remote I/O Master 1 :Remote I/O Slave 1 2 : Remote I/O Slave 2 3 : Remote I/O Slave 3 4 Remote I/O Slave 4 5 : Remote I/O Slave 5 6 : Remote I/O Slave 6	0	E	RO	Identification for master remote I/O. It supports only the I/O Master option.
8	**IO_TYPE_R0**	**4 Unsigned8**		**0**	**E**	**S / O/S**	**Select module type for the rack 0**
9	**IO_TYPE_R1**	**4 Unsigned8**		**0**	**E**	**S / O/S**	**Select module type for the rack 1**
10	**IO_TYPE_R2**	**4 Unsigned8**		**0**	**E**	**S / O/S**	**Select module type for the rack 2**
11	**IO_TYPE_R3**	**4 Unsigned8**		**0**	**E**	**S / O/S**	**Select module type for the rack 3**
12	**IO_TYPE_R4**	**4 Unsigned8**		**0**	**E**	**S / O/S**	**Select module type for the rack 4**
13	**IO_TYPE_R5**	**4 Unsigned8**		**0**	**E**	**S / O/S**	**Select module type for the rack 5**
14	**IO_TYPE_R6**	**4 Unsigned8**		**0**	**E**	**S / O/S**	**Select module type for the rack 6**
15	**IO_TYPE_R7**	**4 Unsigned8**		**0**	**E**	**S / O/S**	**Select module type for the rack 7**
16	**IO_TYPE_R8**	**4 Unsigned8**		**0**	**E**	**S / O/S**	**Select module type for the rack 8**
17	IO_TYPE_R9	4 Unsigned8		0	E	S / O/S	Select module type for the rack 9
18	IO_TYPE_R10	4 Unsigned8		0	E	S / O/S	Select module type for the rack 10
19	IO_TYPE_R11	4 Unsigned8		0	E	S / O/S	Select module type for the rack 11
20	IO_TYPE_R12	4 Unsigned8		0	E	S / O/S	Select module type for the rack 12
21	IO_TYPE_R13	4 Unsigned8		0	E	S / O/S	Select module type for the rack 13

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
22	IO_TYPE_R14	4 Unsigned8		0	E	S / O/S	Select module type for the rack 14
23	**MODULE_STATUS_R0_3**	**Bitstring(2)**				**D / RO**	**Status of modules in rack 0-3.**
24	**MODULE_STATUS_R4_7**	**Bitstring(2)**				**D / RO**	**Status of modules in rack 4-7.**
25	**MODULE_STATUS_R8_11**	**Bitstring(2)**				**D / RO**	**Status of modules in rack 8-11.**
26	**MODULE_STATUS_R12_14**	**Bitstring(2)**				**D / RO**	**Status of modules in rack 12-14.**
27	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
28	BLOCK_ALM	DS-72			Na	D	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.

Legend: ***E – Enumerated Parameter; Na – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile; S – Static.***

Gray Background Line: Default Parameters in Syscon

IDShell Transducer Block

Description

This transducer block provides the following features:

- Configuration of the Initial Settings of the System
- Device and Block Online Diagnostics and Configuration

It is a tool that helps to achieve the interoperability with new devices into System302.

Supported modes

O/S and AUTO.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	unsigned int	0 to 2^{16}	0	None	S/RO	FF – 891
2	TAG_DESC	OctString(32)		Spaces	Na	RW	FF – 891
3	STRATEGY	unsigned int	0 to 2^{16}	0	None	RW	FF – 891
4	ALERT_KEY	unsigned char	1 to 255	1	None	RW	FF – 891
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**		**FF – 891**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	**FF – 891**
7	**UPDATE_EVT**	**EventUpdate**					**FF – 891**
8	**BLOCK_ALM**	**AlarmDiscrete**					**FF – 891**
9	TRANSDUCER_DIRECTORY	unsigned int	0 to 2^{16}			RO	A directory that specifies the number and the starting indices of the transducers in the transducer block. (FF – 903)
10	TRANSDUCER_TYPE	unsigned int	0 to 2^{16}			RO	Identifies the transducer that follows. (FF – 903)
11	XD_ERROR	unsigned char	1 to 255			RO	Defines one of the error codes. (FF – 903)
12	COLLECTION_DIRECTORY	unsigned long	0 to 2^{32}			RO	A directory that specifies the number, the starting indices, and DD Item IDs of data collections in each transducers in the transducer block. (FF – 903)
13	**FUNCTION_IDS**	**Unsigned8**	**1:Passive 2:Active 3:Backup 4:Active_Not_Link_Master 7:Sync_Idle 8:Sync_Main 9:Sync_Backup**	**7**	**E**	**D / RW**	**Role for the local device in the redundancy Passive, Active, Backup and Active_Not_Link_Master are not synchronized roles, valid only for supervision and LAS redundancy. Hot Standby redundancy are set via the following roles: Sync_Idle is the default role, after factory initialization. The 4th port is used to synchronize two different DFI302 processors. Sync_Main indicates the preferential processor to assume the tasks. Sync_Backup indicates the backup processor to assume the tasks.**
14	**UPDATE_TIME**	**unsigned long**	**0 to 2^{32}**	**1000**		**RW**	**Update time for supervision.**
15	ACTUAL_LINK_ADDRESS_1	unsigned int	0 to 2^{16}	0		RO	Actual link address for Port 1.
16	CONF_LINK_ADDRESS_1	unsigned int	0 to 2^{16}	0		RW	Configured link address for Port 1.
17	ACTUAL_LINK_ADDRESS_2	unsigned int	0 to 2^{16}	292		RO	Actual link address for Port 2.
18	CONF_LINK_ADDRESS_2	unsigned int	0 to 2^{16}	0		RW	Configured link address for Port 2.
19	ACTUAL_LINK_ADDRESS_3	unsigned int	0 to 2^{16}	293		RO	Actual link address for Port 3.
20	CONF_LINK_ADDRESS_3	unsigned int	0 to 2^{16}	0		RW	Configured link address for Port 3.
21	ACTUAL_LINK_ADDRESS_4	unsigned int	0 to 2^{16}	294		RO	Actual link address for Port 4.
22	**CONF_LINK_ADDRESS_4**	**unsigned int**	**0 to 2^{16}**	**0**		**RW**	**Configured link address for Port 4.**
23	**SELECT_IDS**	**unsigned char**	**0 to 256**	**0**		**RW**	**Extra functionality of IDShell Application.**
24	**SOFTWARE_NAME**	**VisibleString**		**—**		**RO**	**Name of the last software downloaded to PCI card.**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
25	**SYSTEM_OPERATION**	**unsigned char**	**Redundant Single**	**Single**		**RW**	**System Operation mode (single or redundant). It will impact the calculation of SUP_UPDATE_SUGGESTED.**
26	**SUP_UPDATE_CONFIGURED_ms**	**unsigned long**	**0 to 2^{32}**	**0**		**RW**	**Target update time configured to the system. It may be achieved or not depending on the scheduled traffic, number of MVCs, number of Views, bus parameters. See macro cycle equation (1).**
27	**SUP_UPDATE_SUGGESTED_ms**	**unsigned long**	**0 to 2^{32}**	**—**		**RO**	**Suggested update time based on the programmed traffic on the bus (Scheduled traffic, MVCs, Views, bus parameters, maintenance traffic). Note: Not Available.**
28	**NO_DATA_CHANGE_TIMEOUT_ms**	**unsigned long**	**0 to 2^{32}**	**2000**		**RW**	**Timeout to report data even if a change is not observed.**
29	RESOURCE_FAULT	unsigned char	Ok Failure Recovered			RO	Indicates lack of resource on the card.
30	MVC_ENABLE	unsigned char	Disabled Enabled	Disabled		R/W	Enables supervision by broadcast of MVC configured by IDSHELL. When disabled IDSHELL will use normal procedures to update the requested list of Tags.
31	SCHEDULE_UPDATE	unsigned char	Failed Update Req Updated Updating	—		R/W	A write to this parameter will trigger the update of the LAS schedule based on the information on the network.
32	T1_ms	unsigned long	0 to 2^{32}	8,000		R/W	T1 timer used to the SM manager to timeout the confirmation of Assign Tag, Assign Address, or Enable SM Operation from the SM Agent. See equation (2).
33	T2_ms	unsigned long	0 to 2^{32}	60,000		R/W	T2 timer used by the SM Agent to timeout the Assign Address process. See equation (2).
34	T3_ms	unsigned long	0 to 2^{32}	8,000		R/W	T3 timer used to the SM manager to timeout before send the Enable SM Operation. See equation (2).
35	FIRST_UNPOLLED_ADDRESS	unsigned char	0 to 256	48		R/W	The PCI acting as the LAS will not poll N_UNPOLLED_ADDRESS consecutive address starting on FIRST_UNPOLLED_ADDRESS.
36	N_UNPOLLED_ADDRESS	unsigned char	0 to 256	184		R/W	The PCI acting as the LAS will not poll N_UNPOLLED_ADDRESS consecutive address starting on FIRST_UNPOLLED_ADDRESS.
37	SLOT_TIME_octet	unsigned int	0 to 2^{16}	10		R/W	Devices on the network will use SLOT TIME and MAX_RESPONSE_DELAY to set a timeout to control some activity on the network.
38	MAX_RESPONSE_DELAY_octet	unsigned int	0 to 2^{16}	8		R/W	Devices on the network will use SLOT TIME and MAX_RESPONSE_DELAY to set a timeout to control some activity on the network.
39	MIN_INTER_PDU_DELAY_octet	unsigned char	0 to 256	12		R/W	Minimum time that the network needs to be in silent to allow the device to be prepared to receive the next frame on the network.
40	TARGET_ROTATION_TIME_ms	unsigned long	0 to 2^{32}	—		R/W	Target time to LAS rotates the token to all devices in the network.
41	MAX_CONFIRM_DELAY_ON_DATA_ms	unsigned int	0 to 2^{16}	8260		R/W	Maximum timeout to be configured on client/server VCRs to wait for data confirmation.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
42	LOCAL_VCR_SELECT	unsigned char	First Next None Previous	—			Selects a local VCR in the interface device that owns this transducer block.
43	L_VCR_ID	unsigned char		—		R/W	VCR selected.
44	L_VCR_TYPE_AND_ROLE	unsigned char	Bnu, Publisher Bnu, Subscriber Qub, Client Qub, Server Quu, Source Quu, Sink Undefined	—		RO	VCR type and role.
45	L_VCR_REMOTE_ADDRESS	octet string, 4		—		RO	VCR Remote address.
46	L_VCR_STATISTICS_RESET	unsigned char	Ok Reset	—		R/W	Resets statistics of the selected VCR.
47	L_VCR_ST_N_ABORT	unsigned long	0 to 2^{32}	—		RO	Number of abort on the selected VCR.
48	L_VCR_ST_N_DT_PDU_SENT	unsigned long	0 to 2^{32}	—		RO	Number of DT PDU sent on the selected VCR.
49	L_VCR_ST_N_DT_PDU_RCV	unsigned long	0 to 2^{32}	—		RO	Number of DT PDU received on the selected VCR.
50	L_VCR_ST_N_DT_TIMEOUT	unsigned long	0 to 2^{32}	—		RO	Number of DT failures caused by timeout.
51	L_VCR_ST_REQ_REJECTED	unsigned int	0 to 2^{16}	—		RO	Number of request that could not be queued to this VCR.
52	L_VCR_ST_W_REQ_REJECTED	unsigned int	0 to 2^{16}	—		RO	Number of write request that could not be queued to this VCR.
53	NET_STATUS	bit string	Port 0 mismatch Port 1 mismatch Port 2 mismatch Port 3 mismatch Reserved			RO	It will indicate any occurrence of mismatching between PORT_N_CONF_DEV and PORT_N_DEV_READY. **Note: Not Available.**
54	PORT_SELECT	unsigned char	First Next None Previous	—		R/W	Selects the port to be analyzed or configured in the following parameters.
55	PORT_ID	unsigned char		0		R/W	Port selected. (1, 2, 3 or 4)
56	PORT_UPDATE_PROFILE	unsigned char	Ready Start Update Update Processing	—		R/W	Updates the database of all devices on the selected port.
57	PORT_MACROCYCLE_CONFIGURED_ms	unsigned long	0 to 2^{32}	0		R/W	Configured macro cycle.
58	PORT_MACROCYCLE_SUGGESTED_ms	unsigned long	0 to 2^{32}	—		RO	Suggested macro cycle. **Note: Not Available.**
59	PORT_TOKEN_ROTATION_TIME_ms	unsigned long	0 to 2^{32}	—		RO	Actual period of time that the LAS took to rotate the token to all devices in the network.
60	PORT_N_CONF_DEV	unsigned char	0 to 256	—		R/W	Number of expects stations on this network.
61	PORT_N_DEV	unsigned char	0 to 256	—		RO	Number of devices on the network.
62	PORT_N_DEV_READY	unsigned char	0 to 256	—		RO	Number of device with complete database updated. **Note: Not Available.**
63	PORT_LIVE_LIST_STATUS_1	bit string , 8 bytes 256 bits	De 0 a 15	—		RO	Live list on the selected port.
64	PORT_LIVE_LIST_STATUS_2	bit string , 8 bytes 256 bits	De 16 a 31	—		RO	Live list on the selected port.
65	PORT_LIVE_LIST_STATUS_3	bit string , 8 bytes 256 bits	De 32 a 47	—		RO	Live list on the selected port.
66	PORT_LIVE_LIST_STATUS_4	bit string , 8 bytes 256 bits	De 48 a 63	—		RO	Live list on the selected port.
67	PORT_LIVE_LIST_STATUS_5	bit string , 8 bytes 256 bits	De 64 a 79	—		RO	Live list on the selected port.
68	PORT_LIVE_LIST_STATUS_6	bit string , 8 bytes 256 bits	De 80 a 95	—		RO	Live list on the selected port.
69	PORT_LIVE_LIST_STATUS_7	bit string , 8 bytes 256 bits	De 96 a 111	—		RO	Live list on the selected port.
70	PORT_LIVE_LIST_STATUS_8	bit string , 8 bytes 256 bits	De 112 a 127	—		RO	Live list on the selected port.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
71	PORT_LIVE_LIST_STATUS_9	bit string , 8 bytes 256 bits	De 128 a 143	—		RO	Live list on the selected port.
72	PORT_LIVE_LIST_STATUS_10	bit string , 8 bytes 256 bits	De 144 a 159	—		RO	Live list on the selected port.
73	PORT_LIVE_LIST_STATUS_11	bit string , 8 bytes 256 bits	De 160 a 175	—		RO	Live list on the selected port.
74	PORT_LIVE_LIST_STATUS_12	bit string , 8 bytes 256 bits	De 176 a 191	—		RO	Live list on the selected port.
75	PORT_LIVE_LIST_STATUS_13	bit string , 8 bytes 256 bits	De 192 a 207	—		RO	Live list on the selected port.
76	PORT_LIVE_LIST_STATUS_14	bit string , 8 bytes 256 bits	De 208 a 223	—		RO	Live list on the selected port.
77	PORT_LIVE_LIST_STATUS_15	bit string , 8 bytes 256 bits	De 224 a 239	—		RO	Live list on the selected port.
78	PORT_LIVE_LIST_STATUS_16	bit string , 8 bytes 256 bits	De 240 a 254	—		RO	Live list on the selected port.
79	PORT_STATISTICS_RESET	unsigned char	Ok Reset	Ok		R/W	Resets port statistics.
80	PORT_ST_LIVE_LIST_REV	unsigned char	0 to 256	0		RO	Number of update on the live list. It is incremented every time a device leaves or enters in the live list.
81	PORT_ST_N_MACROCYCLE	unsigned long	0 to 2^{32}	0		RO	Number of macro cycle executed by the selected port.
82	PORT_ST_PDU_SENT	unsigned long	0 to 2^{32}	0		RO	Number of frames sent by the selected port.
83	PORT_ST_PDU_RECEIVED	unsigned long	0 to 2^{32}	0		RO	Number of frames received by the selected port.
84	PORT_ST_WRONG_FCS	unsigned long	0 to 2^{32}	0		RO	Number of frames with wrong FCS received by the selected port.
85	PORT_ST_CLAIM_LAS	unsigned long	0 to 2^{32}	0		RO	Number of Claim Las process initialized by the selected port.
86	PORT_ST_AP_DATA	unsigned long	0 to 2^{32}	0		RO	Percent of application data on the bus.
87	PORT_ST_CON_MAINTENANCE	unsigned long	0 to 2^{32}	0		RO	Percent of connection maintenance data on the bus. Including residual activity and connection frame.
88	PORT_ST_MAINTENANCE_DATA	unsigned long	0 to 2^{32}	0		RO	Percent of maintenance data on the bus.
89	DEVICE_CHANGE_PASSWORD	visible string, 32				R/W	Password to protect against unexpected change of the device address and device ID. Before write to device address and device ID write SYSTEM302 to this parameter.
90	DEVICE_SELECT	unsigned char	First Next None Previous	—		R/W	Selects the device to be analyzed or configured in the following parameters.
91	DEV_ADDRESS	unsigned char	0 to 256	—		R/W	Address of the selected device. Also used to select device by address.
92	DEV_ID	visible string		—		R/W	Device ID of the selected device.
93	DEV_TAG	visible string		—		RO	Device Tag.
94	DEV_STATUS	unsigned char	None Alive Complete DB	—		RO	Device database status in the interface Device.
95	DEV_FORCE_OUT	unsigned char	Force Ok	Ok		R/W	Write to this parameter triggers interface device to force the selected device to leave the network. It will be polled afterwards.
96	DEV_MANUFACTURER_ID	OctetString		—		RO	Device Manufacture ID.
97	DEV_TYPE_2	OctetString		—		RO	Device Type.
98	DEV_FIRST_BLOCK_INDEX	unsigned int	0 to 2^{16}	—		RO	Index of the first Function Block of the selected device.
99	DEV_FIRST_VCR_INDEX	unsigned int	0 to 2^{16}	—		RO	Index of the first VCR of the selected device.
100	DEV_FIRST_OBJECT_LINK_INDEX	unsigned int	0 to 2^{16}	—		RO	Index of the first Object Link of the selected device.
101	DEV_FIRST_FBSTART_INDEX	unsigned int	0 to 2^{16}	—		RO	Index of the first FB Start parameter of the selected device. FB Start defines the Function Block schedule.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
102	DEV_VFD_ID_SM	unsigned long	0 to 2^{32}	—		RO	VFD ID for system management and network management.
103	DEV_VFD_ID_FBAP	unsigned char	0 to 256	—		RO	VFD ID for function block application.
104	DEV_T1_ms	unsigned long	0 to 2^{32}	—		R/W	T1 timer used to the SM manager to timeout the confirmation of Assign Tag, Assign Address, or Enable SM Operation from the SM Agent.
105	DEV_T2_ms	unsigned long	0 to 2^{32}	—		R/W	T2 timer used by the SM Agent to timeout the Assign Address process.
106	DEV_T3_ms	unsigned long	0 to 2^{32}	—		R/W	T3 timer used to the SM manager to timeout before send the Enable SM Operation.
107	DEV_SLOT_TIME_octet	unsigned int	0 to 2^{16}	—		R/W	Devices on the network will use SLOT TIME and MAX_RESPONSE_DELAY to set a timeout to control some activity on the network.
108	DEV_MAX_RESPONSE_DELAY_octet	unsigned int	0 to 2^{16}	—		R/W	Devices on the network will use SLOT TIME and MAX_RESPONSE_DELAY to set a timeout to control some activity on the network.
109	DEV_MIN_INTER_PDU_DELAY_octet	unsigned int	0 to 2^{16}	—		R/W	Minimum time that the network needs to be silent to allow device to be ready to receive the next frame on the network.
110	DEV_MACROCYCLE_ms	unsigned long	0 to 2^{32}	—		R/W	Macro cycle for the function block application.
111	DEV_BLOCK_SELECT	unsigned char	First Next None Previous			R/W	Selects the block to be analyzed or configured in the following parameters.
112	BLK_TYPE	unsigned char	No Selection Resource Transducer Function Block	—		RO	Block Type (Resource, Transducer, or Function Block).
113	BLK_INDEX	unsigned int	0 to 2^{16}	—		R/W	Block Index.
114	BLK_TAG	visible string		—		R/W	Block Tag.
115	BLK_DD_ITEM	octet string		—		RO	Block DD Item.
116	BLK_FIRST_VIEW_INDEX	unsigned int	0 to 2^{16}	—		RO	Block index of first View.
117	DEV_VCR_SELECT	unsigned char	First Next None Previous	—		R/W	Selects the device VCR to be analyzed or configured in the following parameters.
118	VCR_INDEX	unsigned char	0 to 256	—		R/W	Selected VCR.
119	VCR_TYPE_AND_ROLE	unsigned char	Bnu, Publisher Bnu, Subscriber Qub, Client Qub, Server Quu, Source Quu, Sink Undefined	—		R/W	VCR type and role.
120	VCR_LOCAL_ADDR	octet string ,4		—		R/W	VCR Local address.
121	VCR_REMOTE_ADDR	octet string, 4		—		R/W	VCR Remote address.
122	VCR_PRIOTIRY	unsigned char	Invalid Normal Time Available Urgent	—		R/W	VCR priority.
123	VCR_DELIVERY_FEATURES	unsigned char	Classical Disordered Invalid Ordered Unordered	—		R/W	VCR delivery features.
124	VCR_AUTHENTICATION	unsigned char	Invalid Maximal Short Source	—		R/W	VCR authentication.
125	VCR_MAX_DLSDU_SIZE	unsigned int	0 to 2^{16}	—		R/W	VCR Maximum Dlsdu size.
126	VCR_VFD_ID	octet string, 4		—		R/W	VFD associated with the selected VCR.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
127	VCR_FEATURES_SUPPORTED_SEND	octet string, 4		—		R/W	VCR features supported for the send direction.
128	VCR_FEATURES_SUPPORTED_RCV	octet string, 4		—		R/W	VCR features supported for the receive direction.
129	VCR_WRITE_CMD	unsigned char	Access Ok Read Req Write Req	—		R/W	A write to this parameter will trigger the write for the selected VCR with the changed values.
130	DEV_OBJECT_LINK_SELECT	unsigned char	First Next None Previous	—		R/W	Selects the device object link to be analyzed or configured in the following parameters.
131	OBJECT_LINK_ID	unsigned char	0 to 256	—		R/W	Selected object link.
132	LNK_LOCAL_INDEX	unsigned int	0 to 2^{16}	—		R/W	Local index.
133	LNK_VCR	unsigned int	0 to 2^{16}	—		R/W	Index of the VCR associated with the selected object link.
134	LNK_REMOTE_INDEX	unsigned int	0 to 2^{16}	—		R/W	Remote index.
135	LNK_SERVICE	unsigned char	Alert Local MVC Publisher Subscriber Trend Undefined	—		R/W	Service performed by the selected object link.
136	LNK_STALE_CNT	unsigned char	0 to 256	—		R/W	The maximum number of consecutive stale input value before the status is set to BAD.
137	LNK_WRITE_CMD	unsigned char	Access Ok Read Req Write Req	Ok		R/W	A write to this parameter will trigger the write for the selected object link with the changed values.
138	DEV_FBSTART_SELECT	unsigned char	First Next None Previous	—		R/W	Select the device FB start parameter to be analyzed or configured in the following parameters.
139	FBSTART_ID	unsigned char	0 to 256	—		R/W	Selected FB Start.
140	FBSTART_OFFSET_ms	unsigned int	0 to 2^{16}	—		R/W	Offset time from the start of each macro cycle when the function block associated with this parameter will be executed.
141	FBSTART_FB_INDEX	unsigned int	0 to 2^{16}	—		R/W	Index of the function block associated with this parameter.
142	FBSTART_VFD_ID	unsigned long	0 to 2^{32}	—		R/W	VFD associated with this parameter.
143	FBSTART_WRITE_CMD	unsigned char	Access Ok Read Req Write Req	Access Ok		R/W	A write to this parameter will trigger the write for the selected FB Start parameter with the changed values.
144	WR_PARAMETER_VFD	unsigned char	MIB FBAP	—		R/W	VFD to which the parameter to be read/written belongs.
145	RW_PARAMETER_INDEX	unsigned int	0 to 2^{16}	—		R/W	Index of a parameter to be read/writing.
146	RW_PARAMETER_LENGTH	unsigned char	0 to 256	—		R/W	Length of a parameter to be read/writing.
147	RW_PARAMETER_DATA	octet string, 100				R/W	Read data or data to be written.
148	RW_READ_CMD	unsigned char	Access Ok Read Req Write Req	Access Ok		R/W	A write to this parameter will trigger the read for the selected parameter.
149	RW_WRITE_CMD	unsigned char	Access Ok Read Req Write Req	Access Ok		R/W	A write to this parameter will trigger the write for the selected parameter with the changed values in RW_PARAMETER_DATA.
150	DEV_STATISTICS_RESET	unsigned char	Ok Reset	—		R/W	Resets Device Statistics.
151	DEV_ST_N_LIVE_LIST_IN_OUT	unsigned int	0 to 2^{16}	—		RO	Number of times the device get in the interface device live list.
152	DEV_ST_N_PT_RETRIES	unsigned int	0 to 2^{16}	—		RO	Number of pass token retries to this device.
153	DEV_ST_N_DT_RETRIES	unsigned int	0 to 2^{16}	—		RO	Number of data retries to this device.
154	DEV_ST_N_DLPDU_TRANSMITTED	unsigned long	0 to 2^{32}	—		RO	Device number of DLPDU transmitted.
155	DEV_ST_N_GOOD_DLPDU_RCV	unsigned long	0 to 2^{32}	—		RO	Device number of good DLPDU received.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
156	DEV_ST_N_PARTIAL_RCV_PDU	unsigned long	0 to 2^{32}	—		RO	Device number of partial DLPDU received.
157	DEV_ST_N_FCS_FAILURES	unsigned long	0 to 2^{32}	—		RO	Device number of DLPDU with wrong FCS received.
158	DOWNLOAD_CONF_STATUS	unsigned char	Ok No data Processing	No data		RO	Status of maintenance procedure to download a configuration to a device based on the configuration saved previously on the interface device memory. **Note: Not Available. Replaced by partial download.**
159	READ_CONF	unsigned char	Ok Run	Ok		R/W	Command to read configuration and save on interface device memory. **Note: Not Available. Replaced by partial download.**
160	DOWNLOAD_CONF	unsigned char	Ok Run	Ok		R/W	Command to download the last saved configuration to a device or set of devices. **Note: Not Available. Replaced by partial download.**
161	BLK_EXECUTION_TIME	unsigned long	0 to 2^{32}	0		RO	Block Execution Time. This parameter belongs to the block section.
162	APPLICATION_TIME	timevalue		—		R/W	Adjusts the application time, in the interface device.
163	FEATURES	**bitstring**	**SM Timers optimization Automatic set tag/address FB Link status monitoring Hot Swap IDShell**				**Enables automatic procedures of the IDShell. Check notes (3). Note: Not Available.**
164	HOT_SWAP_STATE	**unsigned char**	**Disable Idle Verifying Configuring Rebuilding**				**Reports the procedure status when a device is replaced or re-configured. Note: Not Available.**
165	FB_LINK_STATUS	**unsigned char**	**Disable Ok Failure**				**Indicates the status of the strategy links. Note: Not Available.**
166	REBUILD		**DD Database Hot Swap Database MVC Configuration - Active Station MVC Configuration - Backup Station None**				**Triggers special procedures of the IDShell Application. Check notes (4).**
167	DD_DATABASE_STATUS	**unsigned char**	**Disable Failure Building Idle**				**Indicates the status of the database kept by the Interface Device that contains the information of data types and function block objects.**
168	MVC_STATE	**unsigned char**	**Disable Configuring Idle**				**Reports the state of the machine that configures the MVC. Note: Not Available.**
169	RED_ROLE_L	Unsigned8	1:Passive 2:Active 3:Backup 4:Active_Not_Link_Master 7:Sync_Idle 8:Sync_Main 9:Sync_Backup	7	E	D / RO	Redundancy Role for the local device Idem FUNCTION_IDS description.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
170	RED_STATE_L	Unsigned8	0:Not Ready 1:Standby 2:Active	0	E	D / RO	Redundancy State for the local device **Not Ready** – Not ready to run. **Standby** – Live but not running. **Active** – Running the tasks.
171	RED_SYNC_STATUS _L	Unsigned8	0: Not defined 1: Stand Alone 2: Synchronizing 3: Updating Remote 4: Maintenance 5: Synchronized 6: WARNING: Role Conflict 7: WARNING: Sync Cable Fail 8: WARNING: Updating Remote Fail 9: Warning 1 10: Warning 2	0	E	D / RO	Synchronism Status for the local device 0: Initial value 1: Stand alone operation 2: Checking configuration for synchronize 3: Transferring all the configuration to remote 4: Receiving all the configuration from remote 5: The modules are completely updated with each other 6: The spare module has the same Role of that is running 7: Fail on the synchronism cable 8: Fail on the updating remote 9: Future use 10: Future use
172	RED_ROLE_R	Unsigned8	7:Sync_Idle 8:Sync_Main 9:Sync_Backup	7	E	D / RO	Redundancy Role for the remote device Idem FUNCTION_IDS description.
173	RED_STATE_R	Unsigned8	0:Not Ready 1:Standby 2:Active	0	E	D / RO	Redundancy State for the remote device Idem RED_STATE_L description.
174	RED_SYNC_STATUS_R	Unsigned8	0: Not defined 1: Stand Alone 2: Synchronizing 3: Updating Remote 4: Maintenance 5: Synchronized 6: WARNING: Role Conflict 7: WARNING: Sync Cable Fail 8: WARNING: Updating Remote Fail 9: Warning 1 10: Warning 2	0	E	D / RO	Synchronism Status for the remote device 0: Initial value 1: Stand alone operation 2: Checking configuration for synchronize 3: Transferring all the configuration to remote 4: Receiving all the configuration from remote 5: The modules are completely updated with each other 6: The spare module has the same Role of that is running 7: Fail on the synchronism cable 8: Fail on the updating remote 9: Future use 10: Future use
175	RED_BAD_CONDITIONS_L	Bitstring(2)		<None>	E	D / RO	Bad conditions for the local device See detailed description on users manual
176	RED_BAD_CONDITIONS_R	Bitstring(2)		<None>	E	D / RO	Bad conditions for the remote device See detailed description on users manual
177	RED_RESERVED1	Unsigned8	0 ~ 255	0	NA	D / RW	Reserved for future use.
178	RED_RESERVED2	Unsigned8	0 ~ 255	0	NA	D / RW	Reserved for future use.
179	RED_MAIN_WDG	Unsigned8	0 ~ 255	0	NA	D / RO	Watchdog indicating communication with Main.
180	RED_BACKUP_WDG	Unsigned8	0 ~ 255	0	NA	D / RO	Watchdog indicating communication with Backup.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - Static

Gray Background Line: Custom Parameters

Notes:

(1) Macro cycle Equation:

$T_M = (N_E * 30 + N_D * T_R) * 1.2$

where T_M = macro cycle (ms)

N_E = number of external links

N_D = number of devices

T_R = 30 ms for single operation or

60 ms for redundant operation

(2) Equation:

$T1 < T2 > T3$

$T3 >$ cycle to poll the valid address in the network.

(3) SM Timers Optimization - default: enabled.

IDShell will find the value of T1, T2, T3 suitable to the system.

Automatic Set Tag/Address - default: enabled.

IDShell will automatically set a valid address and tag to a device added to the network. IDShell will solve any collision of address and/or tag.

FB Link Status Monitoring - default: disabled.

IDShell monitor all function block links and indicates the status through FB_LINK_STATUS.

Hot Swap - default: disabled.

IDShell hold information of the function block links for all 4 ports and automatically perform the configuration of the device if Hot Swap function is enabled.

(4) DD Database – the current database is created and a new database with the data types and function block object is rebuild.

Hot Swap Database – IDShell build the function block link database from the information in the network.

MVC Configuration - Active Station/Backup Station – IDShell re-configure the MVC to optimize the communication performance of the network.

Input Transducer Blocks

LD292 / LD302 - Pressure Transducer

Description

The pressure transducer makes the corrected pressure sensor reading PRIMARY_VALUE available to the AI block. The engineering unit and the primary value range are selected from the XD_SCALE in the AI block. The units allowed are: Pa, KPa, MPa, bar, mbar, torr, atm, psi, g/cm², kg/cm², inH20 a 4°C, inH2O a 68°F, mmH20 a 68°F, mmH20 a 4°C, ftH20 a 68°F, inHg a 0°C, mmHg a 0°C. The XD_SCALE range must be inside the sensor range in the unit selected. Note that the XD_SCALE should be used to cancel out wet-legs etc. instead of calibration. The supported mode is OOS and AUTO. As the transducer block runs together with AI block, the transducer block goes to AUTO only if the AI mode block is already in AUTO. The sensor temperature may be read from the SECONDARY_VALUE parameter.

Warning messages may appear in Primary Value status or in the Block Error in certain condition as explain below.

Supported Modes

OOS and AUTO.

BLOCK_ERR

The BLOCK_ERR of the transducer block will reflect the following causes:

- Input Failure – When sensor is disconnected from main electronic board, or the pressure is higher or lower 27.5% of the sensor limit;
- Out of Service – When the block is in OOS mode**.**

Primary_Value Status

The PRIMARY_VALUE status of the transducer block will reflect the following causes:

- Bad::SensorFailure:NotLimited – When sensor is disconnected from main electronic board, or the pressure is higher or lower 27.5% of the sensor limit;
- Uncertain::SensorConvertionNotAccurate:NotLimited – when pressure is between 27.5% of sensor limit and the sensor limit.

Parameters

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
1	ST_REV	Unsigned16	Positive	0	None	S	Indicates the level of static data.
2	TAG_DESC	VisibleString		Null	Na	S	Description of Transducer Block.
3	STRATEGY	Unsigned16		0	None	S	This parameter is not checked and processed by Transducer Block.
4	ALERT_KEY	Unsigned8	1-255	0	Na	S	Number of identification in the plant.
5	**MODE_BLK**	**DS-69**	**OOS,AUTO**	**OOS**	**None**	**S**	**Indicates the operation mode of Transducer Block.**
6	**BLOCK_ERR**	**Bit String**		**Out of Service**	**E**	**D**	**Indicates the status associated with hardware or software in the Transducer.**
7	UPDATE_EVT	DS-73		*	Na	D	It is the alert for any static data.
8	BLOCK_ALM	DS-72		*	Na	D	It is used for configuration, hardware and others failures.
9	TRANSDUCER_DIRECTORY	Array of Unsigned16		0	None	N	It is used to select several Transducer Blocks.
10	TRANSDUCER_TYPE	Unsigned16		Pressure	None	N	Indicates the type of Transducer according to its class.
11	XD_ERROR	Unsigned8		Default value set	None	D	It is used to indicate calibration status.
12	COLLECTION_DIRECTORY	Array of Unsigned 32		0	None	S	Specifies the number of transducer index into Transducer Block.
13	PRIMARY_VALUE_TYPE	Unsigned16		Diff Pressure	None	S	Defines the calculation type for Transducer Block.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
14	**PRIMARY_VALUE**	**DS-65**		*****	**PVR**	**D**	**It is the value and status used by channel.**
15	**PRIMARY_VALUE_RANGE**	**DS-68**		*****	**PVR**	**S**	**The High and Low range limit values, the engineering unit code and the number of digits to the right of the decimal point to be used for Primary Value.**
16	CAL_POINT_HI	Float		*	CU	S	The highest calibrated value.
17	CAL_POINT_LO	Float		*	CU	S	The lowest calibrated value.
18	CAL_MIN_SPAN	Float	URL/40 to URL	*	CU	S	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points (high and low) are not too close together.
19	CAL_UNIT	Unsigned16		*	E	S	The Device Description engineering units code index for the calibration values.
20	SENSOR_TYPE	Unsigned16		Capacitance	Na	S	The type of sensor.
21	SENSOR_RANGE	DS-68		*	PVR	S	The range of sensor.
22	SENSOR_SN	Unsigned32	0 to 2^{32}	*	None	S	The serial number of sensor.
23	SENSOR_CAL_METHOD	Unsigned8		Factory Cal.	None	S	The method of last sensor calibration. ISO defines several standard methods of calibration. This parameter is intended to record that method, or if some other method was used.
24	SENSOR_CAL_LOC	VisibleString		NULL	None	S	The location of last sensor calibration. This describes the physical location at which the calibration was performed.
25	SENSOR_CAL_DATE	Time of Day		Unspecified	None	S	The date of the last sensor calibration.
26	SENSOR_CAL_WHO	VisibleString		NULL	None	S	The name of person who is in charge of last calibration.
27	SENSOR_ISOLATION_MTL	Unsigned16		Unspecified	None	S	Defines the construction material of the isolating diaphragms.
28	SENSOR_FLUID	Unsigned16		Inert	None	S	Defines the type of fill fluid used in the sensor
29	**SECONDARY_VALUE**	**DS-65**		*****	**SVU**	**D**	**The secondary value (temperature value), related to the sensor.**
30	**SECONDARY_VALUE_UNIT**	**Unsigned16**		**Celsius**	**E**	**S**	**The engineering units to be used with SECONDARY_VALUE.**
31	PRESS_LIN_NORMAL	DS-65	± 1	*	None	D	The Linear Normalized Pressure value.
32	PRESS_NORMAL	DS-65	± 1	*	None	D	The Normalized Pressure value.
33	PRESS_CUTOFF	DS-65	± 1	*	None	D	The Cutoff Pressure value.
34	CUTOFF_FLAG	Unsigned8	True/False	False	None	S	The bypass flag for Pressure value.
35	DIGITAL_TEMPERATURE	DS-65	0-255	*	None	D	The digital temperature value.
35	DIFF	Float		*	None	D	The differential pressure value.
37	YDIFF	Float		*	None	D	The y differential pressure value.
38	CAPACITANCE_LOW	Float		*	None	D	The low capacitance value.
39	CAPACITANCE_HIGH	Float		*	None	D	The high capacitance value.
40	BACKUP_RESTORE	Unsigned8		None	None	S	This parameter is used to backup or to restore configuration data.
41	SENSOR_RANGE_CODE	Unsigned16		*	None	S	Indicates the sensor range code.
42	COEFF_POL0	Float	± INF	*	None	S	The polynomial coefficient 0.
43	COEFF_POL1	Float	± INF	*	None	S	The polynomial coefficient 1.
44	COEFF_POL2	Float	± INF	*	None	S	The polynomial coefficient 2.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
45	COEFF_POL3	Float	± INF	*	None	S	The polynomial coefficient 3.
46	COEFF_POL4	Float	± INF	*	None	S	The polynomial coefficient 4.
47	COEFF_POL5	Float	± INF	*	None	S	The polynomial coefficient 5.
48	COEFF_POL6	Float	± INF	*	None	S	The polynomial coefficient 6.
49	COEFF_POL7	Float	± INF	*	None	S	The polynomial coefficient 7.
50	COEFF_POL8	Float	± INF	*	None	S	The polynomial coefficient 8.
51	COEFF_POL9	Float	± INF	*	None	S	The polynomial coefficient 9.
52	COEFF_POL10	Float	± INF	*	None	S	The polynomial coefficient 10.
53	COEFF_POL11	Float	± INF	*	None	S	The polynomial coefficient 11.
54	POLYNOMIAL_VERSION	Unsigned8	30h to FFh	*	None	S	Indicates the polynomial version.
55	CHARACTERIZATION_TYPE	Unsigned8		Other	None	S	Indicates the type of characterization curve.
56	CURVE _BYPASS_LD	Unsigned16		Disable or allow enter points	None	S	Enable and disable the characterization curve.
57	CURVE_LENGTH	Unsigned8	2 to 5	5	None	S	Indicates the length of characterization curve.
58	CURVE_X	Array of Float		*	None	S	Input points of characterization curve.
59	CURVE_Y	Array of Float		*	None	S	Output points of characterization curve.
60	CAL_POINT_HI_BACKUP	Float		*	CU	S	Indicates the backup for high calibration point.
61	CAL_POINT_LO_ BACKUP	Float		*	CU	S	Indicates the backup for low calibration point.
62	CAL_POINT_HI_FACTORY	Float		*	CU	S	Indicates the factory high calibration point.
63	CAL_POINT_LO_FACTORY	Float		*	CU	S	Indicates the factory low calibration point.
64	CAL_TEMPERATURE	Float	-40 a 85 °C	*	°C	S	Defines the temperature calibration point.
65	DATASHEET	Array of Unsigned8		*	None	S	Indicates information about the sensor.
66	ORDERING_CODE	VisibleString		Null	None	S	Indicates information about the sensor and control from factory production.
67	MAXIMUM_MEASURED_PRESSURE	Float	± INF	- Inf	None	S	Indicates the maximum pressure measured
68	MAXIMUM_MEASURED_TEMPERATURE	Float	± INF	- Inf	None	S	Indicates the maximum temperature measured
69	ACTUAL_OFFSET	Float	± INF	*	None	S	Indicates the actual calibrated offset
70	ACTUAL_SPAN	Float	± INF	*	None	S	Indicates the actual span offset
71	MAXIMUM_OFFSET_DEVIATION	Float	± INF	0.5	None	S	Defines the maximum offset before an alarm is generate
72	MAXIMUM_GAIN_DEVIATION	Float	± INF	2.0	None	S	Defines the maximum gain before an alarm is generate
73	OVERPRESSURE_LIMIT	Float	± INF	+ Inf	None	S	Defines the maximum overpressure limit before an alarm is generate
74	MAXIMUM_NUMBER_OF_OVERPRESSURE	Float	± INF	0	None	S	Defines the maximum number of overpressure before an alarm is

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static
CU: CAL_UNIT; PVR – PRIMARY_VALUE_RANGE; Sec: Seconds; SR: SENSOR_RANGE; SVU: SECONDARY_VALUE_RANGE

Gray Background Line: Default Parameters of Syscon

DT302 - Concentration/Density Transmitter

Description

The density transducer makes the corrected reading PRIMARY_VALUE available to the AI block according to configured MEASURED_TYPE. The engineering unit and the primary value range are selected from the XD_SCALE in the AI block. The units allowed are: g/cm³, Kg/m³, lb/ft³, Kg/m³, Kg/m³, degBaum, degBrix, %Plato, INPM, GL, %Soli/wt and API. The XD_SCALE range must be inside the sensor range in the unit selected. The supported mode is OOS and AUTO. As the transducer block runs together with AI block, the transducer block goes to AUTO only if the AI mode block is already in AUTO. The sensor temperature may be read from the SECONDARY_VALUE parameter.

Warning messages may appear in Primary Value status or in the Block Error in certain condition as explain below.

Supported Modes

OOS and AUTO.

BLOCK_ERR

The BLOCK_ERR of the transducer block will reflect the following causes:

- Input Failure – When sensor is disconnected from main electronic board, or the process is out of the sensor range.
- Out of Service – When the block is in OOS mode.

Primary_Value Status

The PRIMARY_VALUE status of the transducer block will reflect the following causes:

- Bad::SensorFailure:NotLimited – When sensor is disconnected from main electronic board, or the process is out of the sensor range.

Parameters

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
1	ST_REV	Unsigned16	Positive	0	None	S	Indicates the level of static data.
2	TAG_DESC	VisibleString		Null	Na	S	Description of Transducer Block.
3	STRATEGY	Unsigned16		0	None	S	This parameter is not checked and processed by Transducer Block.
4	ALERT_KEY	Unsigned8	1-255	0	Na	S	Number of identification in the plant.
5	**MODE_BLK**	**DS-69**	**OS,AUTO**	**O/S**	**None**	**S**	**Indicates the operation mode of Transducer Block.**
6	**BLOCK_ERR**	**Bit String**			**E**	**D**	**Indicates the status associated with hardware or software in the Transducer.**
7	UPDATE_EVT	DS-73			Na	D	It is the alert for any static data.
8	BLOCK_ALM	DS-72			Na	D	It is used for configuration, hardware and others failures.
9	TRANSDUCER_DIRECTORY	Array of Unsigned16			None	N	It is used to select several Transducer Blocks.
10	TRANSDUCER_TYPE	Unsigned16		100	None	N	Indicates the type of Transducer according to its class.
11	XD_ERROR	Unsigned8		0	None	D	It is used to indicate calibration status.
12	COLLECTION_DIRECTORY	Array of Unsigned 32			None	S	Specifies the number of transducer index into Transducer Block.
13	**PRIMARY_VALUE_TYPE**	**Unsigned16**		**Pressure**	**None**	**S**	**Defines the calculation type for Transducer Block.**
14	**PRIMARY_VALUE**	**DS-65**		**0**	**PVR**	**D**	**It is the value and status used by channel.**
15	**PRIMARY_VALUE_RANGE**	**DS-68**	**0-100%**		**PVR**	**S**	**The High and Low range limit values, the engineering unit code and the number of digits to the right of the decimal point to be used for PRIMARY_VALUE.**
16	CAL_POINT_HI	Float		5080.0	CU	S	The highest calibrated value.
17	CAL_POINT_LO	Float		0.0	CU	S	The lowest calibrated value.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
18	CAL_MIN_SPAN	Float	URL/40 to URL	0.0	CU	S	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points (high and low) are not too close together.
19	CAL_UNIT	Unsigned16		MmH2O	E	S	The Device Description engineering units code index for the calibration values.
20	SENSOR_TYPE	Unsigned16		117	Na	S	The type of sensor.
21	SENSOR_RANGE	DS-68		0-100%	PVR	S	The range of sensor.
22	SENSOR_SN	Unsigned32	0 to 2^{32}	0	None	S	The serial number of sensor.
23	SENSOR_CAL_METHOD	Unsigned8		103	None	S	The method of last sensor calibration. ISO defines several standard methods of calibration. This parameter is intended to record that method, or if some other method was used.
24	SENSOR_CAL_LOC	VisibleString		NULL	None	S	The location of last sensor calibration. This describes the physical location at which the calibration was performed.
25	SENSOR_CAL_DATE	Time of Day			None	S	The date of the last sensor calibration.
26	SENSOR_CAL_WHO	VisibleString		NULL	None	S	The name of person who is in charge of last calibration.
27	SENSOR_ISOLATION_MTL	Unsigned16		2	None	S	Defines the construction material of the isolating diaphragms.
28	SENSOR_FLUID	Unsigned16		1	None	S	Defines the type of fill fluid used in the sensor
29	**SECONDARY_VALUE**	**DS-65**		**0**	**SVU**	**D**	**The secondary value (temperature value), related to the sensor.**
30	**SECONDARY_VALUE_UNIT**	**Unsigned16**		**1001 (°C)**	**E**	**S**	**The engineering units to be used with SECONDARY_VALUE.**
31	PRESS_LIN_NORMAL	DS-65	± 1	0	None	D	The Linear Normalized Pressure value.
32	PRESS_NORMAL	DS-65	± 1	0	None	D	The Normalized Pressure value.
33	PRESS_CUTOFF	DS-65	± 1	0	None	D	The Cutoff Pressure value.
34	CUTOFF_FLAG	Unsigned8	True/False	True	None	S	The bypass flag for Pressure value.
35	DIGITAL_TEMPERATURE	DS-65	0-255	0	None	D	The digital temperature value.
35	DIFF	Float		0	None	D	The differential pressure value.
37	YDIFF	Float		0	None	D	The y differential pressure value.
38	CAPACITANCE_LOW	Float		0	None	D	The low capacitance value.
39	CAPACITANCE_HIGH	Float		0	None	D	The high capacitance value.
40	BACKUP_RESTORE	Unsigned8		0	None	S	This parameter is used to do backup or to restore configuration data.
41	SENSOR_RANGE_CODE	Unsigned16		1	None	S	Indicates the sensor range code.
42	COEFF_POL0	Float	± INF	-1	None	S	The polynomial coefficient 0.
43	COEFF_POL1	Float	± INF	0	None	S	The polynomial coefficient 1.
44	COEFF_POL2	Float	± INF	1	None	S	The polynomial coefficient 2.
45	COEFF_POL3	Float	± INF	0	None	S	The polynomial coefficient 3.
46	COEFF_POL4	Float	± INF	2	None	S	The polynomial coefficient 4.
47	COEFF_POL5	Float	± INF	0	None	S	The polynomial coefficient 5.
48	COEFF_POL6	Float	± INF	0	None	S	The polynomial coefficient 6.
49	COEFF_POL7	Float	± INF	0	None	S	The polynomial coefficient 7.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
50	COEFF_POL8	Float	± INF	0	None	S	The polynomial coefficient 8.
51	COEFF_POL9	Float	± INF	0	None	S	The polynomial coefficient 9.
52	COEFF_POL10	Float	± INF	0	None	S	The polynomial coefficient 10.
53	COEFF_POL11	Float	± INF	25	None	S	The polynomial coefficient 11.
54	POLYNOMIAL_VERSION	Unsigned8	30h to FFh	32	None	S	Indicates the polynomial version.
55	CHARACTERIZATION_TYPE	Unsigned8		255	None	S	Indicates the type of characterization curve.
56	CURVE _BYPASS_LD	Unsigned16		Enable&Backup Cal	None	S	Enable and disable the characterization curve.
57	CURVE_LENGTH	Unsigned8	2 to 5	5	None	S	Indicates the length of characterization curve.
58	CURVE_X	Array of Float			None	S	Input points of characterization curve.
59	CURVE_Y	Array of Float			None	S	Output points of characterization curve.
60	CAL_POINT_HI_BAKUP	Float		5080	CU	S	Indicates the backup for high calibration point.
61	CAL_POINT_LO_BAKUP	Float		0	CU	S	Indicates the backup for low calibration point.
62	CAL_POINT_HI_FACTORY	Float		5080	CU	S	Indicates the factory high calibration point.
63	CAL_POINT_LO_FACTORY	Float		0	CU	S	Indicates the factory low calibration point.
64	CAL_TEMPERATURE	Float	-40 a 85 °C	17.496	°C	S	Defines the temperature calibration point.
65	DATASHEET	Array of Unsigned8			None	S	Indicates information about the sensor.
66	ORDERING_CODE	VisibleString		NULL	None	S	Indicates information about the sensor and control from factory production.
67	MAXIMUM_MEASURED_PRESSURE	Float	± INF	- INF	None	S	Indicates the maximum pressure measured.
68	MAXIMUM_MEASURED_TEMPERATURE	Float	± INF	- INF	None	S	Indicates the maximum temperature measured.
69	ACTUAL_OFFSET	Float	± INF		None	S	Indicates the actual calibrated offset.
70	ACTUAL_SPAN	Float	± INF		None	S	Indicates the actual span offset.
71	MAXIMUM_OFFSET_DEVIATION	Float	± INF	0.5	None	S	Defines the maximum offset before an alarm is generated.
72	MAXIMUM_GAIN_DEVIATION	Float	± INF	2.0	None	S	Defines the maximum gain before an alarm is generated.
73	OVERPRESSURE_LIMIT	Float	± INF	+ INF	None	S	Defines the maximum overpressure limit before an alarm is generated.
74	MAXIMUM_NUMBER_OF_OVERPRESSURE	Float	± INF	0	None	S	Defines the maximum number of overpressure before an alarm is generated.
75	GRAVITY	Float		9.785340	None	S	Gravity acceleration.
76	HEIGHT	Float		0.5002	None	S	Distance between the two pressure sensor.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
77	**MEASURED_TYPE**	**Unsigned 8**		**Kg/m^3**	**None**	**S**	**When the transducer is set as density, there are the following choices:** **1 - Density (g/cm^3);** **2 - Density (Kg/m^3);** **3 - Density related to 20°C (g/cm^3);** **4 - Density related to 4°C (g/cm^3);** **5 - Degree Baume;** **6 - Degree Brix;** **7 - Degree Plato;** **8 - Degree INPM;** **9 - GL;** **10 - Solid Percent;** **11 - Density (lb/ft^3);** **12 –API.**
78	LIN_DILATATION_COEF	Float		0.000016	None	S	Linear dilatation coefficient.
79	PRESSURE_COEFFICIE NT	Float		0.5	None	S	Pressure coefficient.
80	TEMP_ZERO	Float			None	S	Offset coefficient for temperature sensor.
81	TEMP_GAIN	Float			None	S	Gain coefficient for the temperature sensor.
82	ZERO_ADJUST_TEMP	Float		20.0	None	S	Zero adjustment temperature.
83	HEIGHT_MEAS_TEMP	Float		20.0	None	S	Temperature when height was measured
84	AUTO_CAL_POINT_LO	Float			None	S	This parameter enables a method for lower calibration. The probe should be in the air and the MEASURED_TYPE and XD_SCALE.UNIT must be Kg/cm^3.
85	AUTO_CAL_POINT_HI	Float			None	S	This parameter enables a method for upper calibration. The probe should be into water and the MEASURED_TYPE and XD_SCALE.UNIT must be Brix. The calibration point is 0 Brix.
86	SOLID_POL_COEFF_0	Float		-0.4987	None	S	Polynomial Coefficient 0 for Solid Percent.
87	SOLID_POL_COEFF_1	Float		1.6229	None	S	Polynomial Coefficient 1 for Solid Percent.
88	SOLID_POL_COEFF_2	Float		-0.0192	None	S	Polynomial Coefficient 2 for Solid Percent.
89	SOLID_POL_COEFF_3	Float		0.0005	None	S	Polynomial Coefficient 3 for Solid Percent.
90	SOLID_POL_COEFF_4	Float		0	None	S	Polynomial Coefficient 4 for Solid Percent.
91	SOLID_POL_COEFF_5	Float		0	None	S	Polynomial Coefficient 5 for Solid Percent.
92	SOLID_LIMIT_LO	Float		0	None	S	Limit lower for Solid Percent.
93	SOLID_LIMIT_HI	Float		100	None	S	Limit upper for Solid Percent.
94	PRESS_COMP	Float			None	S	Factory use
95	SIMULATE_PRESS_ENA BLE	Unsigned 8			None	D	Enable the simulation mode.
96	SIMULATE_PRESS_VAL UE	Float			None	D	Simulate a pressure value in mmH2O a 68°F. Used with SIMULATE_PRESS_ENABLE.
97	SIMULATE_DENSITY_VA LUE	Float			None	D	Simulate density value used to calculate the pressure value.
98	CALCULATED_PRESS_V ALUE	Float			None	D	Calculated pressure according to SIMULATE_DENSITY_VALUE.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
99	CALC_PRESS_CAL_POINT_LO	Float			None	D	Pressure value from AUTO_CAL_POINT_LO method
100	CALC_PRESS_CAL_POINT_HI	Float			None	D	Pressure value from AUTO_CAL_POINT_HI method.
101	DT_RANGE_CODE	Unsigned 8			None	S	Range code. Range 1 (0.5 @ 1.25 g/cm^3) Range 2 (1.0 @ 2.5 g/cm^3) Range 3 (2.0 @ 5.0 g/cm^3)

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static
CU: CAL_UNIT; PVR – PRIMARY_VALUE_RANGE; Sec: Seconds; SR: SENSOR_RANGE; SVU: SECONDARY_VALUE_RANGE

Gray Background Line: Default Parameters of Syscon

TT302 - Temperature Transducer

Description

The temperature transducer makes the direct corrected input or linearized temperature sensor reading PRIMARY_VALUE available to the AI block. The sensor type, the connection and the calculation type are configured at SENSOR_TYPE, SENSOR_CONNECTION and PRIMARY_VALUE_TYPE respectively. Note that when two sensors are being used (i.e. backup, differential or double) the only sensor connection available is two wires. The engineering unit and the primary value range are selected from the XD_SCALE in the AI block. The units allowed are: Ohm for resistance sensor, mV for millivoltage sensor and °C, °F, °R, K for temperature sensor. The XD_SCALE range must be inside the sensor range in the unit selected. The selection of transducer number is done in SENSOR_TRANSDUCER_NUMBER. The second transducer will exist only when the sensor connection is double two wires. In this case two sensors will generate inputs for two transducers. When the sensor works as a backup the second sensor will generate the input if the first one fails. When the sensor works as a differential, the output is the difference of the two inputs. The AI block connected to this transducer has the CHANNEL the same selection as SENSOR_TRANSDUCER_NUMBER. The supported mode is OOS and AUTO. As the transducer block runs together with AI block, the transducer block goes to AUTO only if the AI mode block is already in AUTO. The cold-junction temperature may be read from the SECONDARY_VALUE parameter.

Warning messages may appear in Primary Value status or in the Block Error in certain condition as explain below.

Supported Modes

OOS and AUTO.

BLOCK_ERR

The BLOCK_ERR of the transducer block will reflect the following causes:

- Input Failure – When the sensor is broken or the sensor reading is out of limits
- Out of Service – When the block is in OOS mode.

Primary_Value Status

The PRIMARY_VALUE status of the transducer block will reflect the following causes:

- Bad::SensorFailure:NotLimited – When the sensor is broken or the sensor reading is out of limits.

Parameters

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
1	ST_REV	Unsigned16	Positive	0	None	S	Indicates the level of static data.
2	TAG_DESC	Octet String		Nulls	Na	S	Description of Transducer Block.
3	STRATEGY	Unsigned16		0	None	S	This parameter is not checked and processed by Transducer Block.
4	ALERT_KEY	Unsigned8	1-255	0	None	S	Number of identification in the plant.
5	**MODE_BLK**	**DS-69**	**See Mode**	**OOS**	**Na**	**Mix**	**Indicates the operation mode of Transducer Block.**
6	**BLOCK_ERR**	**Bit String**		**Out of Service**		**D**	**Indicates the status associated with hardware or software in the Transducer.**
7	UPDATE_EVT	DS-73		*	Na	D	It is the alert for any static data.
8	BLOCK_ALM	DS-72		*	Na	D	It is used for configuration, hardware and others failures.
9	TRANSDUCER_DIRECTORY	Array of Unsigned16		0	None	N	It is used to select several Transducer Blocks.
10	TRANSDUCER_TYPE	Unsigned16	See Table	Temperature	E	N	Indicates the type of Transducer according to its class.
11	XD_ERROR	Unsigned8	See Table	Default value set	None	D	It is used to indicate calibration status.
12	COLLECTION_DIRECTORY	Array of Unsigned16		0	None	N	Specifies the number of transducer index into Transducer Block.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
13	**PRIMARY_VALUE_TYPE**	**Unsigned16**	**See Table**	**Process temp.**	**E**	**S**	**Defines the calculation type for Transducer Block.**
14	**PRIMARY_VALUE**	**DS-65**		*****	**PVR**	**D**	**It is the value and status used by channel 1, 2 and 3.**
15	**PRIMARY_VALUE_RANGE**	**DS-68**		**-200/850/Celsius**	**PVR**	**NS**	**The High and Low range limit values, the engineering unit code and the number of digits to the right of the decimal point to be used for Primary Value.**
16	CAL_POINT_HI	Float	+INF	850.0	CU	S	The highest calibrated value.
17	CAL_POINT_LO	Float	-INF	-250.0	CU	S	The lowest calibrated value.
18	CAL_MIN_SPAN	Float		10.0	CU	N	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points (high and low) are not too close together.
19	CAL_UNIT	Unsigned16	See Table	Celsius	E	S	The Device Description engineering units code index for the calibration values.
20	**SENSOR_TYPE**	**Unsigned16**	**See Table**	**Pt100 IEC**	**E**	**S**	**The type of sensor.**
21	SENSOR_RANGE	DS-68		-200/850/Celsius	SR	N	The range of sensor.
22	SENSOR_SN	Unsigned Long		0	None	N	The sensor serial number.
23	SENSOR_CAL_METHOD	Unsigned8	Factory/User	Factory trim	E	S	The method of last sensor calibration. ISO defines several standard methods of calibration. This parameter is intended to record that method, or if some other method was used.
24	SENSOR_CAL_LOC	Visible String		NULL	None	S	The location of last sensor calibration. This describes the physical location at which the calibration was performed.
25	SENSOR_CAL_DATE	Time of Day		Unspecified	None	S	The date of the last sensor calibration.
26	SENSOR_CAL_WHO	Visible String		NULL	None	S	The name of person who is in charge of last calibration.
27	**SENSOR_CONNECTION**	**Unsigned8**	**Double, two, three and four**	**Three wires**	**E**	**S**	**Indicates the number of wires of the sensor connected in the terminal block. It is not possible to change the connection of Transducer 2.**
28	**SECONDARY_VALUE**	**DS-65**	**± INF**	*****	**SVU**	**D**	**The secondary value related to the temperature sensor.**
29	**SECONDARY_VALUE_UNIT**	**Unsigned16**	**See Table**	**Celsius**	**E**	**S**	**The engineering units to be used with the secondary value related to the sensor.**
30	MODULE_SN	Unsigned Long		0	None	N	The module serial number.
31	SECONDARY_VALUE_ACTION	Unsigned8	Enable/Disable	Enable		S	Enable the cold junction compensation.
32	BACKUP_RESTORE	Unsigned8		None	Na	S	This parameter is used to backup or to restore configuration data.
33	CAL_POINT_HI_LAST	Float	+INF	850.0	CU	S	Indicates the last high calibration point.
34	CAL_POINT_LO_LAST	Float	-INF	-200.0	CU	S	Indicates the last low calibration point.
35	CAL_POINT_HI_FACTORY	Float	+INF	850.0	CU	S	Indicates the high factory calibration point.
35	CAL_POINT_LO_FACTORY	Float	-INF	-200.0	CU	S	Indicates the low factory calibration point.
37	ORDERING_CODE	Visible String		*	Na	S	Indicates information about factory production.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
38	TWO_WIRES_COMPENSATION	Unsigned8	Enable/Disable	Disable	Na	D	Allows the compensation of line resistance for double RTD or Ohm sensors.
39	**SENSOR_TRANSDUCER_NUMBER**	**Unsigned8**	**1,2**	**1**	**Na**	**S**	**Selects the Transducer 1 or 2.**
40	FACTORY_DIGITAL_INPUTS	Array of Float		*	None	D	Reads the digital inputs.
41	FACTORY_GAIN_REFERENCE	Unsigned8		0	None	D	Factory use.
42	FACTORY_BORNE_REFERENCE	Unsigned8	1	0	None	D	Factory use.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static CU: CAL_UNIT; PVR – PRIMARY_VALUE_RANGE; Sec: Seconds; SR: SENSOR_RANGE; SVU: SECONDARY_VALUE_RANGE

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Sensor Type	Class	Sensor range – 2-wire (Celsius)	Sensor range – Differential (Celsius)
Cu 10 GE	RTD	-20 to 250	-270 to 270
Ni 120 DIN		-50 to 270	-320 to 320
Pt 50 IEC		-200 to 850	-1050 to 1050
Pt 100 IEC		-200 to 850	-1050 to 1050
Pt 500 IEC		-200 to 450	-650 to 650
Pt 50 JIS		-200 to 600	-800 to 800
Pt 100 JIS		-200 to 600	-800 to 800
0 to 100	Ohm	0 to 100	-100 to 100
0 to 400		0 to 400	-400 to 400
0 to 2000		0 to 2000	-2000 to 2000
B NBS	TC	100 to 1800	-1700 to 1700
E NBS		-100 to 1000	-1100 to 1100
J NBS		-150 to 750	-900 to 900
K NBS		-200 to 1350	-1550 to 1550
N NBS		-100 to 1300	-1400 to 1400
R NBS		0 to 1750	-1750 to 1750
S NBS		0 to 1750	-1750 to 1750
T NBS		-200 to 400	-600 to 600
L DIN		-200 to 900	-1100 to 1100
U DIN		-200 to 600	-800 to 800
-6 to 22	MV	-6 to 22	-28 to 28
-10 to 100		-10 to 100	-110 to 110
-50 to 500		-50 to 500	-550 to 550

IF302 - Current Fieldbus Transducer

Description

The current fieldbus transducer makes the current input reading PRIMARY_VALUE available to the AI block. The engineering unit and the primary value range are selected from the XD_SCALE in the AI block. The only unit allowed is this case is mA. The XD_SCALE must be inside the current range (0-21 mA). When the XD_SCALE range is set to 4 and 20, this makes the transducer follow the NAMUR standard. For different values no status is issued. The selection of the input terminal for this transducer is done in TERMINAL_NUMBER. The AI block connected to this transducer has the CHANNEL the same selection as TERMINAL_NUMBER.

The supported mode is OOS and AUTO. As the transducer block runs together with AI block, the transducer block goes to AUTO only if the AI mode block is already in AUTO.
Warning messages may appear in Primary Value status or in the Block Error in certain condition as explain below.

Supported Modes

OOS and AUTO.

BLOCK_ERR

The BLOCK_ERR of the transducer block will reflect the following causes:

- Input Failure – When input current higher than 20.7 and XD_SCALE EU100 = 20.0 or input current lower than 3.7 and XD_SCALE EU0 = 4.0.
- Out of Service – When the block is in OOS mode.

Primary_Value Status

The PRIMARY_VALUE status of the transducer block will reflect the following causes:

- Bad::SensorFailure:NotLimited – When input current higher than 20.7 and XD_SCALE EU100 = 20.0 or input current lower than 3.7 and XD_SCALE EU0 = 4.0;
- Uncertain::EngUnitRangeViolation:LowLimited – When input current between 3.7 and 3.98 and XD_SCALE EU0 = 4.0;
- Uncertain::EngUnitRangeViolation:HighLimited – When input current between 20.02 and 20.7 and XD_SCALE EU100 = 20.0.

Parameters

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
1	ST_REV	Unsigned16	Positive	0	None	S	Indicates the level of static data.
2	TAG_DESC	VisibleString			Na	S	Description of Transducer Block.
3	STRATEGY	Unsigned16		0	None	S	This parameter is not checked and processed by Transducer Block.
4	ALERT_KEY	Unsigned8	1-255	0	Na	S	Number of identification in the plant.
5	**MODE_BLK**	**DS-69**	**OS, AUTO**	**O/S**	**None**	**S**	**Indicates the operation mode of Transducer Block.**
6	**BLOCK_ERR**	**Bit String**			**E**	**D**	**Indicates the status associated with hardware or software in the Transducer.**
7	UPDATE_EVT	DS-73			Na	D	It is the alert for any static data.
8	BLOCK_ALM	DS-72			Na	D	It is used for configuration, hardware and others failures.
9	TRANSDUCER_DIRECTORY	Array of Unsigned16		65535	None	N	It is used to select several Transducer Blocks.
10	TRANSDUCER_TYPE	Unsigned16		65535	None	N	Indicates the type of Transducer according to its class.
11	XD_ERROR	Unsigned8		16	None	D	It is used to indicate calibration status.
12	COLLECTION_DIRECTORY	Array of Unsigned 32			None	S	Specifies the number of transducer index into Transducer Block.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
13	PRIMARY_VALUE_TYPE	Unsigned16			None	S	Defines the calculation type for Transducer Block.
14	**PRIMARY_VALUE**	**DS-65**	**0-22.0mA**	**0**	**PVR**	**D**	**It is the value and status used by channel 1, 2 and 3.**
15	**PRIMARY_VALUE_RANGE**	**DS-68**		**4.0-20.0mA**	**PVR**	**S**	**The High and Low range limit values, the engineering unit code and the number of digits to the right of the decimal point to be used for Primary Value.**
16	CAL_POINT_HI	Float	15.0-22.0mA	20.0	CU	S	The highest calibrated value.
17	CAL_POINT_LO	Float	0.0-9.0mA	4.0	CU	S	The lowest calibrated value.
18	CAL_MIN_SPAN	Float		6.0	CU	S	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points (high and low) are not too close together.
19	CAL_UNIT	Unsigned16	1211	mA	1211	S	The Device Description engineering units code index for the calibration values.
20	SENSOR_SN	Unsigned32	$0 - 2^{32}$	0	None	S	Sensor Serial Number.
21	CAL_METHOD	Unsigned8		Factory	None	S	The method of last sensor calibration.
22	CAL_LOC	VisibleString		NULL	None	S	The location of last sensor calibration. This describes the physical location at which the calibration was performed.
23	CAL_DATE	Time of Day		0	None	S	The date of the last sensor calibration.
24	SENSOR_CAL_WHO	VisibleString		NULL	None	S	The name of person who is in charge of last calibration.
25	**TERMINAL_NUMBER**	**Unsigned8**	**1,2,3**	**0**	**None**	**S**	**Indicates the input terminal number (1, 2 and 3).**
26	BACKUP_RESTORE	Unsigned8		0	None	S	This parameter is used to backup or to restore configuration data.
27	CAL_POINT_HI_BACKUP	Float		20.0	CU	S	Indicates the backup for high calibration point.
28	CAL_POINT_LO_ BACKUP	Float		4.0	CU	S	Indicates the backup for low calibration point.
29	CAL_POINT_HI_FACTORY	Float		20.0	CU	S	Indicates the high factory calibration point.
30	CAL_POINT_LO_FACTORY	Float		4.0	CU	S	Indicates the low factory calibration point.
31	FACTORY_GAIN_REFERENCE	Float		19.0	None	S	Factory calibration reference value.
32	ORDERING_CODE	VisibleString		Null	None	S	Indicates information about factory production.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static
CU: CAL_UNIT; PVR – PRIMARY_VALUE_RANGE; Sec: Seconds; SR: SENSOR_RANGE; SVU: SECONDARY_VALUE_RANGE

Gray Background Line: Default Parameters of Syscon

TP302 – Position Fieldbus Transducer

Description

The position fieldbus transducer makes the position input reading PRIMARY_VALUE available to the AI block. The engineering unit and the primary value range are selected from the XD_SCALE in the AI block. The only unit allowed is this case is %. The AI block connected to this transducer has the CHANNEL the same selection as TERMINAL_NUMBER. The supported mode is OOS and AUTO. As the transducer block runs together with AI block, the transducer block goes to AUTO only if the AI mode block is already in AUTO. The sensor module temperature may be read from the SECONDARY_VALUE parameter.

Warning messages may appear in Primary Value status or in the Block Error in certain condition as explain below.

Supported Modes

OOS and AUTO.

BLOCK_ERR

The BLOCK_ERR of the transducer block will reflect the following causes:

- Input Failure – When mechanic module is disconnected from main electronic board.
- Out of Service – When the block is in OOS mode.

Primary_Value Status

The PRIMARY_VALUE status of the transducer block will reflect the following causes:
Bad::SensorFailure:NotLimited – When mechanic module is disconnected from main electronic board.

Parameters

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
1	ST_REV	Unsigned16		0	None	S	Indicates the level of static data.
2	TAG_DESC	VisibleString		Null	Na	S	Description of Transducer Block.
3	STRATEGY	Unsigned16		0	None	S	This parameter is not checked and processed by Transducer Block.
4	ALERT_KEY	Unsigned8	1-255	0	None	S	Number of identification in the plant.
5	**MODE_BLK**	**DS-69**	**See Table**	**O/S**	**Na**	**Mix**	**Indicates the operation mode of Transducer Block.**
6	**BLOCK_ERR**	**Bit String**				**D**	**Indicates the status associated with hardware or software in the Transducer.**
7	UPDATE_EVT	DS-73			Na	D	It is the alert for any static data.
8	BLOCK_ALM	DS-72			Na	D	It is used for configuration, hardware and others failures.
9	TRANSDUCER_DIRECTORY	Array of Unsigned16			None	N	It is used to select several Transducer Blocks.
10	TRANSDUCER_TYPE	Unsigned16	See Table	65535	E	N	Indicates the type of Transducer according to its class.
11	XD_ERROR	Unsigned8	See Table	0	None	D	It is used to indicate calibration status.
12	COLLECTION_DIRECTORY	Array of Unsigned 32			None	S	Specifies the number of transducer index into Transducer Block.
13	PRIMARY_VALUE_TYPE	Unsigned16	See Table	65535	None	S	Defines the calculation type for Transducer Block.
14	**PRIMARY_VALUE**	**DS-65**	**± INF**	**0**	**PVR**	**D**	**It is the value and status used by channel 1, 2 and 3.**
15	**PRIMARY_VALUE_RANGE**	**DS-68**	**0-100%**	**100**	**PVR**	**S**	**The High and Low range limit values, the engineering unit code and the number of digits to the right of the decimal point to be used for Primary Value.**
16	CAL_POINT_HI	Float	+INF	100	CU	S	The highest calibrated value.
17	CAL_POINT_LO	Float	-INF	0	CU	S	The lowest calibrated value.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
18	CAL_MIN_SPAN	Float		5.0 %	CU	S	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points (high and low) are not too close together.
19	CAL_UNIT	Unsigned16	See Table	%	E	S	The Device Description engineering units code index for the calibration values.
20	SENSOR_SN	Unsigned32	0 to 232	0		S	The sensor serial number.
21	SENSOR_CAL_METHOD	Unsigned8	See Table	Factory	None	S	The method of last sensor calibration. ISO defines several standard methods of calibration. This parameter is intended to record that method, or if some other method was used.
22	SENSOR_CAL_LOC	VisibleString		NULL	None	S	The location of last sensor calibration. This describes the physical location at which the calibration was performed.
23	SENSOR_CAL_DATE	Time of Day		0	None	S	The date of the last sensor calibration.
24	SENSOR_CAL_WHO	VisibleString		NULL	None	S	The name of person who is in charge of last calibration.
25	**SECONDARY_VALUE**	**DS-65**	**± INF**	**0**	**SUV**	**D**	**The secondary value related to the temperature sensor.**
26	**SECONDARY_VALUE_UNIT**	**Unsigned16**	**See Table**	**1001 (°C)**	**E**	**S**	**The engineering units to be used with the secondary value related to the sensor.**
27	DIGITAL_HALL	Float	0-65536	0	Na	D	Digital Hall Value.
28	DIAGNOSTIC_STATUS	Unsigned16		Good		S	Show the device status (failures and warnings)
29	READ_HALL_CAL_POINT_HI	Float		43786.0		S	Digital Hall value for the highest calibration point.
30	READ_HALL_CAL_POINT_LOO	Float		24111.0		S	Digital Hall value for the lowest calibration point.
31	SENSOR_TEMPERATURE	DS-65		0	°C	D	The sensor temperature value
32	DIGITAL_TEMPERATURE	DS-65	± INF	0	None	D	The digital temperature value.
33	CAL_TEMPERATURE	Float	-40 a 85 °C	25	°C	S	The temperature value used to calibrate the temperature.
34	ACTION_TYPE	Unsigned8	Direct/Reverse	Direct	None	S	Defines if the action is direct or indirect.
35	BACKUP_RESTORE	Unsigned8	See Table	0	Na	S	This parameter is used to backup or to restore configuration data.
35	CAL_POINT_HI_BAKUP	Float	+INF	100	CU	S	Indicates the backup for high calibration point.
37	CAL_POINT_LO_BAKUP	Float	-INF	0	CU	S	Indicates the backup for low calibration point.
38	CAL_POINT_HI_FACTORY	Float	+INF	100	CU	S	Indicates the high factory calibration point.
39	CAL_POINT_LO_FACTORY	Float	-INF	0	CU	S	Indicates the low factory calibration point.
40	ORDERING_CODE	VisibleString		Null	Na	S	Indicates information about factory production.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static
CU: CAL_UNIT; PVR – PRIMARY_VALUE_RANGE; Sec: Seconds; SR: SENSOR_RANGE; SVU: SECONDARY_VALUE_RANGE

Gray Background Line: Default Parameters of Syscon

TEMP – DF45 Temperature Transducer

Overview
This is the transducer block for the module DF45, an eight low signal input module for RTD, TC, mV, Ohm.

Description
This transducer block has parameters to configure the eight inputs of low signal, as well an individual status and value in engineering units for each input. Therefore it is enough to configure only the TEMP block if the purpose is to monitor variables.

If the application is a control loop or calculation, it is also necessary to configure an AI or MAI block to address these variables. One important difference for the TEMP block, when using an AI block to access an input : write to VALUE_RANGE_x parameter is disabled. The user must configure the scale in the XD_SCALE parameter of the AI block, that will be copied to the corresponding VALUE_RANGE_x parameter.

BLOCK_ERR
The BLOCK_ERR will reflect the following causes:
- Block Configuration Error - When it is not compatible the CHANNEL parameter and HC configuration (DFI302);
- Input Failure – At least one input is in failure (DFI302);
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S and AUTO.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**CHANNEL**	**Unsigned16**			**None**	**S / O/S**	**The rack and slot number of the associated DF-45 module coded as RRSXX.**
8	TEMP_0	DS-65				D	Temperature of point 0.
9	TEMP_1	DS-65				D	Temperature of point 1.
10	TEMP_2	DS-65				D	Temperature of point 2.
11	TEMP_3	DS-65				D	Temperature of point 3.
12	TEMP_4	DS-65				D	Temperature of point 4.
13	TEMP_5	DS-65				D	Temperature of point 5.
14	TEMP_6	DS-65				D	Temperature of point 6.
15	TEMP_7	DS-65				D	Temperature of point 7.
16	VALUE_RANGE_0	DS-68		0-100%	VR0	S / O/S	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user may write in this scaling parameter.
17	SENSOR_CONNECTION_0	Unsigned8	1 : differential 2 : 2-wire 3 : 3-wire	3	E	S / O/S	Connection of the sensor 0.
18	**SENSOR_TYPE_0**	**Unsigned8**	**See table below**	**Pt 100 IEC**	**E**	**S / O/S**	**Type of sensor 0.**
19	VALUE_RANGE_1	DS-68		0-100%	VR1	S / O/S	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user may write in this scaling parameter.
20	SENSOR_CONNECTION_1	Unsigned8	1 : differential 2 : 2-wire 3 : 3-wire	3	E	S / O/S	Connection of the sensor 1.
21	**SENSOR_TYPE_1**	**Unsigned8**	**See table below**	**Pt 100 IEC**	**E**	**S / O/S**	**Type of sensor 1.**
22	VALUE_RANGE_2	DS-68		0-100%	VR2	S / O/S	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user may write in this scaling parameter.
23	SENSOR_CONNECTION_2	Unsigned8	1 : differential 2 : 2-wire 3 : 3-wire	3	E	S / O/S	Connection of the sensor 2.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
24	**SENSOR_TYPE_2**	**Unsigned8**	**See table below**	**Pt 100 IEC**	**E**	**S / O/S**	**Type of sensor 2.**
25	VALUE_RANGE_3	DS-68		0-100%	VR3	S / O/S	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user may write in this scaling parameter.
26	SENSOR_CONNECTION_3	Unsigned8	1 : differential 2 : 2-wire 3 : 3-wire	3	E	S / O/S	Connection of the sensor 3.
27	**SENSOR_TYPE_3**	**Unsigned8**	**See table below**	**Pt 100 IEC**	**E**	**S / O/S**	**Type of sensor 3.**
28	VALUE_RANGE_4	DS-68		0-100%	VR4	S / O/S	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user may write in this scaling parameter.
29	SENSOR_CONNECTION_4	Unsigned8	1 : differential 2 : 2-wire 3 : 3-wire	3	E	S / O/S	Connection of the sensor 4.
30	SENSOR_TYPE_4	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 4.
31	VALUE_RANGE_5	DS-68		0-100%	VR5	S / O/S	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user may write in this scaling parameter.
32	SENSOR_CONNECTION_5	Unsigned8	1 : differential 2 : 2-wire 3 : 3-wire	3	E	S / O/S	Connection of the sensor 5.
33	**SENSOR_TYPE_5**	**Unsigned8**	**See table below**	**Pt 100 IEC**	**E**	**S / O/S**	**Type of sensor 5.**
34	VALUE_RANGE_6	DS-68		0-100%	VR6	S / O/S	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user may write in this scaling parameter.
35	SENSOR_CONNECTION_6	Unsigned8	1 : differential 2 : 2-wire 3 : 3-wire	3	E	S / O/S	Connection of the sensor 6.
36	**SENSOR_TYPE_6**	**Unsigned8**	**See table below**	**Pt 100 IEC**	**E**	**S / O/S**	**Type of sensor 6.**
37	VALUE_RANGE_7	DS-68		0-100%	VR7	S / O/S	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user may write in this scaling parameter.
38	SENSOR_CONNECTION_7	Unsigned8	1 : differential 2 : 2-wire 3 : 3-wire	3	E	S / O/S	Connection of the sensor 7.
39	SENSOR_TYPE_7	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 7.
40	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
41	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

Code	Sensor Type	Class	Sensor range – Differential (Celsius)	Sensor range – 2-wire (Celsius)	Sensor range – 3-wire (Celsius)
1	Cu 10 GE	RTD	-270 to 270	-20 to 250	-20 to 250
2	Ni 120 DIN		-320 to 320	-50 to 270	-50 to 270
3	Pt 50 IEC		-1050 to 1050	-200 to 850	-200 to 850
4	Pt 100 IEC		-1050 to 1050	-200 to 850	-200 to 850
5	Pt 500 IEC		-270 to 270	-200 to 450	-200 to 450
6	Pt 50 JIS		-850 to 850	-200 to 600	-200 to 600
7	Pt 100 JIS		-800 to 800	-200 to 600	-200 to 600
51	0 to 100	Ohm		0 to 100	0 to 100
52	0 to 400			0 to 400	0 to 400
53	0 to 2000			0 to 2000	0 to 2000
151	B NBS	TC	-1600 to 1600	100 to 1800	
152	E NBS		-1100 to 1100	-100 to 1000	
153	J NBS		900 to 900	-150 to 750	
154	K NBS		-1550 to 1550	-200 to 1350	
155	N NBS		-1400 to 1400	-100 to 1300	
156	R NBS		-1750 to 1750	0 to 1750	
157	S NBS		-1750 to 1750	0 to 1750	
158	T NBS		-600 to 600	-200 to 400	
159	L DIN		-1100 to 1100	-200 to 900	
160	U DIN		-800 to 800	-200 to 600	
201	-6 to 22	MV		-6 to 22	
202	-10 to 100			-10 to 100	
203	-50 to 500			-50 to 500	

If DIAG.BEHAVIOR parameter is "Adapted":

- When the configuration of sensor type means a different class, the connection is automatically changed to default (RTD and Ohm – 3-wire, TC and mV – 2-wire).

Input Function Blocks

AI - Analog Input

Overview

The Analog Input block takes the input data from the Transducer block, selected by channel number, and makes it available to other function blocks at its output.

Schematic

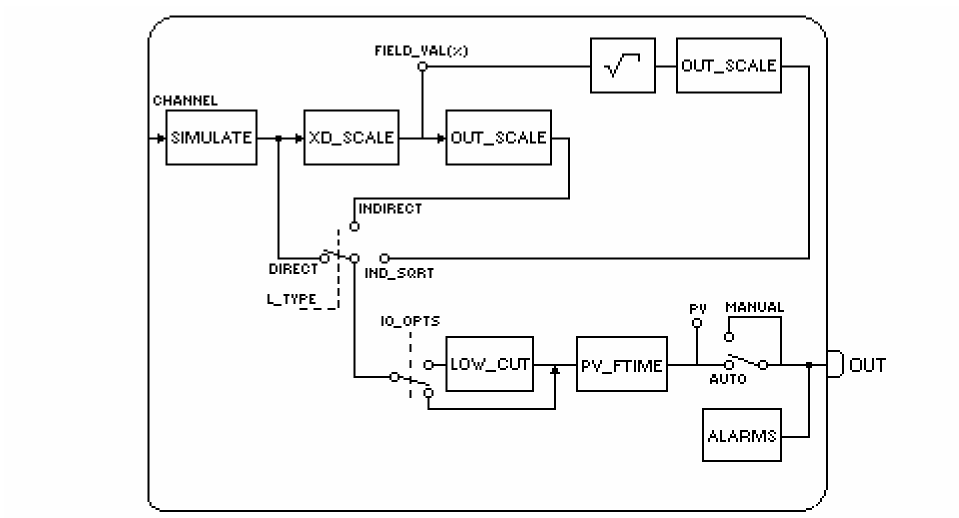


Figure 2.1 – Analog Input Schematic

Description

The AI block is connected to the transducer block through the CHANNEL parameter that must match with the following parameter in the transducer block:

- SENSOR_TRANSDUCER_NUMBER parameter for the TT302
- TERMINAL_NUMBER parameter for the IF302

The CHANNEL parameter must be set to 1 (one) if the AI block is running in the LD302, and no configuration is necessary in the transducer block to connect it to the AI block.

Transducer scaling (XD_SCALE) is applied to the value from the channel to produce the FIELD_VAL in percent. The XD_SCALE engineering units code and range must be suitable to the sensor of transducer block connected to the AI block, otherwise a block alarm indicating configuration error will be generated.

The L_TYPE parameter determines how the values passed by the transducer block will be used into the block. The options are:
Direct - the transducer value is passed directly to the PV. Therefore OUT_SCALE is useless.
Indirect - the PV value is the FIELD_VAL value converted to the OUT_SCALE.
Indirect with Square Root - the PV value is square root of the FIELD_VAL converted to the OUT_SCALE.

PV and OUT always have identical scaling based on OUT_SCALE.
The LOW_CUT parameter is an optional characteristic that may be used to eliminate noise near zero for a flow sensor. The LOW_CUT parameter has a corresponding "Low cutoff" option in the IO_OPTS bit string. If the option bit is true, any calculated output below the low cutoff value (LOW_CUT) will be changed to zero.

BLOCK_ERR

The BLOCK_ERR of the AI block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when one or more of the following situations occur:
    - When the CHANNEL or L_TYPE parameters have an invalid value;
    - When the XD_SCALE does not have a suitable engineering unit or range for the sensor of transducer block.
    - When it is not compatible the CHANNEL parameter and HC configuration (DFI302).

- Simulate Active – When the Simulate is active.
- Input Failure – I/O module failure (DFI302)
- Out of Service – When the block is in O/S mode.
- Failure in transmitter sensor.

Supported Modes
O/S, MAN and AUTO.

Status Handling
The AI block does not support cascade path. Then, the output status has not a cascade sub-status.

When the OUT value exceeds the OUT_SCALE range and no worse condition exists in the block then the OUT status will be "uncertain, EU Range Violation".

The following options from STATUS_OPTS apply, where Limited refers to the sensor limits: (see in the Function block options to more details about each option)

- Propagate Fault Forward
- Uncertain if Limited
- BAD if Limited
- Uncertain if Man mode

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter.**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**PV**	**DS-65**			**PV**	**D / RO**	**Process analog value for use in executing the function.**
8	**OUT**	**DS-65**	**OUT_SCALE +/- 10%**		**OUT**	**D / Man**	**The analog value calculated as a result of executing the function.**
9	SIMULATE	DS-82	1: Disable ; 2: Active are the Enable/Disable options.	Disable		D	Allows the input value to be manually supplied when simulate is enabled. In this case, the simulate value and status will be the PV value.
10	**XD_SCALE**	**DS-68**	**Depends on the device type. See the manual. See the corresponding manual for details.**	**Depends on the device type. See description for details.**	**XD**	**S / Man**	**The high and low scale values, to transducer for a specified channel. The Default value for each Smar device is showed below: LD292/302: 0 to5080 [mmH2O] IF302: 4 to 20 [mA] TT302: -200 to 850 [ºC] TP302: 0 to 100 [%] DT302: 1000 to 2500 [kg / m3] DFI302: 100,0,1342 0 to 100 [%]**
11	**OUT_SCALE**	**DS-68**		**0-100%**	**OUT**	**S / Man**	**The high and low scale values to the OUT parameter.**
12	GRANT_DENY	DS-70		0	na	D	
13	**IO_OPTS**	**Bitstring(2)**	**See Block Options**	**0**	**na**	**S / O/S**	**See Block Options**
14	**STATUS_OPTS**	**Bitstring(2)**	**See Block Options**	**0**	**Na**	**S / O/S**	**See Block Options**
15	**CHANNEL**	**Unsigned16**		**0**	**None**	**S / O/S**	**For more details about the configuration of this parameter, see Chapter 1 "CHANNEL Configuration".**
16	**L_TYPE**	**Unsigned8**	**1: Direct 2: Indirect 3: Indirect Square Root**	**0**	**E**	**S / Man**	**Determines how the values passed by the transducer block may be used: Directly (Direct); with a percent (Indirect) ; or with a percent and with square root (Ind Sqr Root).**

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
17	**LOW_CUT**	**Float**	**Non-Negative**	**0**	**OUT**	**S**	**A value of zero percent of scale is used in block processing if the transducer value falls below this limit, in % of scale. This feature may be used to eliminate noise near zero for a flow sensor.**
18	**PV_FTIME**	**Float**	**Non-Negative**	**0**	**Sec**	**S**	**Time constant of a single exponential filter for the PV, in seconds.**
19	**FIELD_VAL**	**DS-65**			**%**	**D / RO**	**Raw value of the field device in percent of the PV range, with a status reflecting the Transducer condition, before signal characterization (L_TYPE) or filtering (PV_FTIME).**
20	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
21	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.
22	**ALARM_SUM**	**DS-74**	**See Block Options**		**Na**	**S**	**The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.**
23	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged
24	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. In order to clear the alarm the amount the PV must return within the alarm limit plus hysteresis.
25	HI_HI_PRI	Unsigned8	0 to 15			S	Priority of the high high alarm.
26	HI_HI_LIM	Float	OUT_SCALE, +INF	+INF	OUT	S	The setting for high high alarm in engineering units.
27	HI_PRI	Unsigned8	0 to 15			S	Priority of the high alarm.
28	**HI_LIM**	**Float**	**OUT_SCALE, +INF**	**+INF**	**OUT**	**S**	**The setting for high alarm in engineering units.**
29	LO_PRI	Unsigned8	0 to 15			S	Priority of the low alarm.
30	**LO_LIM**	**Float**	**OUT_SCALE, -INF**	**-INF**	**OUT**	**S**	**The setting for low alarm in engineering units.**
31	LO_LO_PRI	Unsigned8	0 to 15			S	Priority of the low low alarm.
32	LO_LO_LIM	Float	OUT_SCALE, -INF	-INF	OUT	S	The setting for low low alarm in engineering units.
33	HI_HI_ALM	DS-71			OUT	D	The status for high high alarm and its associated time stamp.
34	HI_ALM	DS-71			OUT	D	The status for high alarm and its associated time stamp.
35	LO_ALM	DS-71			OUT	D	The status for low alarm and its associated time stamp.
36	LO_LO_ALM	DS-71			OUT	D	The status for low low alarm and its associated time stamp.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":

The default value of CHANNEL is the lowest available number.
The default value of L_TYPE is direct.
The required mode for writing is the actual mode, regardless the target mode: OUT

DI - Discrete Input

Overview

The DI block takes the manufacturer's discrete input data, selected by channel number, and makes it available to other function blocks at its output.

Schematic

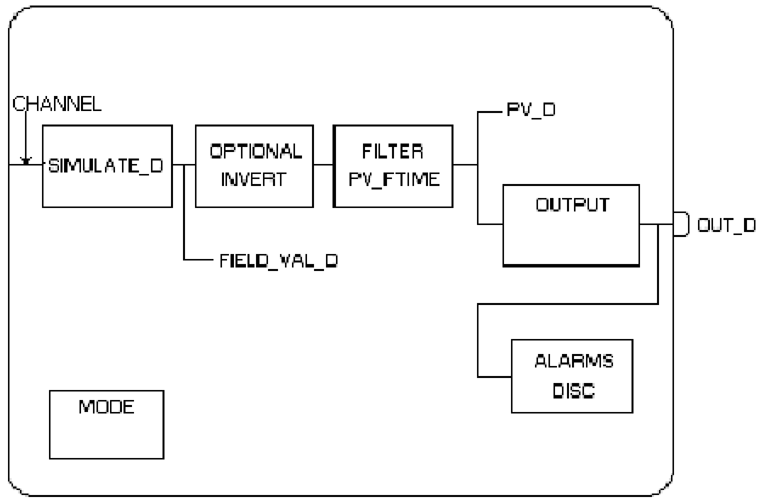


Figure 2.2 – Discrete Input Schematic

Description

The FIELD_VAL_D shows the true on/off state of the hardware, using XD_STATE. The Invert I/O option can be used to do a Boolean NOT function between the field value and the output. 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). 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. The PV_D is always the value that the block will place in OUT_D if the mode is Auto. If Man is allowed, someone may write a value to OUT_D. The PV_D and the OUT_D always have identical scaling. OUT_STATE provides scaling for PV_D.

BLOCK_ERR

The BLOCK_ERR of the DI block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when one or more of the following situations occur:
  - When the CHANNEL parameter has an invalid value;
  - When it is not compatible the CHANNEL parameter and HC configuration (DFI302).
- Simulate Active – When the Simulate is active;
- Input Failure – I/O module failure (DFI302);
- Out of Service – When the block is in O/S mode.

Supported Modes

O/S, Man, and Auto.

Status Handling

The DI block does not support cascade path. Then, the output status has not a cascade sub-status. The following options from STATUS_OPTS apply: Propagate Fault Forward

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**PV_D**	**DS-66**			**PV**	**D / RO**	**The primary discrete value for use in executing the function, or a process value associated with it.**
8	**OUT_D**	**DS-66**	**OUT_STATE**		**OUT**	**D / Man**	**The primary discrete value calculated as a result of executing the function.**
9	SIMULATE_D	DS-83	1: Disable ; 2: Active are the Enable/Disable options.	Disable		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.
10	XD_STATE	Unsigned16		0	XD	S	Index to the text describing the states of a discrete for the value obtained from the transducer.
11	OUT_STATE	Unsigned16		0	OUT	S	Index to the text describing the states of a discrete output.
12	GRANT_DENY	DS-70		0	Na	D	
13	IO_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
14	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
15	**CHANNEL**	**Unsigned16**		**0**	**None**	**S / O/S**	**For more details about the configuration of this parameter, see Chapter 1 “CHANNEL Configuration”.**
16	**PV_FTIME**	**Float**	**Non-Negative**	**0**	**Sec**	**S**	**Time constant of a single exponential filter for the PV, in seconds.**
17	**FIELD_VAL_D**	**DS-66**			**On/Off**	**D / RO**	**Raw value of the field device discrete input, with a status reflecting the Transducer condition.**
18	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
19	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.
20	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
21	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged
22	DISC_PRI	Unsigned8	0 to 15	0		S	Priority of the discrete alarm.
23	DISC_LIM	Unsigned8	PV_STATE	0	PV	S	State of discrete input which will generate an alarm.
24	DISC_ALM	DS-72			PV	D	The status and time stamp associated with the discrete alarm.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

MAI - Multiple Analog Input

Description

The MAI block makes available for the FF network eight analog variables of the I/O subsystem through its eight output parameters OUT_1 through OUT_8.

For DFI working with Analog Input, the 4-20mA or 1-5V range must be worked. In this case the output values are in percent from 0 to 100%. If it is necessary to work in another configuration, the AI block must be used.

Status indication in the output parameters OUT_x depends on the I/O subsystem and the transducer block, that is manufacturer specific. For example, if there is individual detection of sensor failure, it will be indicated in the status of related OUT_x parameter. Problem in the interface to the I/O subsystem will be indicated in the status of all OUT_x as BAD – Device Failure.

BLOCK_ERR

The BLOCK_ERR of the MAI block will reflect the following causes:

- Other – the number of MDI, MDO, MAI and MAO blocks or the device tag in FB700 is different from LC700;
- Block Configuration Error – the configuration error occurs when the OCURRENCE/CHANNEL has an invalid value (FB700) or it is not compatible the CHANNEL parameter and HC configuration (DFI302);
- Input failure – the CPU of LC700 stopped working (FB700) or I/O module failure (DFI302);
- Power up – there is no CPU of LC700 in the rack or the hardware configuration of LC700 has an error;
- Out of Service – When the block is in O/S mode.

Status Handling

The status of OUT_x will be the following if the BLOCK_ERR indicates:

- Other – Bad : Configuration Error
- Input failure – Bad : Device Failure
- Power up – Bad : Device Failure

Supported Modes

O/S, MAN and AUTO.

Schematic

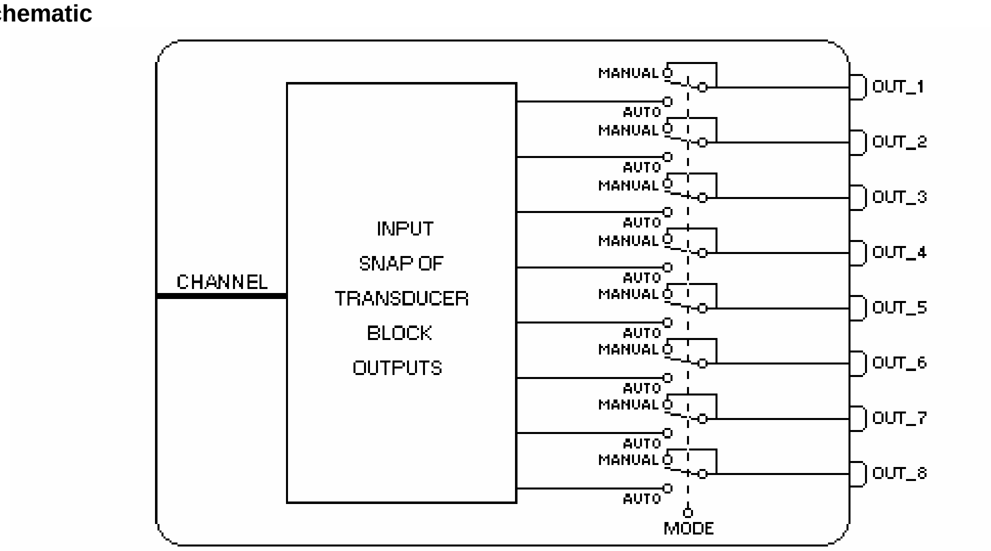


Figure 2.3 – Multiple Analog Input Schematic

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**OCCURRENCE / CHANNEL**	**Unsigned16**		**0**	**None**	**S / O/S**	**For more details about the configuration of this parameter, see Chapter 1 "CHANNEL Configuration". It defines the transducer to be used going to or from the physical world. It addresses a group of eight points.**
8	**OUT_1**	**DS-65**				**D / Man**	**Numbered analog input 1.**
9	**OUT_2**	**DS-65**				**D / Man**	**Numbered analog input 2.**
10	**OUT_3**	**DS-65**				**D / Man**	**Numbered analog input 3.**
11	**OUT_4**	**DS-65**				**D / Man**	**Numbered analog input 4.**
12	**OUT_5**	**DS-65**				**D / Man**	**Numbered analog input 5.**
13	**OUT_6**	**DS-65**				**D / Man**	**Numbered analog input 6.**
14	**OUT_7**	**DS-65**				**D / Man**	**Numbered analog input 7.**
15	**OUT_8**	**DS-65**				**D / Man**	**Numbered analog input 8.**
16	UPDATE_EVT	DS-73			Na	D	
17	BLOCK_ALM	DS-72			Na	D	

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":

The default value of OCCURRENCE is the number of MAI blocks instantiated for the FB-700.
The required mode for writing is the actual mode, regardless the target mode: OUT_1, OUT_2, …, OUT_8.

Device type	Description
FB700	Block has OCCURRENCE parameter
DFI302	Block has CHANNEL parameter

MDI - Multiple Discrete Input

Description

The MDI block makes available for the FF network eight discrete variables of the I/O subsystem through its eight output parameters OUT_D1 through OUT_D8. Status indication in the output parameters OUT_Dx depends on the I/O subsystem and the transducer block, that is manufacturer specific. For example, if there is individual detection of sensor failure, it will be indicated in the status of related OUT_Dx parameter. Problem in the interface to the I/O subsystem will be indicated in the status of all OUT_Dx as BAD – Device Failure.

BLOCK_ERR

The BLOCK_ERR of the MDI block will reflect the following causes:

- Other – the number of MDI, MDO, MAI and MAO blocks or the device tag in FB700 is different from LC700;
- Block Configuration Error – the configuration error occurs when the OCCURRENCE has an invalid value (FB700) or it is not compatible the CHANNEL parameter and HC configuration (DFI302);
- Input failure – the CPU of LC700 stopped working (FB700) or I/O module failure (DFI302);
- Power up – there is no CPU of LC700 in the rack or the hardware configuration of LC700 has an error;
- Out of Service – When the block is in O/S mode.

Status Handling

The status of OUT_Dx will be the following if the BLOCK_ERR indicates:

- Other – Bad : Configuration Error
- Input failure – Bad : Device Failure
- Power up – Bad : Device Failure

Supported Modes

O/S, MAN and AUTO.

Schematic

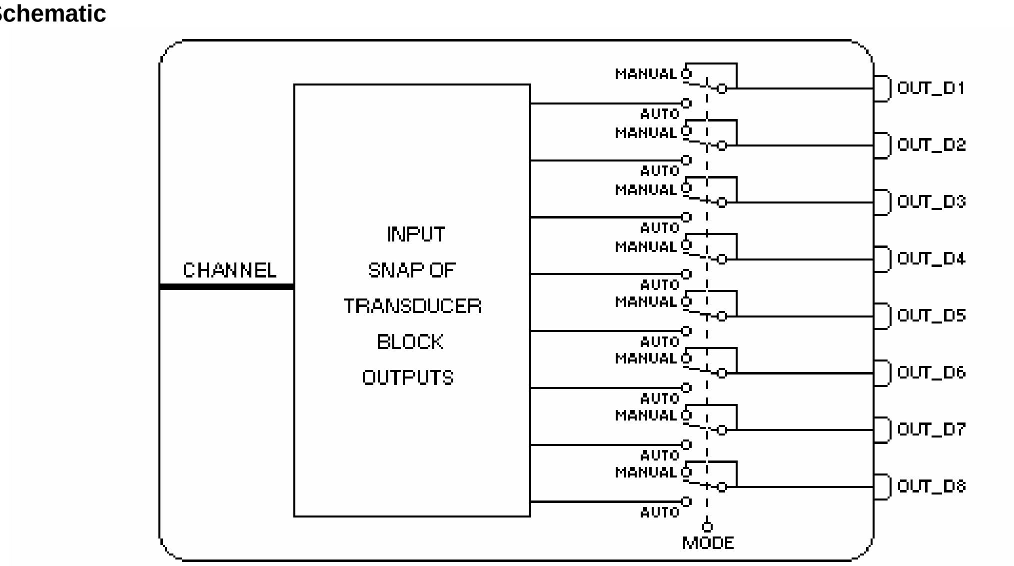


Figure 2.4 –Multiple Discrete Input Schematic

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**OCCURRENCE / CHANNEL**	**Unsigned16**		**0**	**None**	**S / O/S**	**For more details about the configuration of this parameter, see Chapter 1 "CHANNEL Configuration". It defines the transducer to be used going to or from the physical world. It addresses a group of eight points.**
8	**OUT_D1**	**DS-66**				**D / Man**	**Numbered discrete input 1.**
9	**OUT_D2**	**DS-66**				**D / Man**	**Numbered discrete input 2.**
10	**OUT_D3**	**DS-66**				**D / Man**	**Numbered discrete input 3.**
11	**OUT_D4**	**DS-66**				**D / Man**	**Numbered discrete input 4.**
12	**OUT_D5**	**DS-66**				**D / Man**	**Numbered discrete input 5.**
13	**OUT_D6**	**DS-66**				**D / Man**	**Numbered discrete input 6.**
14	**OUT_D7**	**DS-66**				**D / Man**	**Numbered discrete input 7.**
15	**OUT_D8**	**DS-66**				**D / Man**	**Numbered discrete input 8.**
16	UPDATE_EVT	DS-73			Na	D	
17	BLOCK_ALM	DS-72			Na	D	

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":

The default value of OCCURRENCE is the number of MDI blocks instantiated for the FB-700.
The required mode for writing is the actual mode, regardless the target mode: OUT_1, OUT_2, …, OUT_8.

Device type	Description
FB700	Block has OCCURRENCE parameter
DFI302 AND DC302	Block has CHANNEL parameter

PUL – Pulse Input

Overview
The Pulse Input Block provides analog values based on a pulse (counter) transducer input. There are two primary outputs available. An accumulation output is intended to be connected to an integrator block for differencing, conversion, and integration. This is most useful when the count rate is low relative to the block execution rate. For high count rates, the accumulated count of pulses per block execution can be interpreted as an analog rate (vs. accumulation) value and can be alarmed. (Alarm conditions include high, high-high, low, and low-low alarms.)

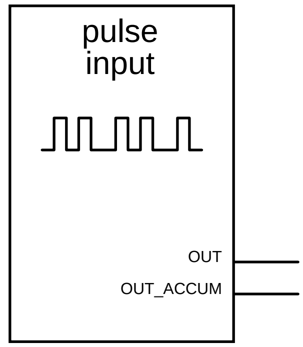


Figure 2.5 –Pulse Input

Schematic

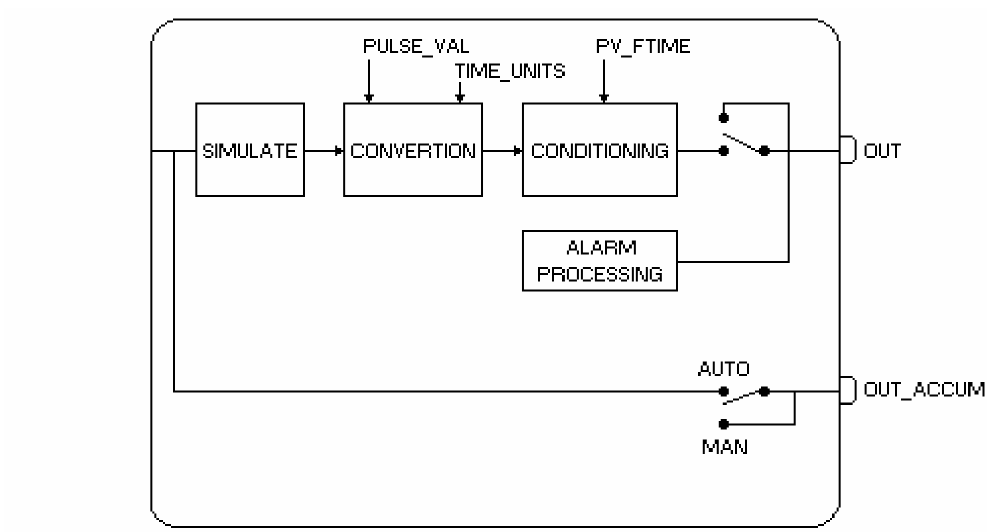


Figure 2.6 –Pulse Input Schematic

Description
OUT is a connectable bipolar (signed) analog value output of the PI block. It is determined by taking the number of counts accumulated since the last execution of the block, multiplying by the value of each pulse (PULSE_VAL), dividing by the block's execution rate in seconds, converting to units/minute, units/hour, or units/day in accordance with the TIME_UNITS enumeration, and filtering using PV_FTIME. PV_FTIME is the time constant for a filter. Alarming is performed on this filtered value. Reverse flow may be detected from the transducer and indicated via a negative value of OUT.

Pre-filtered value = (change_in_counts * PULSE_VAL / exec_period) * time_unit_factor
Where,

CHANGE_IN_COUNTS is the number of counts received since last execution
PULSE_VAL is the value in engineering units of each pulse
EXEC_PERIOD is the execution period of the block in seconds
Time_Unit_Factor is 1 sec/sec, 60 sec/min, 3600 sec/hour, or 86400 sec/day, per the TIME_UNITS index.

For example, 70 pulse counts are received by the transducer in the 0.5 second execution period of the PI block. The metering device manufacturer specifies that each pulse represents 0.1 gallons of flow. The user wants the flow rate expressed in "gallons per minute". PULSE_VAL should be set to 0.1. TIME_UNITS should be set to "units/minute". The related time_unit_factor will be "60 sec/min". Using the above equation, the pre-filtered rate value will then be computed as:

((70 pulses * 0.1 gallons/pulse) / 0.5 sec) * 60 sec/min =
(7.0 gallons/ 0.5 sec) * 60 sec/min =
(14.0 gallons/sec) * 60 sec/min =
840 gallons/min

OUT_ACCUM is a connectable float output of the PI block. It is intended to be connected to the Integrator block for totalization, so it only accumulates enough to avoid rollover between executions of the Integrator block. It represents a continuous accumulation of counts from the transducer, limited to the range of values from 0 to 999,999. It can count either up or down. An increment of the accumulation 999,999 by 1 will result in the accumulation 0 and a decrement of the accumulation 0 by 1 will result in the accumulation 999,999. A maximum change to the accumulation of ±499,999 counts is permitted to be reflected in OUT_ACCUM in a single execution of the block. If a change of counts greater in magnitude than 499,999 occurs at the transducer:

- The change in OUT_ACCUM is limited to 499,999 of the proper sign,
- The OUT_ACCUM status's quality is set to uncertain,
- The OUT_ACCUM status's sub-status is set to "Engr. Units Range Violation",
- The OUT_ACCUM status's limits = low (if negative) or limits = high (if positive) indicator is set
- A BLOCK_ALM must be issued.

CHANNEL is used to associate the block with the hardware that is connected to this block. It defines the transducer to be used coming from the physical world.

Optionally the filter (PV_FTIME) can be used to get instant flow mainly when there are low frequencies. For example, if the pulse card is reading a frequency of 1.5 Hz with a filter of 4 seconds, the output will have values between 1.40 and 1.57. For the frequency of 0.5 Hz, the output values will be between 0.41 and 0.58.

Supported Modes
O/S, Manual and Auto modes are supported.

Mode Handling
Manual mode "disconnects" the input from the output and permits manual substitution of the value. OUT is the alarmed value and the value which normally would be substituted, but OUT_ACCUM may also be substituted.

On transition from Manual to Auto, the PV filter will be initialized to the value of OUT, and the accumulated total will be set to the value of OUT_ACCUM.

Status Handling
This block has no inputs from other blocks and therefore does not react to status of other blocks. Both the OUT and the OUT_ACCUM outputs have status and will reflect the status of the transducer (e.g. hardware failure) and the mode of the block (e.g., out-of-service, manual, etc.) using the conventional rules of status.

An unusable status (bad) for OUT will cause the alarm processing to be suspended. Current alarms will not be cleared and new alarms will not be generated until the status returns to a usable status.

Simulation
The SIMULATE_P parameter is provided to simulate pulse input as a rate in pulses/second, rather than the actual transducer value. The value entered in the SIMULATE_P record is considered to be the signed change in accumulation per second. The quality of the status entered is passed to the status of OUT and OUT_ACCUM.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	PV	DS-65			PV	D / RO	Process analog value for use in executing the function.
8	**OUT**	**DS-65**	**OUT_SCALE +/- 10%**		**OUT**	**D / Man**	**The analog value calculated as a result of executing the function.**
9	**OUT_ACCUM**	**DS-65**			**None**	**N / Man**	**This parameter is the number of counts accumulated in an on-going basis. It is not normally reset except that it wraps around to zero after reaching 999,999 counts. The value is based on the transducer input in Auto mode and is the last transducer value of the value specified by the operator/engineer in Man mode. (Its meaning is most useful when the number of counts received between executions of the block is small.) It is intended to be connected to the counter input of an integrator block. The OUT_ACCUM value may increase or decrease by a maximum of 499,999 counts per execution.**
10	SIMULATE_P	DS-82	1: Disable ; 2: Active are the Enable/Disable options.	Disable		D	Allows the transducer input to the Pulse Input block to be manually supplied when simulate is enabled. When simulation is disabled, the simulate value and status track the actual value and status. The value is the rate of change of the transducer count in counts per second, not the accumulation.
11	**PULSE_VAL**	**Float**		**0**	**None**		**Value of each metered pulse in engineering units. Used only to calculate PV and OUT. Not used for OUT_ACCUM calculation.**
12	TIME_UNITS	Unsigned8	1: seconds 2: minutes 3: hours 4: days 5: [day-[hr:[min[:sec]]]]	0	E	S	Time units factor to be used in the conversion of the output.
13	OUT_SCALE	DS-68		0-100%	OUT	S / Man	The high and low scale values to the OUT parameter.
14	GRANT_DENY	DS-70		0	na	D	
15	IO_OPTS	Bitstring(2)	See Block Options	0	na	S / O/S	See Block Options
16	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
17	**CHANNEL**	**Unsigned16**		**0**	**None**	**S / O/S**	**For more details about the configuration of this parameter, see Chapter 1 “CHANNEL Configuration”.**
18	PV_FTIME	Float	Non-Negative	0	Sec	S	Time constant of a single exponential filter for the PV, in seconds.
19	FIELD_VAL	DS-65			%	D / RO	Raw value of the field device with a status reflecting the Transducer condition, before filtering (PV_FTIME).
20	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
21	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.
22	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
23	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged
24	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. In order to clear the alarm the amount the PV must return within the alarm limit plus hysteresis (percentage of OUT_SCALE).
25	HI_HI_PRI	Unsigned8	0 to 15			S	Priority of the high high alarm.
26	HI_HI_LIM	Float	OUT_SCALE, +INF	+INF	OUT	S	The setting for high high alarm in engineering units.
27	HI_PRI	Unsigned8	0 to 15			S	Priority of the high alarm.
28	HI_LIM	Float	OUT_SCALE, +INF	+INF	OUT	S	The setting for high alarm in engineering units.
29	LO_PRI	Unsigned8	0 to 15			S	Priority of the low alarm.
30	LO_LIM	Float	OUT_SCALE, -INF	-INF	OUT	S	The setting for low alarm in engineering units.
31	LO_LO_PRI	Unsigned8	0 to 15			S	Priority of the low low alarm.
32	LO_LO_LIM	Float	OUT_SCALE, -INF	-INF	OUT	S	The setting for low low alarm in engineering units.
33	HI_HI_ALM	DS-71			OUT	D	The status for high high alarm and its associated time stamp.
34	HI_ALM	DS-71			OUT	D	The status for high alarm and its associated time stamp.
35	LO_ALM	DS-71			OUT	D	The status for low alarm and its associated time stamp.
36	LO_LO_ALM	DS-71			OUT	D	The status for low low alarm and its associated time stamp.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is “Adapted”:

The default value of CHANNEL is the lowest available number.
The required mode for writing is the actual mode, regardless the target mode : OUT

Control and Calculation Function Blocks

PID - PID Control

Overview
The PID block offers a lot of control algorithms that use the Proportional, integral and derivative terms.

Schematic

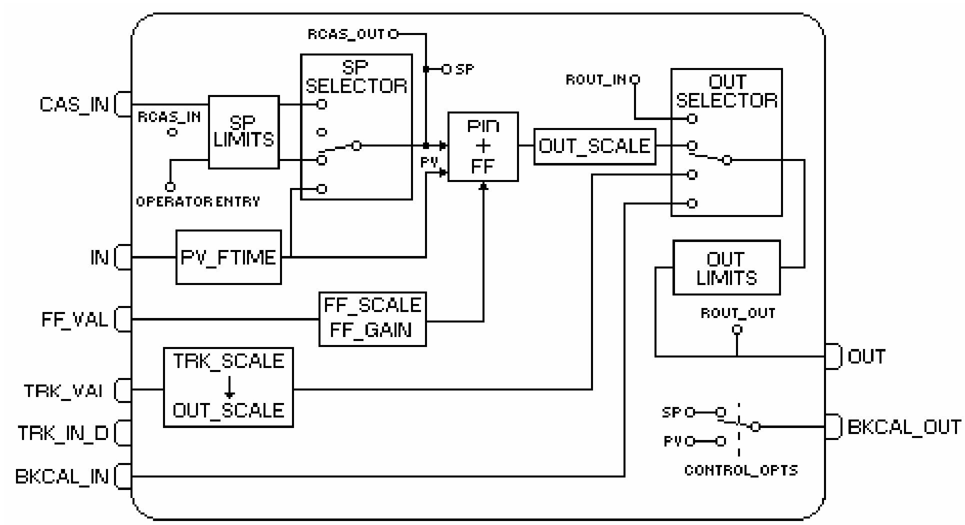


Figure 2.7 –PID Control Schematic

Description
The algorithm of the PID is the non-iterative or ISA. In this algorithm, the GAIN is applied to all terms of the PID, and the Proportional and the Integral actuate over the error, and the derivative actuates over the PV value. Therefore user changes of SP will not cause bump in the output due to the derivative term when the block is in Auto.

As long as an error exists, the PID function will integrate the error, which moves the output in a direction to correct the error. PID blocks may be cascaded when the difference in process time constants of a primary and secondary process measurement makes it necessary or desirable.

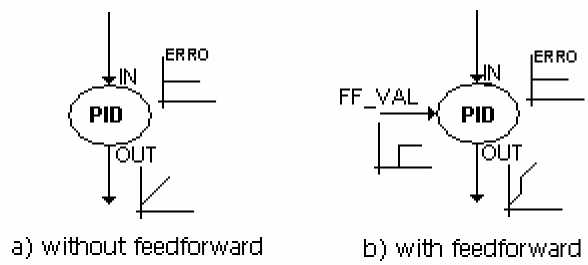
See the PV calculation and SP calculation section for details.

Direct and Reverse Acting
It is possible to choose the direct or reverse action of control that is made through the "Direct Acting" bit in the CONTROL_OPTS parameter:

- If the "Direct acting" bit is true then the error is obtained subtracting the SP from the PV:
  Error = (PV – SP)
- If the "Direct acting" bit is false (clear), the choice is "Reverse acting" then the error is obtained subtracting the PV from the SP:
  Error = (SP – PV)

The Default value of the "Direct acting" bit is false, it means "reverse action".

Feed forward Control
The PID block supports the feed forward algorithm. The FF_VAL input is supplied by an external value, which is proportional to some disturbance in the control loop. The value is converted to output scale using the FF_SCALE and OUT_SCALE parameters. This value is multiplied by the FF_GAIN and added to the output of the PID algorithm.



If the status of FF_VAL is Bad, the last usable value will be used. When the status returns to good, the difference of FF_VAL values will be subtracted from BIAS_A/M in order to avoid bump in the output.

PID Constants
GAIN (Kp), RESET (Tr), and RATE (Td) 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 to these parameters should be able to display the user's preference.

Bypass
When bypass is active the SP value will be transferred to the OUT without the calculation of PID terms. Bypass is used in secondary cascade controller when the PV is bad.

Conditions to turn the Bypass on:
- The "Bypass Enable" bit in the CONTROL_OPTS must be true.
- BYPASS parameter is changed to ON.
- The BYPASS parameter is the ON/OFF switch that activates the bypass. By default, it can be changed only when the block mode is Man or O/S. Optionally, when the "Change of Bypass in an automatic mode" bit in the FEATURES_SEL parameter in Resource block is true, then the block permits that the BYPASS switch changes in automatic modes too.

There is special treatment when the Bypass parameter changes ON/OFF in order to avoid bump in the output. When the bypass is switched to ON, the SP receives the OUT value in percent of the OUT_SCALE. And when the bypass is switched to OFF, the SP receives the PV value.

Transition in BYPASS	Action
OFF -> ON	OUT -> SP with scaling conversion
ON -> OFF	PV -> SP

Below, there is an example of the bypass in the PID block working as a PID slave in cascade control.

Step 1 – the status of IN is bad, therefore the actual mode of PID is Man
Step 2 - the target mode is changed to Man in order to write BYPASS
Step 3 – the user sets BYPASS to ON, and OUT is transferred to SP with scaling conversion
Step 4 – the user changes the target mode to Cas
Step 5 – the PID block reaches the Cas mode, despite of IN. Status.
Step 7 – the status of IN becomes good
Step 8 - the target mode is changed to Man in order to write BYPASS
Step 9 – the user sets BYPASS to OFF, and PV is transferred to SP

CONTROL_OPTS = “Bypass Enable”

Steps	1	2	3	4	5	6	7	8	9	10	11
Target	Cas	Man		Cas				Man		Cas	
Bypass	Off		On						Off		
IN	Bad	Bad	Bad	Bad	Bad	Bad	GNC 80	GNC 80	GNC 80	GNC 80	GNC 80
SP	GC 50	GC 50	GC 20	GC 20	GC 20	GC 20	GC 20	GC 20	GC 80	GC 80	GC 80
Actual	Man	Man	Man	Man	Cas	Cas	Cas	Man	Man	Man	Cas
BKCAL_OUT	NI	NI	NI	IR	GC	GC	GC	NI	NI	IR	GC
OUT	GC 20	GC 20	GC 20	GC 20	GC 20	GC 20	GC 20	GC 20	GC 20	GC 20	GC 20

Legend: GNC-Good Non Cascade status; GC-Good Cascade status

Output Tracking
The PID block supports the output track algorithm, which allows the output to be forced to a tracking value when the tracking switch is on.

In order to activate the output tracking, the block should attend the following conditions:

- bit “Track Enable” in the CONTROL_OPTS parameter must be true;
- the target mode is an automatic mode (Auto, Cas and Rcas) or Rout;
- status TRK_VAL and TRK_IN_D are usable, it means the status is good or uncertain and the bit STATUS_OPTS.”Use Uncertain as good” is true;
- the value of TRK_IN_D is active;
- If the target mode is Man, it is necessary, besides the above conditions, the bit “Track in Manual” in the CONTROL_OPTS parameter must be true.

When the tracking output is active, the OUT will be transferred to TRK_VAL converted in OUT_SCALE. The limit status becomes constant and the actual mode goes to LO.

If the TRK_IN_D or TRK_VAL status is unusable, the tracking output will be disabled and PID will return to the normal operation.

Additional features for the Enhanced PID block (EPID)

The EPID function block provides the following additional features:

1- Different type of transfer from a “manual” mode to an “automatic” mode.

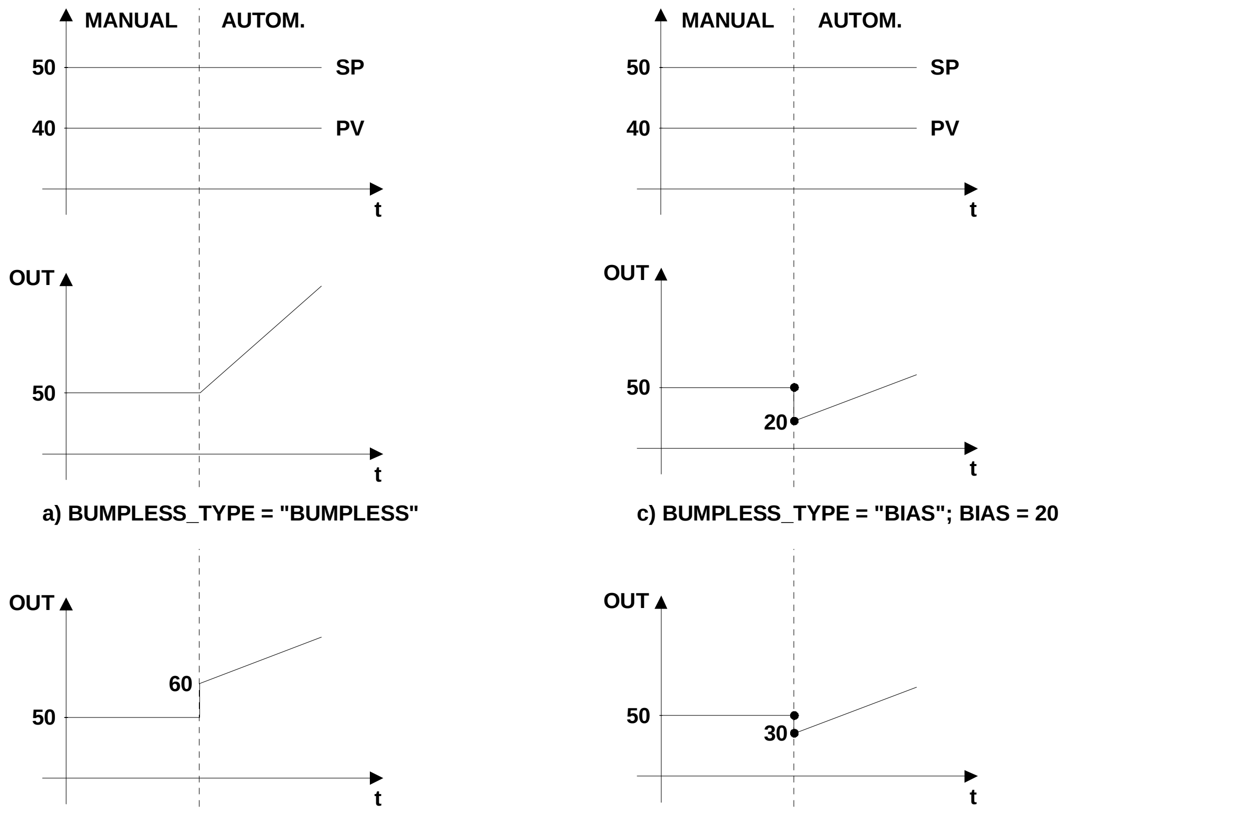
The BUMPLESS_TYPE parameter provides four types of transfer from a “manual” mode to an “automatic” mode:

a.bumpless : This is the default value and the behavior of the standard PID block. The block starts to calculate from the last value in the “manual“ mode.

b.Last + proportional: The block starts to calculate from the last value in the “manual“ mode plus the proportional term

c. Bias: The block starts to calculate from the BIAS parameter.

d. Bias + proportional: The block starts to calculate from the BIAS parameter plus the proportional term**.**



a) BUMPLESS_TYPE = "BUMPLESS"

c) BUMPLESS_TYPE = "BIAS"; BIAS = 20

b) BUMPLESS_TYPE = "LAST + PROPORCIONAL"

d) BUMPLESS_TYPE = "BIAS + PROPORCIONAL"; BIAS = 20

2-.Special treatment to Output Tracking

Special treatment is made when the output tracking is enabled:
The algorithm generates an IFS status in the output in the following situations:

- When TRK_IN_D has an unusable status and the “IFS if Bad TRK_IN_D” bit in PID_OPTS is true.
- When TRK_VAL has an unusable status and the “IFS if Bad TRK_VAL” bit in PID_OPTS is true.

The mode is changed to Man when the tracking inputs are not usable in the following ways:

- When the TRK_IN_D is not usable and the “Man if Bad TRK_IN_D” bit in PID_OPTS is true then the mode will be Man and the OUT will be the last value. Optionally, if the “target to Man if Bad TRK_IN_D” bit in the PID_OPTS is true, then the target mode will be changed to Man too.
- When the TRK_VAL is not usable and the “Man if Bad TRK_VAL” bit in PID_OPTS is true, then the mode will be Man and the OUT will be the last usable value. Optionally, if the “target to Man if Bad TRK_VAL” bit in the PID_OPTS is true, then the target mode will be changed to Man too.

Optionally, the block target mode will be changed to Manual by the block algorithm when the “tracking” is active. To set this feature, the “Target to Man if tracking active” bit in the PID_OPTS parameter needs to be true.

The required actions are summarized in the following table:

Situation	PID_OPTS	Mode		Algorithm Action
		Target	Actual	
TRK_IN_D is not usable	0x00		"auto"	. Output tracking is not active. . The algorithm continues the normal calculation.
	IFS if Bad TRK_IN_D		"auto" -> Iman	. Output tracking is not active. . The algorithm continues the normal calculation. . OUT.Status is GoodC-IFS. . When the output block goes to fault state, the upper blocks go to Iman.
	Man if Bad TRK_IN_D		Man	. Output tracking is not active. . The algorithm stops the calculation.
	"Target to Man if Bad TRK_IN_D" ; "Man if Bad TRK_IN_D"	Man	Man	. Output tracking is not active. The target mode is changed to Man.
TRK_VAL is not usable	0x00		"auto"	. Output tracking is not active. . The algorithm continues the normal calculation.
	IFS if Bad TRK_VAL		"auto" -> Iman	. Output tracking is not active. . The algorithm continues the normal calculation. OUT.Status is GoodC-IFS. . When the output block goes to fault state, the upper blocks go to Iman.
	Man if Bad TRK_VAL		Man	. Output tracking is not active. . The algorithm stops the calculation.
	"Target to Man if Bad TRK_VAL" ; "Man if Bad TRK_VAL"	Man	Man	. Output tracking is not active. the target mode is changed to Man.
TRK_IN_D and TRK_VAL is usable, TRK_IN_D is active, output tracking is enabled			LO	Output Tracking is active. **(*)**

(*) Feature available only in transmitters with version 3.52 (DD 0601) or higher, and DF51 with version 3.8.0 (DD 04xx) or higher

If the additional parameters of EPID block is configured with the default values, the block works as the standard PID block**.**

BLOCK_ERR
The BLOCK_ERR of the PID block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when the BYPASS and SHED_OPT parameters have an invalid value;
- Out of Service – it occurs when the block is in O/S mode.

Supported Modes
O/S,IMAN, LO, MAN, AUTO, CAS, RCAS and ROUT.

Control Algorithm

$$OUT = GAIN * \left[E + \frac{RATE * S}{1 + \alpha * RATE * S} * PV + \frac{E}{RESET * S} \right] + BIAS\_A/M + FEEDFORWARD$$

NOTE: ① BIAS_A/M: Internal BIAS Calculated on changing to automatic modes (RCAS, CAS, AUTO).

- α: Pseudo - Derivative Gain Equals to 0.13

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**PV**	**DS-65**			**PV**	**D / RO**	**Process analog value. This is the IN value after pass over the PV filter.**
8	**SP**	**DS-65**	**PV_SCALE +/- 10%**		**PV**	**N / Auto**	**The analog set point. Can be set manually, automatically through the interface device or another field device.**
9	**OUT**	**DS-65**	**OUT_SCALE +/- 10%**		**OUT**	**N / Man**	**The output value result of the PID calculation.**
10	**PV_SCALE**	**DS-68**		**0-100%**	**PV**	**S / Man**	**The high and low scale values to the PV and SP parameter.**
11	**OUT_SCALE**	**DS-68**		**0-100%**	**OUT**	**S / Man**	**The high and low scale values to the OUT parameter.**
12	GRANT_DENY	DS-70		0	na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
13	**CONTROL_OPTS**	**Bitstring(2)**	**See Block Options**	**0**	**na**	**S / O/S**	**See Block Options**
14	**STATUS_OPTS**	**Bitstring(2)**	**See Block Options**	**0**	**Na**	**S / O/S**	**See Block Options**
15	**IN**	**DS-65**			**PV**	**D**	**The primary input value of the block, or PV value.**
16	PV_FTIME	Float	Non-Negative	0	Sec	S	Time constant of a single exponential filter for the PV, in seconds.
17	BYPASS	Unsigned8	1:Off 2:On	0	E	S / Man	When bypass is set, the setpoint value (in percent) will be directly transferred to the output.
18	**CAS_IN**	**DS-65**				**D**	**This parameter is the remote setpoint value, which must come from another Fieldbus block, or a DCS block through a defined link.**
19	SP_RATE_DN	Float	Positive	+INF	PV/Sec	S	Ramp rate at which upward setpoint changes in PV units per second. It is disable if is zero or +INF. Rate limiting will apply only in AUTO mode.
20	SP_RATE_UP	Float	Positive	+INF	PV/Sec	S	Ramp rate at which downward setpoint changes in PV units per second. It is disable if is zero or +INF. Rate limiting will apply only in AUTO mode.
21	**SP_HI_LIM**	**Float**	**PV_SCALE +/- 10%**	**100**	**PV**	**S**	**The setpoint high limit is the highest setpoint operator entry that can be used for the block.**
22	**SP_LO_LIM**	**Float**	**PV_SCALE +/- 10%**	**0**	**PV**	**S**	**The setpoint low limit is the lowest setpoint operator entry that can be used for the block.**
23	**GAIN**	**Float**		**0**	**None**	**S**	**Proportional term of the PID. It is the Kp value.**
24	**RESET**	**Float**	**Positive**	**+INF**	**sec**	**S**	**Integral term of the PID. It is the Tr value.**
25	BAL_TIME	Float	Positive	0	sec	S	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds. In the PID block, it may be used to specify the time constant at which the integral term will move to obtain balance when the output is limited and the mode is Auto, Cas, or Rcas.
26	**RATE**	**Float**	**Positive**	**0**	**sec**	**S**	**Derivative term of the PID. It is the Td value.**
27	**BKCAL_IN**	**DS-65**			**OUT**	**N**	**The value and status from a lower block's BKCAL_OUT that is used to prevent reset windup and to initialize the control loop.**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
28	OUT_HI_LIM	Float	OUT_SCALE +/- 10%	100	OUT	S	Limits the maximum output value.
29	OUT_LO_LIM	Float	OUT_SCALE +/- 10%	0	OUT	S	Limits the minimum output value.
30	BKCAL_HYS	Float	0 to 50%	0.5%	%	S	The amount that the output must change away from its output limit before the limit status is turned off, expressed as a percent of the span of the output.
31	**BKCAL_OUT**	**DS-65**			**PV**	**D / RO**	**The value and status required by an upper block's BKCAL_IN so that the upper block may prevent reset windup and provide bumpless transfer to closed loop control.**
32	RCAS_IN	DS-65			PV	D	Target setpoint and status provided by a supervisory Host to a analog control or output block.
33	ROUT_IN	DS-65			OUT	D	Target output and status provided by a Host to the control block for use as the output (Rout mode).
34	SHED_OPT	Unsigned8	1: NormalShed, NormalReturn 2: NormalShed, NoReturn 3: ShedToAuto, NormalReturn 4: ShedToAuto, NoReturn 5: ShedToMan, NormalReturn 6: ShedToMan, NoReturn 7: ShedToRetainedTarget, NormalReturn 8: ShedToRetainedTarget, NoReturn	0		S	Defines action to be taken on remote control device timeout.
35	RCAS_OUT	DS-65			PV	D / RO	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.
36	ROUT_OUT	DS-65			OUT	D / RO	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
37	TRK_SCALE	DS-68		0-100%	TRK	S / Man	The high and low scale values, engineering units code, and number of digits to the right of the decimal point, associated with TRK_VAL.
38	**TRK_IN_D**	**DS-66**			**On/Off**	**D**	**This discrete input is used to initiate external tracking of the block output to the value specified by TRK_VAL.**
39	**TRK_VAL**	**DS-65**			**TRK**	**D**	**This input is used as the track value when external tracking is enabled by TRK_IN_D.**
40	FF_VAL	DS-65			FF	D	The feed forward value and status.
41	FF_SCALE	DS-68		0-100%	FF	S	The feedforward input high and low scale values, engineering units code, and number of digits to the right of the decimal point.
42	FF_GAIN	Float		0	none	S/Man	The gain that the feed forward input is multiplied by before it is added to the calculated control output.
43	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
44	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.
45	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
46	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged
47	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. In order to clear the alarm the amount the PV must return within the alarm limit plus hysteresis.
48	HI_HI_PRI	Unsigned8	0 to 15	0		S	Priority of the high high alarm.
49	HI_HI_LIM	Float	PV_SCALE, +INF	+INF	PV	S	The setting for high high alarm in engineering units.
50	HI_PRI	Unsigned8	0 to 15	0		S	Priority of the high alarm.
51	HI_LIM	Float	PV_SCALE, +INF	+INF	PV	S	The setting for high alarm in engineering units.
52	LO_PRI	Unsigned8	0 to 15	0		S	Priority of the low alarm.
53	LO_LIM	Float	PV_SCALE, +INF	-INF	PV	S	The setting for low alarm in engineering units.
54	LO_LO_PRI	Unsigned8	0 to 15	0		S	Priority of the low low alarm.
55	LO_LO_LIM	Float	PV_SCALE, +INF	-INF	PV	S	The setting for low low alarm in engineering units.
56	DV_HI_PRI	Unsigned8	0 to 15	0		S	Priority of the deviation high alarm.
57	DV_HI_LIM	Float	0 to PV span, +INF	+INF	PV	S	The setting for deviation high alarm in engineering units.
58	DV_LO_PRI	Unsigned8	0 to 15	0		S	Priority of the deviation low alarm.
59	DV_LO_LIM	Float	-INF, -PV span to 0	-INF	PV	S	The setting for deviation low alarm in engineering units.
60	HI_HI_ALM	DS-71			PV	D	The status for high high alarm and its associated time stamp.
61	HI_ALM	DS-71			PV	D	The status for high alarm and its associated time stamp.
62	LO_ALM	DS-71			PV	D	The status for low alarm and its associated time stamp.
63	LO_LO_ALM	DS-71			PV	D	The status for low low alarm and its associated time stamp.
64	DV_HI_ALM	DS-71			PV	D	The status for deviation high alarm and its associated time stamp.
65	DV_LO_ALM	DS-71			PV	D	The status for deviation low alarm and its associated time stamp.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

EPID - Enhanced PID

Additional Parameters

Idx	Parameter	Type	Valid Range/ Options	Default Value	Units	Mode To Change	Description
66	**BUMPLESS_TYPE**	**Unsigned8**	**0: Bumpless 1: Last+Proportional 2: Bias 3: Bias+Proportional**	**0**	**E**	**S / Man**	**Options that defines the algorithm action to start the output when the block transfer from “manual” to “automatic” mode.**
67	BIAS	Float		0	OUT	S	The bias value to use in the PID algorithm when the BUMPLESS type is “Bias” or “Bias+Proportional”.
68	PID_OPTS	Bitstring(2)	See block options	0		S / O/S	The options for handling the additional features of the output tracking.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is “Adapted”:

The default value of BYPASS is OFF.
The default value of SHED_OPT is NormalShed/NormalReturn.
The required mode for writing is the actual mode, regardless the target mode: SP and OUT.

APID – Advanced PID

Overview

The advanced PID function block provides the following additional features comparing to the standard PID algorithm and the enhanced PID:

- Selection of the terms (proportional, integral, derivative) calculated on error or process variable
- PI Sampling algorithm
- Adaptive gain
- Configurable Limits of anti reset wind-up
- Special treatment for the error
- Discrete output to indicate the actual mode

The standard features as well the enhanced ones are described in the PID block, therefore they will not be repeated here.

Schematic

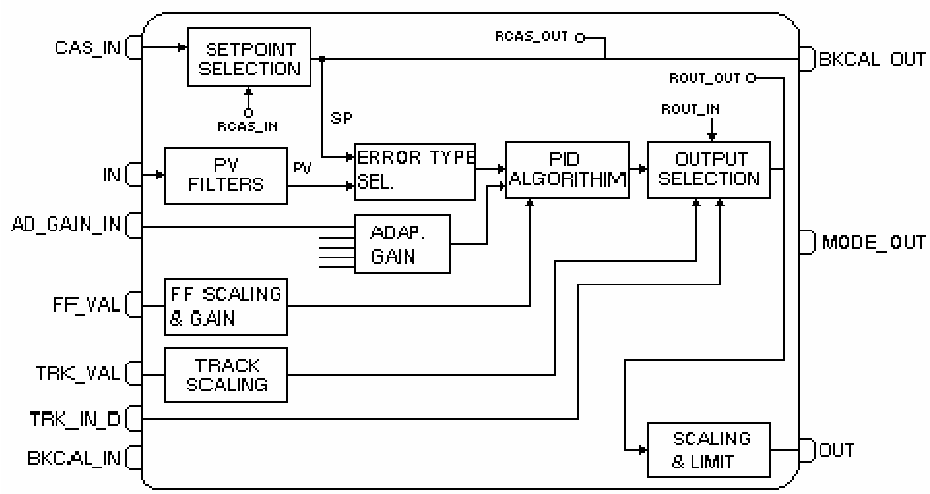


Figure 2.8 – Advanced PID Schematic

Description

Selection of the terms (proportional, integral, derivative) calculated on error or process variable.

The control algorithm can be ideal parallel or not iterative (ISA). For each algorithm can choose the terms (proportional, integral, and derivative) calculated on error or process variable by setting the PID_TYPE parameter. Where:

- PI.D - The P and I terms are calculated based on the error and the D term on the PV.
- PID - The P, I and D terms are calculated based on the error.
- I.PD - The I is calculated based on the error and the P and D terms on the PV.

PI Sampling algorithm

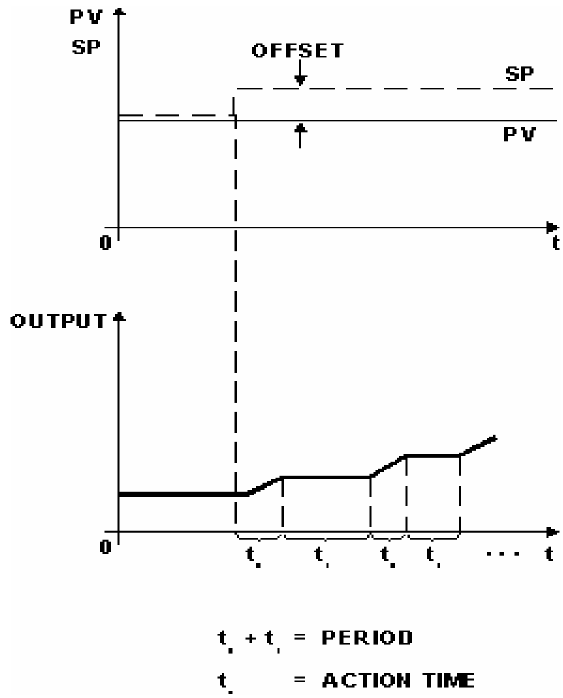


Figure 2.9 – PI Sampling Algorithm

The output is calculated based on the PI algorithm during time t_o. After that, the algorithm stops calculating and it holds the last value during time t_1, The time t_o is adjusted by SAMP_ON, and t_1 by (SAMP_PER – SAMP_ON).

If the SAMP_PER is less than SAMP_ON or SAMP_ON is zero, then the algorithm works as an ordinary PI controller.

Adaptive gain

The adaptive gain permits to change the algorithm PID terms by a factor obtained in a curve established by CURVE_X and CURVE_Y parameters. This curve is based in SP, PV, Error, OUT or another value set in AD_GAIN_IN parameter. The algorithm actions that will be changed are defined by the AD_GAIN_ACTION parameter. The AD_GAIN_IN_SEL parameter selects the input value to enter into the curve in order to get the adaptive gain.

The CURVE_X points of the curve are in the same engineering units of the selected variable. The CURVE_Y points are the adaptive gain. The adaptive gain (G) changes the PID constants GAIN, RESET and RATE to:

GAIN'= G * GAIN

RESET' = RESET / G

RATE' = G * RATE

If the curve has less than 20 configured points, the non-configured points shall be set with +INF. The curve must have crescent values in the X axis. Any configuration error will be indicated by the BLOCK_ALM parameter. If the curve has a configuration error, and thus the adaptive gain value will be the CURVE_Y corresponding to the highest CURVE_X point.

If the AD_GAIN_IN is selected and it has a bad status, the algorithm uses the last usable value to provide bumpless transfer.

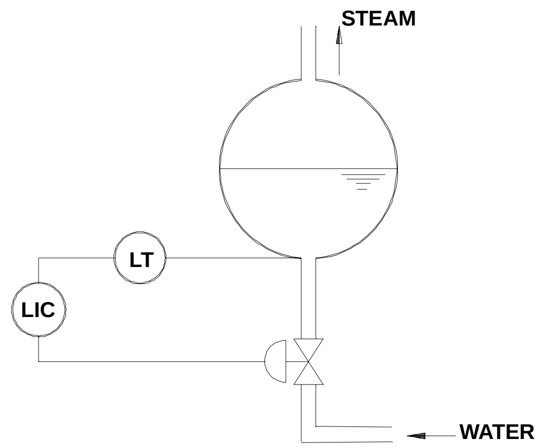


Figure 2.10 – Simple Level Control of the Caldron Tank

The volume variations are nonlinear with the level variations. The dotted line of figure below shows the volume gain with the level. Note that the volume varies slowly (low gain), around 50% level and varies very fast (high gain) around the level extremes.

The control action must have a gain that is the inverse of the process gain. This is shown by the continuous line of the figure below.

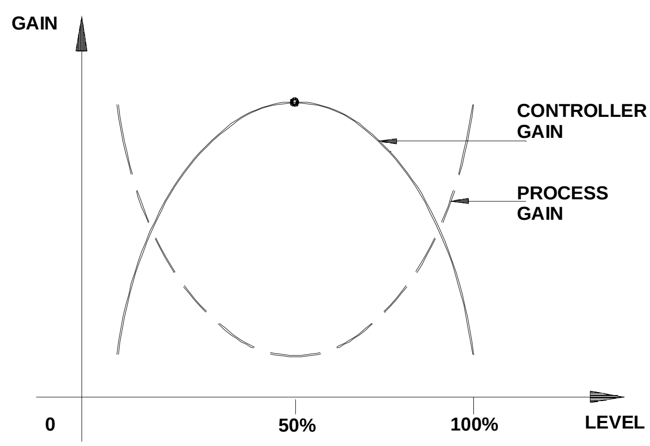


Figure 2.11 – Process and Controller Gain

The adaptative gain characteristic can be configured as shown in Fig 4.9.7. This curve can be represented by the following points of Curve 1: (X1 = 0; Y1 = 0.2; X2 = 20; Y2 = 0.8; X3 = 40; Y3 = 0.96; etc.).

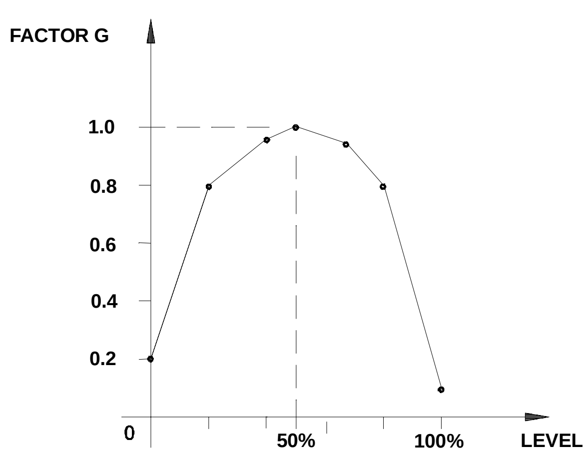


Figure 2.12 – Gain Curve as a Function of PV

While planning the configuration, observe the following:

1. It is not necessary to use all 13 points of the curve.

2. It is fundamental to use the 0% and the 100% of the determining variable (-100 and +100% for the Error).

3. It is recommendable to program the variable up to 102%, since the variable may be above 100%.

4. Tuning is normally done for G = 1. In the example, the control becomes slower above or below 50% of the level.

Adaptative Gain is also very useful for pH control.

Configurable Limits of anti reset wind-up
The saturation limits to integral term can be changed by the ARW_LOW and ARW_UP parameters. Then the control algorithm stops the integral calculation when the output signal reaches the anti-reset wind-up limits. The proportional and derivative calculations are not affected.

The Anti Reset Wind-up will not be stopped to the output limits, i.e., when the ARW_UP limit is greater than OUT_HI_LIM, the OUT is clamped in the OUT_HI_LIM value, but internally the algorithm continue the integral calculation until the ARW_UP limit. The user can avoid this case configuring the ARW_UP less or equal to OUT_HI_LIM. The same idea applies to the low limit.

Special Treatment for the Error
The treatment of the error in the control process can be chosen by the ERROR_TYPE parameter.
The quadratic error can be applied on only integral term or on all PID terms. In the quadratic error, the considered error for the calculation will be:

$$\hat{e} = \frac{e * |e|}{100}$$

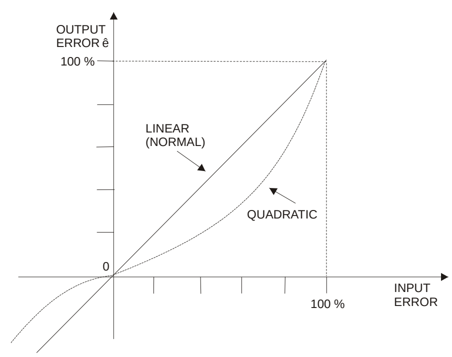


Figure 2.13 – Treatment of the Error

In order to use the GAP control to consider the cases where the control is unstable over a band around SP due the dead band of the actuator or due the noise or other things, there is a special gain in the error type.

In order to use the ERROR_TYPE as special gain it is necessary to define the ERROR_BAND where it will be applied the special gain GAIN_BAND parameter on the error. If the ERROR_BAND is zero the algorithm will not apply the special gain.

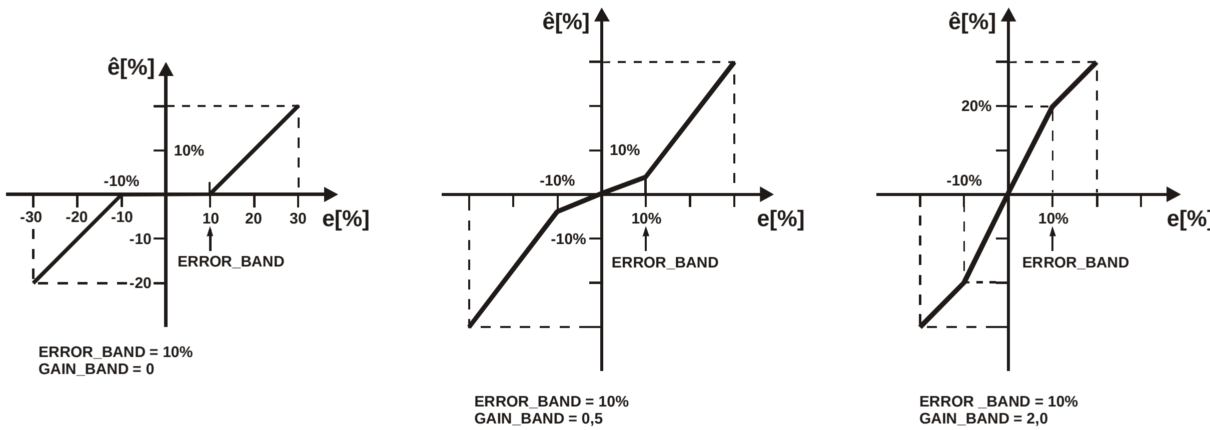


Figure 2.14 – Application Example of GAIN_BAND and ERROR_BAND

Mode indication

The MODE_IND parameter is used to configure which mode(s) types in the actual mode will be indicated by a TRUE value in the discrete output MODE_OUT. If more than one mode type is chosen, then it will be used an OR logic.

Working as a standard PID

If the additional parameters of APID block is configured with the default values, then it works as the standard PID block.

BLOCK_ERR

The BLOCK_ERR will reflect the following causes:

- Block Configuration Error – the configuration error occurs when the BYPASS or SHED_OPT parameter has an invalid value or the curve has any of the following problems:
    - o CURVE_X[i] > CURVE_X[I+1]
    - o If the curve is not using **effectively** 20 points and any non-configured point is different from +INFINITY.
- Out of Service – it occurs when the block is in O/S mode.

Supported modes

O/S, IMAN, LO, MAN, AUTO, CAS, RCAS and ROUT.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
66	MODE_OUT	DS-66				D / RO	This output parameter will be set if the “MODE_IND” parameter indicates one of the modes shown by actual mode.
67	MODE_IND	Bitstring	Actual mode bitstring	0		D	This parameter selects the mode(s) that will be compared with the actual mode to set the “MODE_OUT” parameter.
68	AD_GAIN_ACTION	Unsigned8	0: Disable 1: PID 2: PI 3: P 4: I 5: D	0	E	S / Man	It chooses the term(s) of PID algorithm multiplied by the adaptive gain.
69	AD_GAIN_IN_SEL	Unsigned8	0: SP 1: PV 2: Error 3: OUT 4: AD_GAIN_IN	0	E	S / Man	It selects the input to enter into the curve in order to get the adaptive gain. The option Error may be selected if ERROR_TYPE is Normal.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
70	AD_GAIN_IN	DS-65				D	Input parameter to enter into the curve in order to get the adaptive gain.
71	CURVE_X	20 Floats		0's	EU of variable selected by AD_GAIN_IN_SEL	S	Curve input points. The x_i points of the curve are defined by an array of twenty points.
72	CURVE_Y	20 Floats		0's	Na	S	Curve output points. The y_i points of the curve are defined by an array of twenty points.
73	**ERROR_TYPE**	**Unsigned8**	**0: Normal** **1: Quadratic (Integral)** **2: Quadratic (all terms)** **3: Special gain**	**0**	**E**	**S / Man**	**Type of error used by the PID algorithm. The options Quadratic and Special gain may be selected if AD_GAIN_IN_SEL is different of Error.**
74	**ERROR_BAND**	**Float**	**0-300%**	**0**	**%**	**S**	**It is applied a special treatment for error within the "ERROR_BAND".**
75	GAIN_BAND	Float	0-10	0	Na	S	Special gain applied to the error, if it is selected in the ERROR_BAND.
76	**PID_TYPE**	**Unsigned8**	**0:PI.D + ISA** **1:PID + ISA** **2:I.PD + ISA** **3:PI Sampling + ISA** **4:PI.D + Parallel** **5:PID + Parallel** **6:I.PD + Parallel** **7:PI Sampling+Parallel**	**0**	**E**	**S**	**Type of PID algorithm.**
77	SAMP_ON	Float	0-10800	0	Sec	S	Time interval of the PID algorithm activity, therefore (SAMP_PER – SAMP_ON) means the hold time.
78	SAMP_PER	Float	0-10800	0	Sec	S	Period of the PI sampling algorithm.
79	**BUMPLESS_TYPE**	**Unsigned8**	**0: Bumpless** **1: Last+Proportional** **2: Bias** **3: Bias+Proportional**	**0**	**E**	**S / Man**	**This parameter defines the type of transfer from a "manual" mode to an "automatic" mode.**
80	BIAS	Float		0	OUT	S	The bias value to use in the PID algorithm when the BUMPLESS type is "Bias" or "Bias+Proportional".
81	ARW_UP	Float		+ INF	OUT	S	High limit for anti reset windup.
82	ARW_LOW	Float		- INF	OUT	S	Low limit for anti reset windup.
83	PID_OPTS	Bitstring(2)		0		S / O/S	A bit string for handling the additional characteristics of the output tracking.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

ARTH - Arithmetic

Description

The ARTH block is intended for use in calculating measurements from combinations of signals from sensors. It is not intended to be used in a control path, so it does not support cascades or back calculation. It does no conversions to percent, so scaling is not supported. It has no process alarms.

The block has 5 inputs. The first two are dedicated to a range extension function that results in a PV, with status reflecting the input in use. The remaining three inputs are combined with the PV in a selection of four term math functions that have been found useful in a variety of measurements. The inputs used to form the PV must come from devices with the desired engineering units, so that the PV enters the equation with the right units. Each of the additional inputs has a bias and gain constant. The bias can be used to correct for absolute temperature or pressure. The gain can be used to normalize terms within a square root function. The output also has gain and bias constants for any further adjustment required.

The range extension function has a graduated transfer, controlled by two constants referenced to IN. An internal value, g, is zero for IN less than RANGE_LO. It is one when IN is greater than RANGE_HI. It is interpolated from zero to one over the range of RANGE_LO to RANGE_HI.
The equation for PV follows:

$$PV = g * IN + (1 - g) * IN\_LO$$

if :
IN < RANGE_LO or
IN_LO < RANGE_HI and status of IN is unusable and status of IN_LO is usable:

g = 0
IN > RANGE_HI or
IN > RANGE_LO and status of IN is usable and status of IN_LO is unusable:

g = 1
RANGE_LO ≤ IN ≤ RANGE_HI:

$$g = \frac{IN - RANGE\_LO}{RANGE\_HI - RANGE\_LO}$$

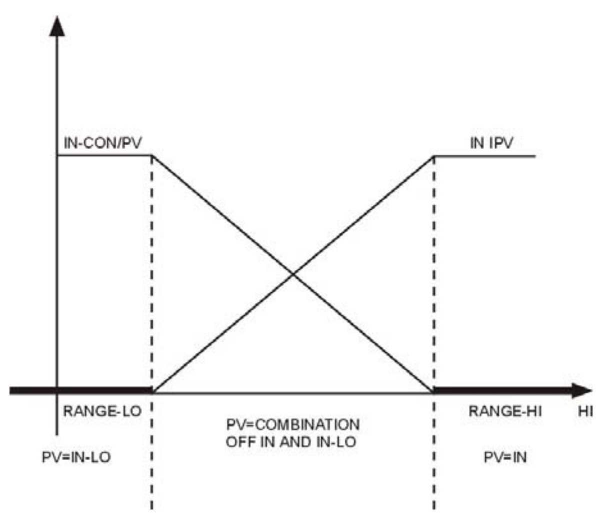


Figure 2.15 –The Range Extension Function

If the status of IN_LO is unusable and IN is usable and greater than RANGE_LO, then g will be set to one. If the status of IN is unusable, and IN_LO is usable and less than RANGE_HI, then g will be set to zero. In each case the PV will have a status of Good until the condition no longer applies.

Otherwise, the status of IN_LO is used for the PV if g is less than 0.5, while IN is used for g greater than or equal to 0.5.

Six constants are used for the three auxiliary inputs. Each has a BIAS_IN_i and a GAIN_IN_i. The output has a BIAS and GAIN static constant. For the inputs, the bias is added and the gain is applied to the sum. The result is an internal value called t_i in the function equations.
t_i = (IN_i + BIAS_IN_i) ∗ GAIN_IN_i

The flow compensation functions have limits on the amount of compensation applied to the PV, to assure graceful degradation if an auxiliary input is unstable.
The following equations have the compensation factor limited to COMP_HI_LIM and COMP_LO_LIM:

- flow compensation , linear
- flow compensation, square root
- flow compensation, approximate
- BTU flow
- Traditional multiply divide

Arithmetic exceptions:
a) Division by zero will produce a value equals to OUT_HI_LIM or OUT_LO_LIM, it depends on the sign of PV.
b) Roots of negative numbers will produce the root of the absolute value, with a negative sign.

Although the output is not scaled, it still has absolute high and low limits, to keep the values reasonable.

Minimum Configuration
RANGE_HI and RANGE_LO: If the range extension function is not used, these two parameters must be set to +INF and –INF, respectively. The inputs IN_1, IN_2 and IN_3 must be configured according to the equation type selected (see in the table the available equation types), or using INPUT_OPTS to disable determined input. Therefore the PV will be a copy of IN.

If the ARITH_TYPE is one of five first equations, the COMP_HI_LIM and COMP_LO_LIM parameters must be set properly. The default value of COMP_HI_LIM parameter is zero.

As the default value of GAIN parameter is zero, it is necessary to set a suitable value.

BLOCK_ERR
The BLOCK_ERR of the Arithmetic block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when the ARITH_TYPE has an invalid value;
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S, MAN and AUTO.

Status Handling
The status of PV depends on the factor “g”, if it is less than 0.5, then it will be used the status of IN_LO, and otherwise it will be the status of IN.

The INPUT_OPTS parameter allows the usage of auxiliary inputs with less than good status. The status of unused inputs is ignored.

The status of the output will be that of the PV, except for when the status of PV is good and the status of a used auxiliary input is not good and INPUT_OPTS is not configured to use it. In this case, the status of OUT will be Uncertain.

Schematic

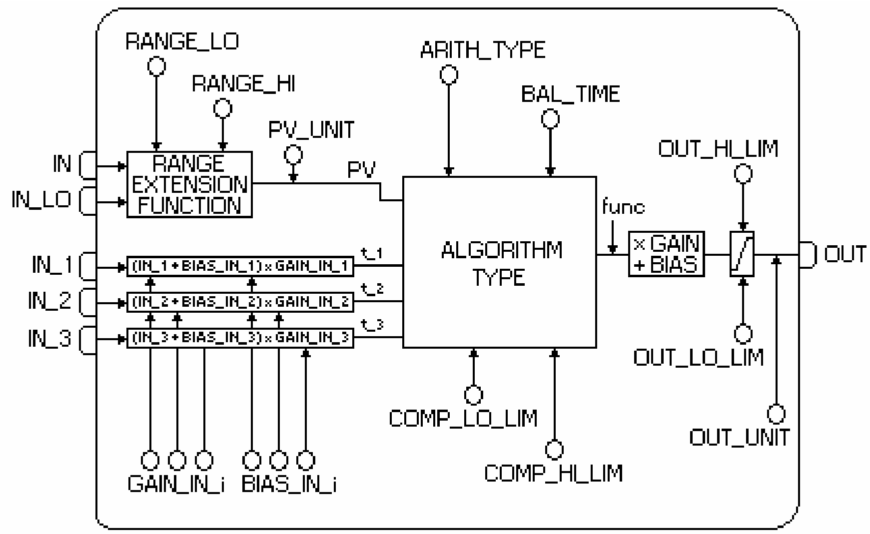


Figure 2.16 – Schematic

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter.**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**PV**	**DS-65**			**PV**	**D / RO**	**Process analog value for use in executing the function.**
8	**OUT**	**DS-65**	**OUT_SCALE +/- 10%**		**OUT**	**D / Man**	**The analog value calculated as a result of executing the function.**
9	PRE_OUT	DS-65			OUT	D / RO	Displays what would be the OUT value and status if the mode was Auto or lower.
10	**PV_UNITS**	**Unsigned16**		**0**	**PV**	**S**	**The engineering units index for display. See Arithmetic block.**
11	**OUT_UNITS**	**Unsigned16**		**0**	**OUT**	**S**	**The engineering units of the output for display.**
12	GRANT_DENY	DS-70		0	na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
13	**INPUT_OPTS**	**Bitstring(2)**		**0**	**na**	**S / O/S**	**Option bit string for handling the status of the auxiliary inputs.**
14	**IN**	**DS-65**			**PV**	**D**	**The primary input of the block**
15	**IN_LO**	**DS-65**			**PV**	**D**	**Input for the low range transmitter, in a range extension application.**
16	**IN_1**	**DS-65**			**None**	**D**	**Numbered input 1.**
17	**IN_2**	**DS-65**			**None**	**D**	**Numbered input 2.**
18	**IN_3**	**DS-65**			**None**	**D**	**Numbered input 3.**
19	**RANGE_HI**	**Float**		**0**	**PV**	**S**	**If PV has a value larger than this range, it will use the IN value.**
20	**RANGE_LO**	**Float**		**0**	**PV**	**S**	**If PV has a value less than this range, it will use the IN_LOW value.**
21	**BIAS_IN_1**	**Float**		**0**	**None**	**S**	**The constant to be added to IN_1.**
22	**GAIN_IN_1**	**Float**		**0**	**None**	**S**	**The constant to be multiplied times (IN_1 + bias).**
23	**BIAS_IN_2**	**Float**		**0**	**None**	**S**	**The constant to be added to IN_2.**
24	**GAIN_IN_2**	**Float**		**0**	**None**	**S**	**The constant to be multiplied times (IN_2 + bias).**

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
25	**BIAS_IN_3**	**Float**			**None**	**S**	**The constant to be added to IN_3.**
26	**GAIN_IN_3**	**Float**		**0**	**None**	**S**	**The constant to be multiplied times (IN_3 + bias).**
27	**COMP_HI_LIM**	**Float**		**0**	**None**	**S**	**The high limit imposed on the PV compensation term.**
28	**COMP_LO_LIM**	**Float**		**0**	**None**	**S**	**The low limit imposed on the PV compensation term.**
29	**ARITH_TYPE**	**Unsigned8**	**1= Flow comp. linear 2= Flow comp. square root 3= Flow comp. approx. 4= BTU flow 5= Traditional mult. div. 6= Average 7= Traditional summer 8= Fourth order polynomial 9= HTG comp. level**	**0**	**E**	**S**	**This parameter identifies which equation will be used.**
30	BAL_TIME	Float	Positive	0	Sec	S	It specifies the time for the output be actuated in a bumpless transition from Man mode to Auto mode.
31	**BIAS**	**Float**		**0**	**OUT**	**S**	**The bias value used in computing the function block output, expressed in engineering units.**
32	**GAIN**	**Float**		**0**	**None**	**S**	**Dimensionless value used by the block algorithm in calculating the block output.**
33	**OUT_HI_LIM**	**Float**		**100**	**OUT**	**S**	**Limits the maximum output value.**
34	**OUT_LO_LIM**	**Float**		**0**	**OUT**	**S**	**Limits the minimum output value**
35	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
36	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":
The default value of ARITH_TYPE is the Gas flow compensation for linear transmitters, equation type 1.

The required mode for writing is the actual mode, regardless the target mode : OUT

Equation Types

ARITH_ TYPE	Equation
1 Flow comp. Linear	$OUT = PV * f * GAIN + BIAS$ where $f = \left[\frac{T1}{T2}\right]$ is limited
2 Flow comp. Square root	$OUT = PV * f * GAIN + BIAS$ where $f = \left[\sqrt{\frac{T1}{T2 * T3}}\right]$ is limited
3 Flow comp. Approx.	$OUT = PV * f * GAIN + BIAS$ where $f = \left[\sqrt{T1 * T2 * T3^2}\right]$ is limited
4 BTU flow	$OUT = PV * f * GAIN + BIAS$ where $f = [T1 - T2]$ is limited
5 Traditional mult. div.	$OUT = PV * f * GAIN + BIAS$ where $f = \left[\frac{T1}{T2} + T3\right]$ is limited
6 Average	$OUT = \frac{PV + T1 + T2 + T3}{f} * GAIN + BIAS$ Where f is number of inputs used in computation (unusable inputs are not used).
7 Traditional summer	$OUT = (PV + T1 + T2 + T3) * GAIN + BIAS$
8 Fourth order polynomial	$OUT = (PV + T1^2 + T2^3 + T3^4) * GAIN + BIAS$
9 HTG comp. Level	$OUT = \frac{PV - T1}{PV - T2} * GAIN + BIAS$

Examples

ARITH_ TYPE	Example	Example equation	Note
1	Gas flow compensation for linear transmitters (e.g. turbine)	$Q_b = Q_f * K * \frac{P}{T}$	
2	Gas flow compensation For DP transmitters.	$Q_b = Q_f * K * \sqrt{\frac{P}{T * Z}}$	Z may be constant or an input from other block (AGA3)
3	Approx. liquid & steam flow comp.	$Q_b = Q_f * K * \sqrt{(K + K * T + K * T^2)}$ $Q_b = Q_f * K * \sqrt{(K + K * P)}$	Temperature connected to 3 and 4
4	BTU meter (heat flow)	$Q_{HEAT} = K * Q_{VOL} * (t_1 - t_2)$	
5	Simple “hard” (non-cascade) ratio	$Q_{SP} = Q_{WILD} * RATIO$	output is setpoint to PID block
6	Average of four temperature measurements	$t_a = \frac{t_1 + t_2 + t_3 + t_4}{f}$	.
7	Difference in pressure (or level)	$P_{bm} = P_b - P_m$	
9	Simple HTG compensated level	$h_{BT} = \frac{P_B - P_T}{P_B - P_M} * h_{BM}$	

NOTE: Square root of the third power may be achieved by selecting ARITH_TYPE = 3 and connecting input to IN and IN_1. Square root of the fifth power may likewise be achieved by connecting the input to IN, IN_1 and IN_3.

SPLT-Splitter

Description

The splitter block provides the capability to drive multiple outputs from a single input, usually a PID. This block would normally be used in split ranging or sequencing of multiple valve applications. Included in the block features are the capability to open valves as part of a predetermined schedule and leave open or closed a given valve after the controller has transitioned off the valve. The splitter supports two outputs. Since this block will participate in the control path after a PID block, back calculation support is included.

IMPORTANT
All parameters and features with **(*)** are available only in transmitters with version 3.52 (DD 0601) or higher, and DF51 with version 3.8.0 (DD 04xx) or higher

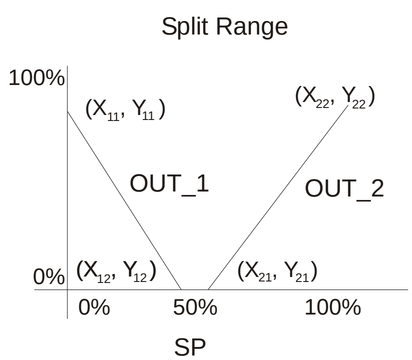
The application(s) targeted for the splitter block would be a single output from a controller which is used to control up to two valves in either split ranging fashion or as sequenced operation. Split ranging is that application where two valves are used such as a reactor where heating and cooling must be applied by the same controller. The controller action, direct or reversing, is implicitly reversed owing to the change in slope of the function as the input increases or decreases. Sequencing as applied to this document is when two or more valves are used to manipulate the flow of some material and the controller action is not reversed implicitly or otherwise. An example is pH control where added valves are required to increase the loop rangeability.

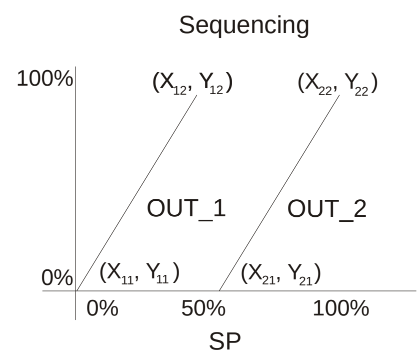
The following parameters are used to specify the signal splitter operation:
X11, Y11   X12, Y12

X21, Y21   X22, Y22

Where X_{nJ} is the value of CAS_IN associated with OUT_n and X_{n1} and X_{n2} refers to the 1st and 2nd coordinates respectively. The Y values are defined in the same way.

A graphical representation of the splitter vs. controller output is shown below. Both a Split range and Sequencing application are shown.



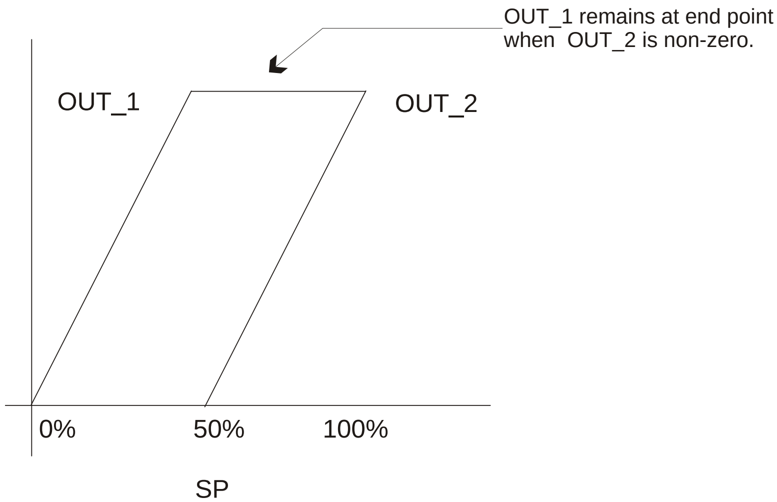


IN_ARRAY	OUT_ARRAY
X_{11}	Y_{11}
X_{12}	Y_{12}
X_{21}	Y_{21}
X_{22}	Y_{22}

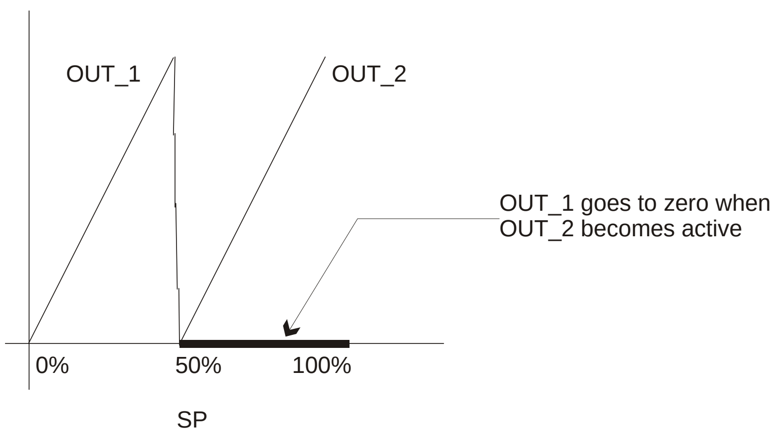
By specifying the coordinates as shown above the endpoints of the lines are defined. The contents of the respective X's and Y's are held in IN_ARRAY and OUT_ARRAY parameters. If a set of points is specified such that a region of the input range is not specified then the block will interpolate to the endpoint of the input value, either high or low.

The parameter LOCKVAL provides an option to specify whether OUT_1 remains at its ending level when control is switched to OUT_2, or goes to zero. If LOCKVAL is true, OUT_1 remains at its current value when OUT_2 is non-zero. If LOCKVAL is false then as soon as the OUT_2 becomes non-zero then OUT_1 goes to zero. The parameter OUT_1 will be the initial value if LOCKVAL = FALSE and the parameter OUT_ARRAY must be "Sequencing".

In the situation below, LOCKVAL = TRUE.



In the situation below, LOCKVAL = FALSE.



(*) Additionally, the parameter LOCK_VAL = "SP on Cas Restart" does the return output BKCAL_OUT for the upper block uses the SP value instead of the BKCAL_IN in the cascade initialization.

Supported Modes
O/S, IMAN, Auto and Cas.

Status Handling
Sub-status values received at CAS_IN will be passed to both outputs, except for those used in the cascade handshake. **An IFS will go to both the active and the inactive outputs.** The back calculation status will only come from the active output. An output held by LOCKVAL is not active. Limit status must be inverted if the slope of the active output is negative. No limits are sent back on BKCAL_OUT if neither output is active.

Actual mode	BKCAL_IN_1	BKCAL_IN_2	BKCAL_OUT	ACTION
Iman	NI	NI	NI	BKCAL_OUT limited high and low to (X12 + X21)/2
Auto or Cas	NI	OK	OK	BKCAL_OUT limited to X21 low and X22 high
Auto or Cas	OK	NI	OK	BKCAL_OUT limited to X11 low and X12 high
Iman	IR	NI	IR	Initialize cascade to value given by curve X1 vs Y1
Auto or Cas	IR	OK	OK	Initialize OUT_1 using internal offset from Y1
Iman	NI	IR	IR	Initialize cascade to value given by curve X2 vs Y2
Auto or Cas	OK	IR	OK	Initialize OUT_2 using internal offset from Y2

Legend: NI-not invited; IR-initialization request; OK-working in cascade

Schematic

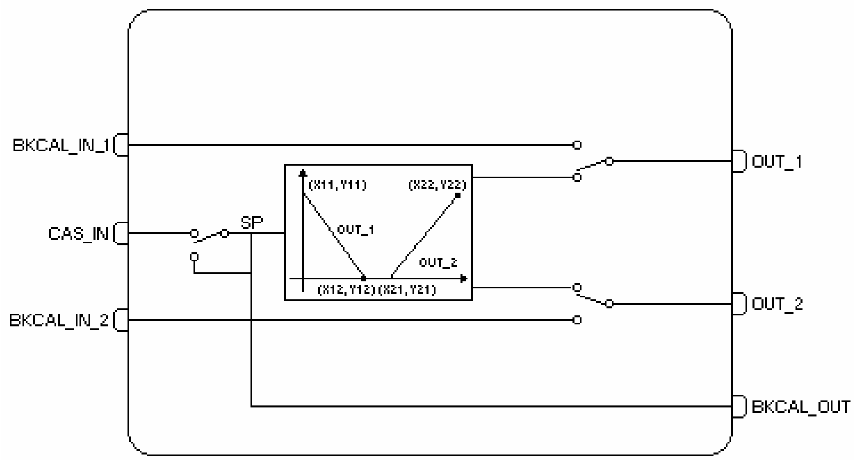


Figure 2.17 – Schematic

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter.**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	**SP**	**DS-65**				**N / Auto**	**The analog set point.**
8	**OUT_1**	**DS-65**			**OUT1**	**D / RO**	**Numbered output parameter 1.**
9	**OUT_2**	**DS-65**			**OUT2**	**D / RO**	**Numbered output parameter 2.**
10	OUT_1_UNITS	Unsigned16		0	E	S	The units code for the corresponding output.
11	OUT_2_UNITS	Unsigned16		0	E	S	The units code for the corresponding output.
12	GRANT_DENY	DS-70		0	Na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
13	**STATUS_OPTS**	**Bitstring(2)**		**0**	**Na**	**S / OOS**	**Options which the user may select in the block processing of status.**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
14	**CAS_IN**	**DS-65**				**D**	**This parameter is the remote setpoint value, which must come from another Fieldbus block, or a DCS block through a defined link.**
15	**BKCAL_OUT**	**DS-65**				**D / RO**	**The value and status required by an upper block's BKCAL_IN so that the upper block may prevent reset windup and provide bumpless transfer to closed loop control.**
16	**IN_ARRAY**	**4 Floats**		**0's**		**S**	**An array which contains the values of the input or X variables.**
17	**OUT_ARRAY**	**4 Floats**		**0's**		**S**	**An array which contains the values of the output or Y variables.**
18	LOCKVAL	Unsigned8	0:FALSE 1:TRUE 2- SP on Cas restart **(*)** 3- Lock & SP On cas restart **(*)**	FALSE	**E**	S	Flag for holding the first output at current value when the other output is non-zero. It also allowed BKCAL_OUT receives SP or BKCAL_IN in the cascade initialization.
19	**BKCAL_IN_1**	**DS-65**				**N**	**The back calculated input required to initialize a lower cascade 1.**
20	**BKCAL_IN_2**	**DS-65**				**N**	**The back calculated input required to initialize a lower cascade 2.**
21	BAL_TIME	Float		0	Sec	S	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds.
22	UPDATE_EVT	DS-73			na	D	This alert is generated by any change to the static data.
23	BLOCK_ALM	DS-72			na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":
The required mode for writing is the actual mode, regardless the target mode: SP

CHAR - Signal Characterizer

Description

The signal characterizer block has two sections, each with an output that is a non-linear function of the respective inputs. The function is determined by a single look-up table with x-y coordinates of twenty points each. The status of input is copied to the corresponding output, so the block may be used in the control or process signal path. An option can swap the axes of the function for section 2, so that it can be used in the backward control path.

IMPORTANT
All parameters and features with **(*)** are available only in transmitters with version 3.52 (DD 0601) or higher, and DF51 with version 3.8.0 (DD 04xx) or higher

The block interpolates correlates the input IN_1 to the output OUT_1 and the input IN_2 to the output OUT_2 according to a curve given by the points:

[x_1 ;y_1], [x_2 ; y_2].............[x_{20} ; y_{20}]

where x corresponds to the Input and y to the Output. The x-coordinates are given in engineering units of the input. The y-coordinates are given in engineering units of the output.

How to configure not used points

If the curve has m points, m<20, the non-configured points, [$x_{m+1;}$ y_{m+1}], [$x_{m+2;}$ y_{m+2}],…. [$x_{20;}$ y_{20}] shall be set with +INFINITY.

Working with more than One Characterizer Block in Series (*)

When the application needs more than the limit of a CHAR block (more than 20 points in the curve), it can use many CHAR blocks in series. To do this, it is necessary to configure in the SWAP_2 parameter:

- Indicate which is the first, the intermediate blocks and the last block of the CHAR series. Thus, the input parameters will be limited by the lower X value of the curve indicated by FIRST (Low Limit) and the upper X value of the curve indicated by LAST (High Limit).
- If the SWAP was used, thus all the curve blocks must be defined with "Swap & xxxx" (SWAP & FIRST, SWAP & INTERMEDIATE, SWAP & LAST).
- The first, intermediate and last values are for the two inputs: IN_1 and IN_2.
- When the SWAP_2 value is equal 0 – No Swap or 1 – Swap, the block will work as "Alone", that is, as not supporting CHAR blocks in series.

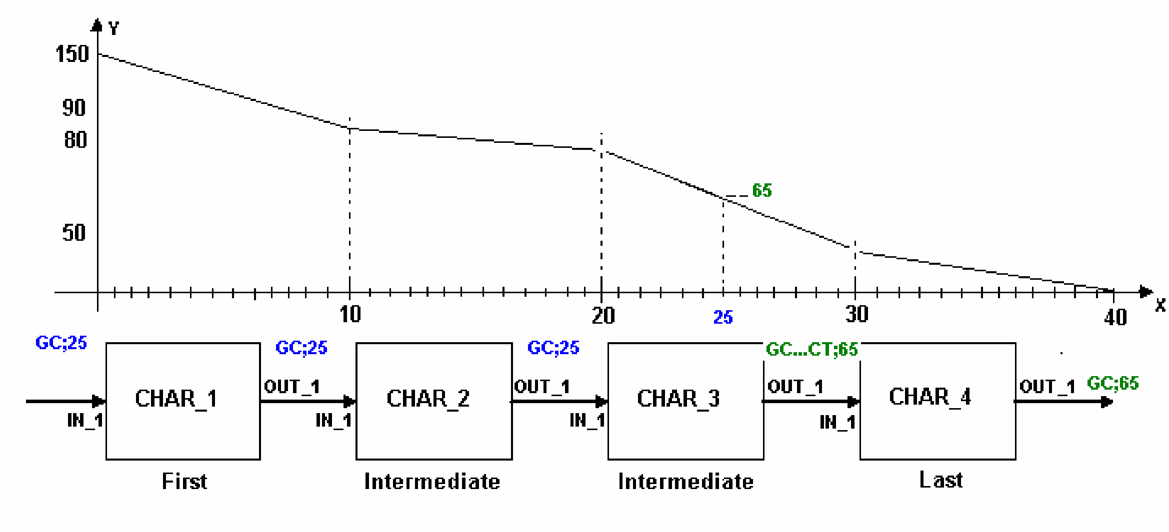
To work in series, the CURVE_X parameter must be always crescent in relation to the points inside the block and also in relation to the other blocks of the CHAR cascade. For example, the order of the block configuration of the example below must be followed:

1. CHAR1 – Swap_2 = "First".
2. CHAR2 – Swap_2 = "Intermediate"
3. CHAR3 – Swap_2 = "Intermediate"
4. CHAR4 – Swap_2 = "Last"

If the order was not followed correctly, the blocks will not indicate configuration error, but the algorithm will not work correctly.

The status limit "**Constant"** will be used between the CHAR blocks to indicate the value was "Resolved" by the block. At the end, the Status Limit will be "**Not Limited**" (even the curve was limited the status limit will not used).

In the following example, the application needs 80 points to be configured. In this case is necessary to use four CHAR blocks. It considers the input value for the first block (CHAR_1) is 25. The value is repassed for the CHAR_1 and CHAR_2 blocks because the input value is out of the curve limits of these blocks. The value is "resolved" by the CHAR_3 block that repasses the Y correspondent value for the following block, as well the "Constant" Status Limit. Thus, the following blocks (CHAR_4 in the example), when check the input with "Constant" limit, know the value was already "resolved" and repass it for the output.



The Cascade Swap is supported, since the curve was monotonic in the whole extension. The check if the curve is monotonic for all cascade blocks does not exist, thus if the curve was not monotonic, the result will be the first Y value found.

BLOCK_ERR
The BLOCK_ERR will reflect the following causes:

- Block Configuration Error – the configuration error occurs when the BYPASS parameter has an invalid value or the curve has any of the following problems:
  - CURVE_X[i] > CURVE_X[I+1]
  - If the curve is not using **effectively** 20 points and any non-configured point is different from +INFINITY.
  - If SWAP_2 is true and the curve is not monotonic.
- Out of Service – it occurs when the block is in O/S mode.

Supported Modes
O/S and AUTO.

Status Handling
The quality and sub-status of OUT_1 and OUT_2 reflect the status of IN_1 and IN_2, respectively.
If one of the curve limits is reached, the appropriate limit is indicated. Limits are reversed if the curve slope is negative.
The status of output will be Bad – Configuration Error if there is an error as indicated in the BLOCK_ERR parameter.

Schematic

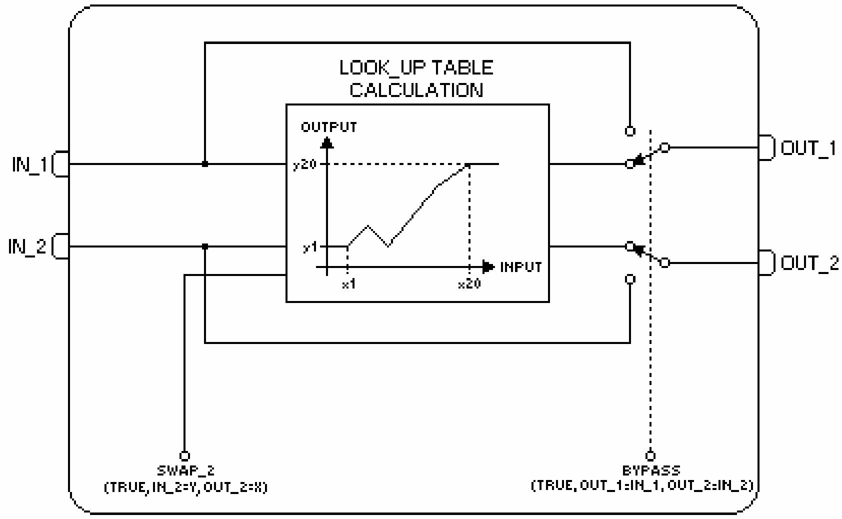


Figure 2.18 – Schematic

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	**OUT1**	**DS-65**			**Y**	**D / RO**	**Numbered output parameter 1. The interpolation result of IN_1.**
8	OUT2	DS-65			X or Y	D / RO	Numbered output parameter 2. The interpolation result of IN_2.
9	X_UNITS	Unsigned16			E	S	The engineering unit of the variables corresponding to the x-axis for display.
10	Y_UNITS	Unsigned16			E	S	The engineering unit of the variables corresponding to the y-axis for display.
11	GRANT_DENY	DS-70		0	Na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
12	CONTROL_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
13	**IN_1**	**DS-65**				**D**	**Numbered input parameter 1.**
14	IN_2	DS-65				D	Numbered input parameter 2.
15	BYPASS	Unsigned8	1:Off 2:On	0	E	S / Man	When bypass is set, the input value will be directly transferred to the output.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
16	SWAP_2	Unsigned8	0 – False 1 – Swap 2 – First **(*)** 3 – Intermediate**(*)** 4 – Last **(*)** 5 – Swap & First**(*)** 6 – Swap & Intermediate **(*)** 7 – Swap & Last **(*)**	0	**E**	S/O/S	0 – False – No Swap e not support cascade of char. 1 – Swap – Swap the curve for OUT_2 e not support cascade of char. 2 – First – No swap and the block is the first block of the curve. 3 – Intermediate – No swap and the block is an intermediate block in the curve 4 – Last - No swap and the block is the last block in the curve. 5 – Swap & First – Swap the curve for OUT_2 and is the first block of the curve. 6 – Swap & Intermediate- Swap the curve for OUT_2 and an intermediate block of the curve. 7 – Swap & Last - Swap the curve for OUT_2 and the block is the last block in the curve.
17	**CURVE_X**	**20 Floats**		**0's**	**X**	**S**	**Curve input points. The x_i points of the curve are defined by an array of twenty points.**
18	**CURVE_Y**	**20 Floats**		**0's**	**Y**	**S**	**Curve output points. The y_i points of the curve are defined by an array of twenty points.**
19	UPDATE_EVT	DS-73			na	D	This alert is generated by any change to the static data.
20	BLOCK_ALM	DS-72			na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":
The default value of BYPASS is Off.
The default value of all elements of CURVE_X is +INF.
The default value of all elements of CURVE_Y is +INF.

INTG - Integrator

Description

The Integrator Function Block integrates a variable in function of the time or accumulates the counting of a Pulse Input block. The integrated or accumulated value is compared to pre-trip and trip limits, generating discrete signals when these limits are reached. The integrated value may go up, starting from zero, or down, starting from the trip value (parameter SP).

In order to determine the amount of uncertain or bad readings, the block integrates the variables with bad or bad and uncertain status separately (parameter RTOTAL). The values used in this second integration are the values with good status just before they went from good to bad or uncertain. Featuring two flow inputs, the block can calculate and integrate net flow. This can be used to calculate volume or mass variation in vessels or as an optimizing tool for flow ratio control.

The basic function of the Integrator block is to integrate an analog value over time. It can also accumulate the count pulses coming from Pulse Input blocks or from another Integrator Block. This block is normally used to totalize flow, giving total mass or volume over a certain time, or totalize power, giving the total energy.

Inputs

The block has two dual purpose inputs IN_1 and IN_2. Each input can receive a measurement per unit of time (rate) or an accumulated number of pulses. Each input can receive one of the following types of variables:

RATE - When the variable connected to the input is a rate, that is, kg/s, W, Gal/hour, etc. This input can come from, or is derived from the output OUT of a Pulse Input block or from the output of an Analog Input block.

ACCUM - When the input comes from the OUT_ACCUM of a Pulse Input block, it represents a continuous accumulation of pulse counts from a transducer. Other application can be an accumulation when the input is connected to another Integrator block, this case will be a relative accumulation.

The input type is configured in the INTEG_OPTS Bit string parameter. The corresponding bits for IN_1 and IN_2 can be set as False when the input type is RATE or TRUE when the input type is ACCUM.

If the input option is RATE

- Each input needs a parameter to define the rate time unit: [TIME_UNIT1] or [TIME_UNIT2]. The time units are used to convert the two rates in units of mass, volume or energy per second.
-
- The second analog input may be converted into the same units of the first input. This is achieved by a unit conversion factor, given by the parameter [UNIT_CONV].

Each rate, multiplied by the block execution time, gives the mass, volume or energy increment per block execution. This increment will be added or subtracted in a register, according to some rules defined ahead.

The following diagram is an example of using inputs of RATE type

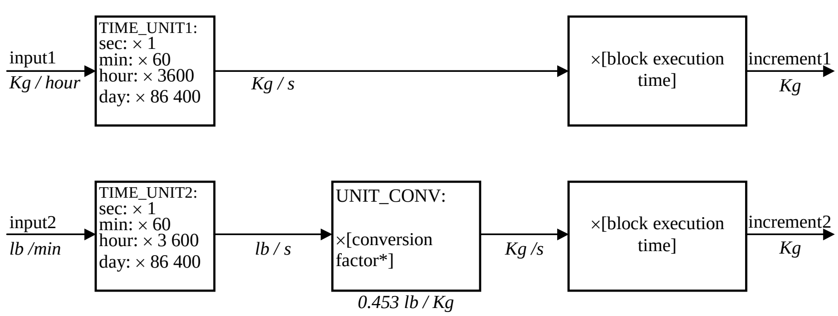


Figure 2.19 - Increment Calculation with Rate Input

If the input option is ACCUM

- The counter inputs generally come from OUT_ACCUM outputs of Pulse Input blocks. And also they can be connected to another Integrator block to provide a relative totalization with the first Integrator block.
-
- The Integrator block shall determine the variation of the counter input readings since the last execution.
- As the output ACCUM_OUT of the Pulse Input block wraps up when the counting reaches 999,999 and does not increment or decrement by more than 499,999 per cycle, the variation is determined as follows:

a) If the difference between the reading in one cycle and the reading in the preceding cycle is smaller than 500,000 or larger than (-500,000), the difference will be taken as variation.
- If the difference between the reading in one cycle and the reading in the preceding cycle is larger or equal to (+500,000), add (-1.000,000) and use the result as the variation.

c) If the difference between the reading in one cycle and the reading in the preceding cycle is smaller or equal to (-500,000), add (+1.000,000) and use the result as the variation.

- If the output OUT of another integrator block is used, that block should be programmed to have only increasing counting.

- The variation of each input must be multiplied by the value, in engineering units, of each pulse given by:**PULSE_VAL1 and PULSE_VAL2.** The result is the increment in engineering units of, for example, mass, volume or energy per block execution.

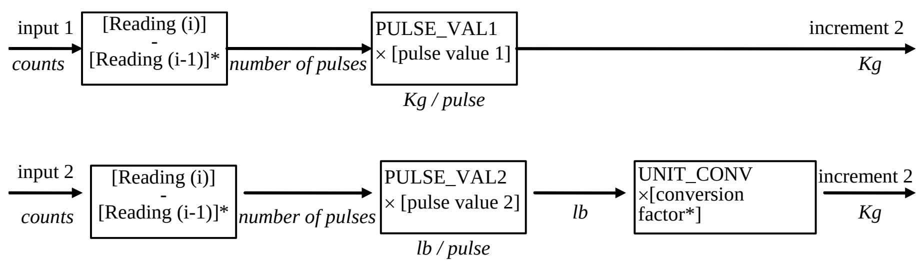


Figure 2.20- Increment Calculation with Counter Input

Net Flow

In order to distinguish forward and reverse flows, the Integrator block considers a negative sign as an indication of reverse flow. Some flow meters already indicate forward and reverse flows by adding a sign to the measurement value. Others use a separate binary signal.

This signal can be connected to the inputs REV_FLOW1 and REV_FLOW2, with the following options:
0 = False (not invert signal)
1 = True (invert signal)

where True will invert the signal of the IN_i signal.

The net flow is obtained by adding the two increments. The net increment will have a positive or negative signal to indicate the net flow direction. In order to integrate the difference between the inflow and outflow of a tank, for example, the second one can be assigned to be negative.

The net flow direction to be considered in the totalization is defined in INTEG_OPTS. The following options are available:

- FORWARD - only positive flows (after application of REV_FLOWi) are totalized. The negative values will be treated as zero. FORWARD is selected when the bit corresponding to Forward is set to *true.*

- REVERSE - only negative flows are totalized. The positive values will be treated as zero. REVERSE is selected when the bit corresponding to Reverse is set to *true.*

- TOTAL - both positive and negative values will be totalized. Both option bits Forward and Reverse must be set to *true* or to *false.*

Inputs totalization

There are two values for the totalization:

- TOTAL (OUT) - the increments are added every cycle when the inputs have the status *good, good* or *uncertain,* or last usable value if *bad.* The status to be considered as usable are defined in INTEG_OPTS.
- RTOTAL - the rejected increments with status not selected by INTEG_OPTS are added according to some rules described below.

a) If INTEG_OPTS has no selection for status, the increments with *uncertain* or *bad* status must be added to RTOTAL. The last value with good status is used in place of the input value with *bad* status.
b) If INTEG_OPTS has the USE_UNCERTAIN bit set, only the increments originated by inputs with *bad* input status shall be added to RTOTAL. The last usable value is used in the totalization.
c) If INTEG_OPTS has the USE_BAD bit set, the last usable value goes to TOTAL and nothing to RTOTAL.

The main totalization TOTAL may use inputs with different status, according to a selection established by INTEG_OPTS:

- USE_UNCERTAIN - Use *good* and *uncertain* inputs when this bit is set to *true.*
- USE_BAD - Use the last *good* or *uncertain* input before it went to *bad* when this bit is set to *true*.
- USE_GOOD - Use *good* inputs when both former bits are set to *false.*

If both bits are set to true, the option USE_ANY is selected.

The increments totalized in TOTAL can be read in the output OUT. The engineering units used in are defined in OUT_UNITS.

Integration types

The integration can start from zero and go up or it can start from a Setpoint value (SP) and go down. The totalization may be reset in different ways. This is defined by the parameter INTEG_TYPE:

- UP_AUTO - Counts up starting from zero with automatic reset when SP is reached
- UP_DEM - Counts up starting from zero with demand reset
- DN_AUTO - Counts down starting from SP with auto reset when zero is reached
- DN_DEM - Counts down starting from SP with demand reset
- PERIODIC - Counts up and is reset periodically according to CLOCK_PER
- DEMAND - Counts up and is reset on demand
- PER&DEM - Counts up and is reset periodically or on demand

Resetting total

The block has a discrete input to reset the integration RESET_IN. While this input parameter has value TRUE, the block will be on reset, therefore it will start to integrate only after it goes to FALSE.

The operator can send an operator command to reset the counting by making OP_CMD_INT = RESET. The mechanism to reset using this parameter is different from that one used in the RESET_IN, because a write operation in the OP_CMD parameter with RESET value will cause a reset, but the block will start to integrate soon after it, despite of the OP_CMD_INT remains with RESET.

Block takes a snapshot of TOTAL (OUT), RTOTAL and SP prior the reset and keep the information in the registers STOTAL, SRTOTAL and SSP, respectively. The information is kept at least until the next reset.

The integrator shall reject reset requests for 5 seconds after a reset. This is to guarantee that the snapshots values are exposed to FIELDBUS before they can be overwritten.

The number of reset is counted in the N_RESET register. This counter can not be written nor reset.

Reset always clean the counters, except when the options UP_AUTO or DN_AUTO are selected. A residue beyond the trip value may be considered in the next batch if the option CARRY of INTEG_OPTS is set*.* This residue will be "carried" to the next batch by:

a) Start counting from the residue value, instead of zero, when UP_AUTO is selected.
b) Start counting from (SP-Residue) when DN_AUTO is selected.

Outputs of Batch Totalizer

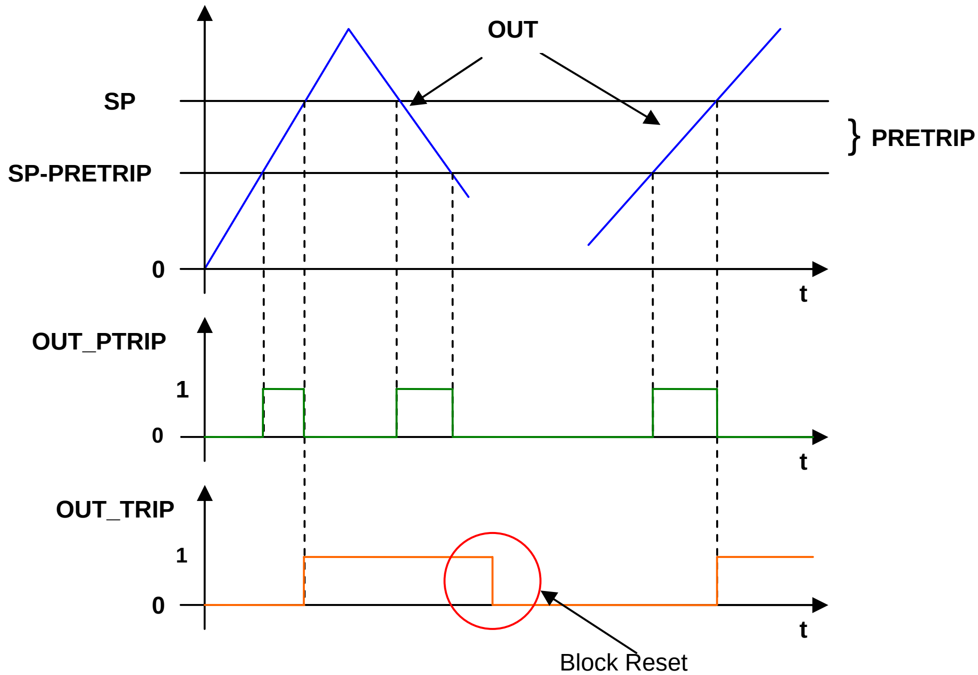
When the integration is counting up and OUT is equal to or larger than the value of SP-PRETRIP, the output OUT_PTRIP is set. If the OUT value is equal to or larger than SP, the discrete output OUT_TRIP is set, for this case the OUT_PTRIP keeps set.

When the integration is counting down, it starts from a value given by SP. When OUT is equal to or less than the value PRE_TRIP, the output OUT_PTRIP is set. When OUT is zero, the discrete output OUT_TRIP is set, for this case the output OUT_PTRIP keeps set.

Examples for Positive and Negative Totalizations

- Positive Totalization

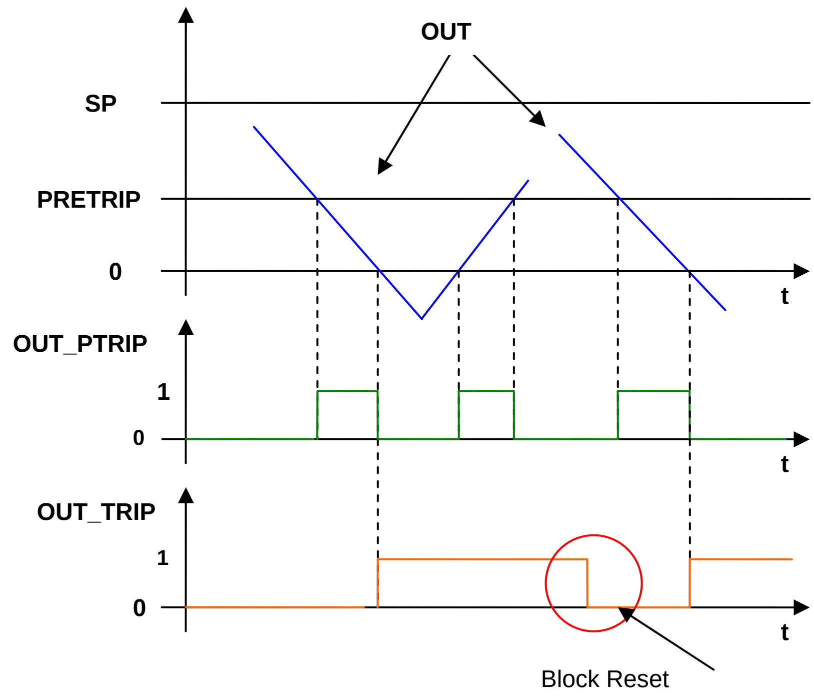
For positive totalization, the options UP_AUTO, UP_DEM and PERIODIC must be selected. The parameters OUT_TRIP and OUT_PTRIP will be as shown in figure below:



OUT_PTRIP = 1 when SP > OUT ≥SP-PRETRIP
OUT_PTRIP = 0 when OUT < SP-PRETRIP or OUT> SP
OUT_TRIP = 1 when OUT ≥ SP
OUT_TRIP = 0 when block has a Reset (OUT = 0)

- Negative Totalization

For negative totalization, the options DN_AUTO and DN_DEM must be selected. The parameters OUT_TRIP and OUT_PTRIP will be as shown in figure below:



OUT_PTRIP = 1 when 0 < OUT ≤ PRETRIP
OUT_PTRIP = 0 when OUT > PRETRIP or OUT ≤ 0
OUT_TRIP = 1 when OUT ≤ 0
OUT_TRIP = 0 when block has a Reset (OUT = SP)

BLOCK_ERR

The BLOCK_ERR of the INTG block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when TIME_UNIT1, TIME_UNIT2 or INTEG_TYPE parameters have an invalid value;
- Out of Service – it occurs when the block is in O/S mode.

Supported Modes

O/S, MAN and AUTO.

Status

If IN_1 or IN_2 is not connected, it will be ignored. The configuration of INTEG_OPTS (Use Bad / Uncertain) will be applied to the worst status between IN_1 and IN_2. OUT will receive the status determined by the GOOD_LIM and UNCERT_LIM parameters.

The percentage of rejected counts (RTOTAL) in the whole totalization (TOTAL+RTOTAL) may be determined by calculating the parameter PCT_INCL as it follows:

$$\mathbf{PCT\_INCL} = \frac{\mathbf{TOTAL}}{(\mathbf{TOTAL} + \mathbf{RTOTAL})}$$

The output status follows the following rules:

- The acceptable limit for *good* status is established by GOOD_LIM.
- The acceptable limit for *uncertain* status is established by UNCERT_LIM. If
- When the block mode is Automatic, and if PCT_INCL ≥ GOOD_LIM, the status of OUT will be *good.* If PCT_INCL ≥ UNCERT_LIM the status will be *uncertain*, otherwise the status will be *bad.*

Schematic

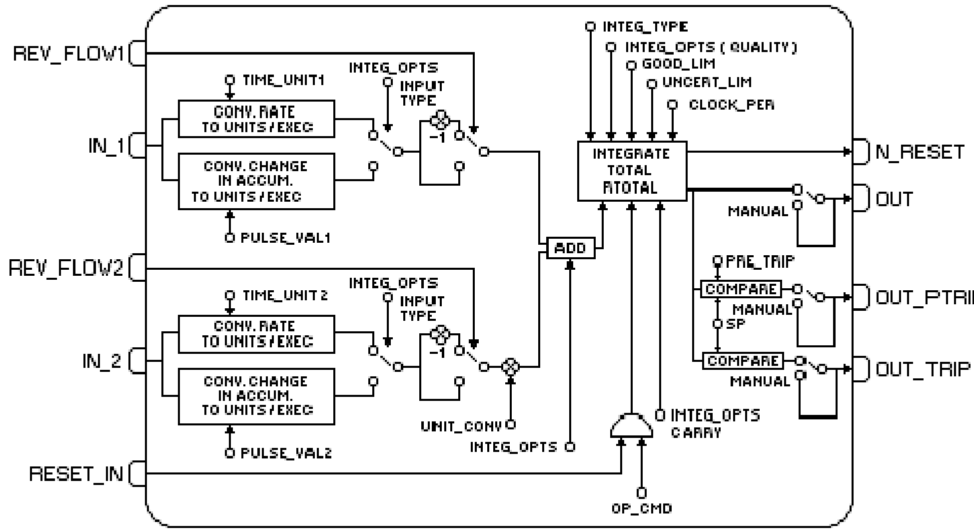


Figure 2.21 – Integrator Schematic

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**SP**	**DS-65**			**OUT**	**N / Auto**	**The analog set point for trip detection.**
8	**OUT**	**DS-65**			**OUT**	**N / Man**	**The primary analog value calculated as a result of executing the function. It is the result of integration.**
9	OUT_UNITS	Unsigned16		0	OUT	S	The engineering units of the output for display.
10	GRANT_DENY	DS-70		0	Na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
11	**IN_1**	**DS-65**		**0**		**D**	**Input parameter for flow 1.**
12	**IN_2**	**DS-65**		**0**		**D**	**Input parameter for flow 2.**
13	OUT_TRIP	DS-66		0	On/Off	D	For positive totalization, this parameter is set when OUT is equal to or larger than SP. For negative totalization, this parameter is set when OUT is equal to or less than zero. This parameter is only reset when block has a Reset.
14	OUT_PTRIP	DS-66		0	On/Off	D	For positive totalization, this parameter is set when it is between the range (SP-PRETRIP) ≤ OUT < SP and reset when it is out of this range. For negative totalization, this parameter is set when it is between the range 0 < OUT ≤ PRETRIP and reset when it is out of this range.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
15	**TIME_UNIT1**	**Unsigned8**	**1:seconds 2:minutes 3:hours 4:days**	**0**	**E**	**S/Man**	**Converts the rate time units in seconds.**
16	**TIME_UNIT2**	**Unsigned8**	**1:seconds 2:minutes 3:hours 4:days**	**0**	**E**	**S/Man**	**Converts the rate time units in seconds.**
17	UNIT_CONV	Float		1	none	S/Man	Factor to convert the engineering units of input 2 into the engineering units of input 1.
18	PULSE_VAL1	Float		0	none	S/Man	Determines the mass, volume or energy per pulse. It is used only in accum mode.
19	PULSE_VAL2	Float		0	none	S/Man	Determines the mass, volume or energy per pulse. It is used only in accum mode.
20	REV_FLOW1	DS-66	0=FORWARD 1=REVERSE		E	D	It indicates reverse flow in IN_1 when *true.*
21	REV_FLOW2	DS-66	0=FORWARD 1=REVERSE		E	D	It indicates reverse flow in IN_2 when *true.*
22	**RESET_IN**	**DS-66**	**0:Off 1:Reset**		**E**	**D**	**Resets the totalizer - OUT parameter.**
23	STOTAL	Float		0	OUT	D	Indicates the snapshot of the totalizer - OUT parameter just before a reset.
24	RTOTAL	Float		0	OUT	D	Indicates the totalization of *bad* or *bad* and *uncertain* inputs, according to INTEG_OPTS.
25	SRTOTAL	Float		0	OUT	D	The snapshot of RTOTAL just before a reset.
26	SSP	Float		0	OUT	D	The snapshot of SP.
27	**INTEG_TYPE**	**Unsigned8**	**1=UP_AUTO 2=UP_DEM 3=DN_AUTO 4=DN_DEM 5=PERIODIC 6=DEMAND 7=PER&DEM**	**0**	**E**	**S**	**Defines the type of counting (up or down) and the type of resetting (demand or periodic)**
28	**INTEG_OPTS**	**Bitstring(2)**			**none**	**S**	**A bit string to configure the type of input (rate or accum.) used in each input, the flow direction to be considered in the totalization, the status to de considered in TOTAL and if the totalization residue shall be used in the next batch (only when INTEG_TYPE = *UP_AUTO* or *DN_AUTO*).**
29	CLOCK_PER	Float		0	Sec	S	Establishes the period for periodic reset, in seconds.
30	PRE_TRIP	Float		0	OUT	S	Adjusts the amount of mass, volume or energy that will set OUT_PTRIP when the integration reaches (SP-PRE_TRIP) when counting up or PRE_TRIP when counting down.
31	N_RESET	DS-65			none	N / RO	Counts the number of resets. It can not be written on nor reset.
32	PCT_INCL	Float			%	D / RO	Indicates the percentage of inputs with *good* stati compared to the ones with *bad* or *uncertain* and *bad* stati.
33	GOOD_LIM	Float	0 to 100%	0.1	%	S	Sets the limit for PCT_INCL. Below this limit OUT receives the status *good.*

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
34	UNCERT_LIM	Float	0 to 100%	0.2	%	S	Sets the limit for PCT_INCL. Below this limit OUT receives the status *uncertain.*
35	**OP_CMD_INT**	**Unsigned8**	**0=Undefined 1=Reset**		**E**	**D**	**Operator command. RESET. Resets the totalizer.**
36	OUTAGE_LIM	Float	Positive	0	Sec	S	The maximum tolerated duration for power failure. This feature is not supported.
37	UPDATE_EVT	DS-73			na	D	This alert is generated by any change to the static data.
38	BLOCK_ALM	DS-72			na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":
The default value of TIME_UNIT1 is seconds.
The default value of TIME_UNIT2 is seconds.
The default value of INTEG_TYPE is UP_DEM.
The required mode for writing is the actual mode, regardless the target mode: SP and OUT.

AALM - Analog Alarm

Description

The Analog Alarm Block provides alarm condition reporting on an analog output of any block. Alarm conditions include high, high-high, low, and low-low alarms. These limits are computed based on gains and biases from a process setpoint input, thus providing dynamic deviation alarming. An option to temporarily expand alarm limits after a setpoint change is provided. Also, an alarm condition may be ignored for a specified period of time to avoid nuisance alarm reporting.

IMPORTANT
All parameters and features with **(*)** are available only in transmitters with version 3.52 (DD 0601) or higher, and DF51 with version 3.8.0 (DD 04xx) or higher

The input value, IN, is filtered according to the PV_FTIME time-constant, to become PV. PV is then alarmed in the *auto* mode.

Alarm limits may be dynamically calculated from process setpoint (PSP). The operating limits (same parameter names as limits, but suffixed with an "X") are calculated from specified gains and biases as follows:

HI_HI_LIMX = PSP * HI_GAIN + HI_HI_BIAS + EXPAND_UP (or default to HI_HI_LIM if any used parameter is undefined)

HI_LIMX = PSP * HI_GAIN + HI_BIAS + EXPAND_UP (or default to HI_LIM if any used parameter is undefined)

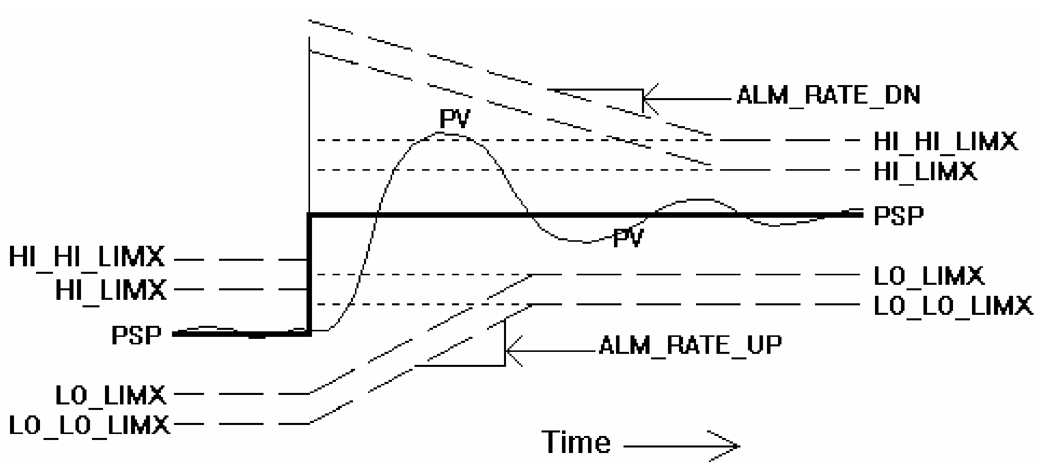
LO_LIMX = PSP * LO_GAIN - LO_BIAS - EXPAND_DN (or default to LO_LIM if any used parameter is undefined)

LO_LO_LIMX = PSP * LO_GAIN - LO_LO_BIAS - EXPAND_DN (or default to LO_LO_LIM if any used parameter is undefined)

Undefined means:

- HI_GAIN/HI_HI_BIAS = ± INF
- PSP_STATUS = BAD O/S

Effective alarm limits may be temporarily expanded on step setpoint changes to avoid nuisance alarms. The operating high alarm limits are increased by a calculated term, EXPAND_UP. The operating low alarm limits are decreased by a calculated term, EXPAND_DN. See the example in the following time chart:



Both the level 1 (advisory) and level 2 (critical) effective alarm limits are expanded after a setpoint change by the absolute value of the change to PSP. The expansions then decay toward the base limits at a rate determined by ALM_RATE_UP and ALM_RATE_DN parameters. This permits normal and over-damped process responses to avoid alarms on the initial change and permits under-damped process responses to avoid alarms on overshooting or ringing. The following properties and rules apply:

- The four limits initially expand by the same value, the setpoint change.

The two high limits always expand by the same value, EXPAND_UP, and decay by the same rate, ALM_RATE_DN (which may differ from the low limits).

- The two low limits always expand by the same value, EXPAND_DN, and decay by the same rate, ALM_RATE_UP (which may differ from the high limits).

- The expansion feature may be suppressed in the upward direction by setting ALM_RATE_DN to zero. The expansion feature may be suppressed in the downward direction by setting ALM_RATE_UP to zero.

- Additional step setpoint changes prior to complete decay of a previous expansion will expand the alarm limits in each direction to the maximum of the remaining expansion value or new expansion value.

IGNORE_TIME

The existence of a new alarm condition may be temporarily ignored by setting the IGNORE_TIME parameter to the number of seconds to disregard the alarm. Both the reporting of the alarm and the possible change to PRE_OUT_ALM will be ignored during this time. This parameter does not delay the clearing of the existence of the alarm on return-to-normal. If the alarm condition does not persist for IGNORE_TIME seconds, it will not be reported.

OUT_ALM indication

OUT_ALM parameter will be the PRE_OUT_ALM value when the block is in Auto mode.

PRE_OUT_ALM and OUT_ALM indicate the existence of one or more selected alarm conditions per the specification of the OUT_ALM_SUM parameter. Enumerated choices of the OUT_ALM_SUM parameter and their included alarm conditions are listed below:

OUT_ALM_SUM	INCLUDED ALARM CONDITIONS			
	HI_HI_ALM	HI_ALM	LO_ALM	LO_LO_ALM
ANY	✓	✓	✓	✓
LOWs			✓	✓
HIGHs	✓	✓		
LEVEL1		✓	✓	
LEVEL2	✓			✓
LO_LO				✓
LO			✓	
HI		✓		
HI_HI	✓			
NONE				

For example, if LOWs is chosen for OUT_ALM_SUM, either a LO_ALM or LO_LO_ALM being *true* will cause OUT_ALM to be set to *true*. If LEVEL1 is chosen for OUT_ALM_SUM, either a LO_ALM or HI_ALM being *true* will cause OUT_ALM to be set to *true*.

The OUT_ALM parameter can be used for control purposes, for example , as an interlock signal, besides the basic function of alarm monitoring.

Simple alarm calculation: static alarm limits, no expansion and no delay to detection

The alarm limits will be static (HI_HI_LIM, HI_LIM, LO_LIM and LO_LO_LIM are the effective operating alarm limits) if the corresponding gain or bias is +/- INF, or the input PSP is left unconnected with status Bad – O/S.

The alarm limit expansion will be disabled by setting ALM_RATE_DN and ALM_RATE_UP to zero,
The detection of an alarm will be without delay setting IGNORE_TIME to zero.

Additional Features of the Analogical Alarm Block (*)

The OUT_D output signalize when the IN input is not usable. When the IN.Status is Bad or (Uncertain and the STATUS_OPTS does not have the bit option “Use Uncertain as Good” set), the OUT_D value will be 1.When the IN.Status is usable the value will be zero

Optionally, the OUT_D and OUT_ALM outputs will be able to inverted, when the respective bits in the INVERT_OPTS parameter were set.

BLOCK_ERR

The BLOCK_ERR of the Analog Alarm block will reflect the following causes:

- Out of Service – When the block is in O/S mode.

Supported Modes

O/S, MAN and AUTO.

Status Handling

The block will not filter an IN value with a bad status or uncertain status (and "Use Uncertain" option in STATUS_OPTS is not set), but will instead, filter to the last usable value of PV and assign it the unusable status from IN. When the status of IN returns to a usable value (good or uncertain [and "Use Uncertain" option in STATUS_OPTS is set]), the value of PV will again be filtered toward the value of IN with the status of IN.

The status of OUT is set to the status of PV (and IN) when in auto mode.

If the worst quality of the stati of PV and PSP is bad, or uncertain (and "Use Uncertain" option in STATUS_OPTS is not set) the alarm test will not be performed and the status of PRE_OUT_ALM will be set to bad (non-specific). Otherwise, the alarm test will be performed and the quality of the status of PRE_OUT_ALM will be set to the worst quality of the stati of PV and PSP (good or uncertain). While the alarm condition is not being evaluated due to unusable stati, existing alarms will not be cleared and new alarms will not be generated. Prior alarm conditions may still be acknowledged.

In auto mode, the status of OUT_ALM will be set to the status of PRE_OUT_ALM. In man mode, the limits status of OUT_ALM is set to double-limited.

Schematic

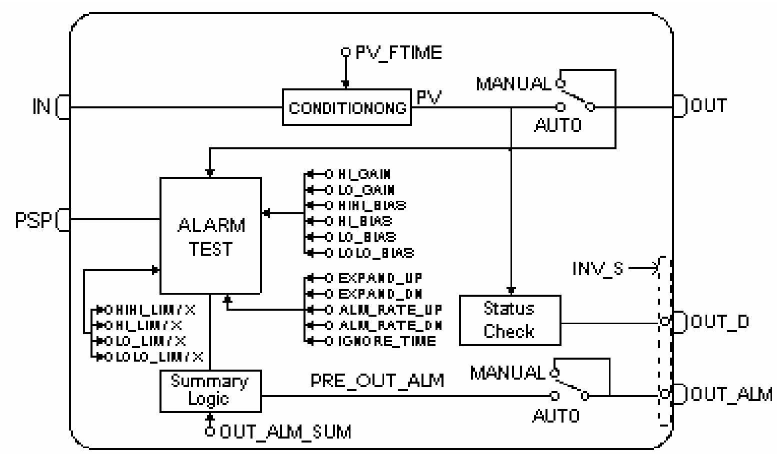


Figure 2.22 – Analog Alarm Schematic

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	PV	DS-65			PV	D / RO	Process analog value. This is the IN value after pass over the PV filter.
8	**OUT**	**DS-65**	**OUT_SCALE +/- 10%**		**OUT**	**N / Man**	**The output value result of the block calculation.**
9	OUT_SCALE	DS-68		0-100%	OUT	S / Man	The high and low scale values to the OUT parameter.
10	GRANT_DENY	DS-70		0	na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
11	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
12	PV_FTIME	Float	Non-Negative	0	Sec	S	Time constant of a single exponential filter for the PV, in seconds.
13	**IN**	**DS-65**			**PV**	**D**	**The primary input value of the block, or PV value.**
14	PSP	DS-65			PV	D	This is the process setpoint, which may be used for alarm limit determination.
15	HI_GAIN	Float		1.1		S	This gain multiplies PSP before addition of biases for HI_LIM and HI_HI_LIM.
16	LO_GAIN	Float		0.9	Na	S	This gain multiplies PSP before subtraction of biases for LO_LIM and LO_LO_LIM.
17	HI_HI_BIAS	Float	Positive	1.0	Out	S	This bias is added to PSP*HI_GAIN to determine HI_HI_LIM.
18	HI_BIAS	Float	Positive	0.0	Out	S	This bias is added to PSP*HI_GAIN to determine HI_LIM.
19	LO_BIAS	Float	Positive	0.0	Out	S	This bias is subtracted from PSP*LO_GAIN to determine LO_LIM.
20	LO_LO_BIAS	Float	Positive	1.0	Out	S	This bias is subtracted from PSP*LO_GAIN to determine LO_LO_LIM.
21	PRE_OUT_ALM	DS-66			E	D/RO	This parameter is the alarm summary variable of the analog alarm block. If the block is in Man mode, it will have the same value and status of OUT_ALM parameter.
22	**OUT_ALM**	**DS-66**			**E**	**D**	**This parameter is the alarm summary variable of the analog alarm block when in *Auto* mode and is the value specified by the operator/engineer in *Man* mode. It is a discrete parameter that indicates if the block is in alarm condition (value 1) or if not (Value 0).**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
23	**OUT_ALM_SUM**	**Unsigned8**	**0:NONE 1:LO_LO 2:LO 3:LOWs 4:HI 6:LEVEL1 8:HI_HI 9:LEVEL2 12:HIGHs 15:ANY**	**0**	**E**	**S**	**Specifies the alarms conditions which must be *true* in order for OUT_ALM to be set to *true*: ANY, LOWs, HIGHs, LEVEL1, LEVEL2, LO_LO, LO, HI, or HI_HI.**
24	ALM_RATE_UP	Float	Positive	0.0	OUT/sec	S	Ramp rate at which downward alarm expansion due to step PSP changes is decayed in the upward direction. Expressed in engineering units per second. Expansion feature disabled in the downward direction if set to zero. (Positive)
25	ALM_RATE_DN	Float	Positive	0.0	OUT/sec	S	Ramp rate at which upward alarm expansion due to step PSP changes is decayed in the downward direction. Expressed in engineering units per second. Expansion feature disabled in the upward direction if set to zero. (Positive)
26	EXPAND_UP	Float			OUT	D/RO	Amount, in engineering units, that base HI and HI_HI limits are expanded after a setpoint change. Dynamically calculated by block. Initially expanded by the amount of a setpoint change and decayed at the rate of ALM_RATE_UP. (Positive)
27	EXPAND_DN	Float			OUT	D/RO	Amount, in engineering units, that base LO and LO_LO limits are expanded after a setpoint change. Dynamically calculated by block. Initially expanded by the amount of a setpoint change and decayed at the rate of ALM_RATE_DN. (Positive)
28	IGNORE_TIME	Float	Positive	0.0	Sec	S	The time, in seconds, to ignore the existence of a new alarm condition. There is no delay on clearing the existence of the alarm on return to normal. If the alarm does not persist for IGNORE_TIME seconds, it will not be reported. Does not apply to self-clearing (transient) type alarms.
29	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
30	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.
31	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
32	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged
33	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. In order to clear the alarm the amount the PV must return within the alarm limit plus hysteresis.
34	HI_HI_PRI	Unsigned8	0 to 15	0		S	Priority of the high high alarm.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
35	**HI_HI_LIM**	**Float**	**OUT_SCALE, +INF**	**+INF**	**OUT**	**S**	**The setting for high high alarm in engineering units.**
36	HI_HI_LIMX	Float	OUT_SCALE, +INF	+INF	OUT	D/RO	The setting for high high alarm in engineering units.
37	HI_PRI	Unsigned8	0 to 15	0		S	Priority of the high alarm.
38	**HI_LIM**	**Float**	**OUT_SCALE, +INF**	**+INF**	**OUT**	**S**	**The setting for high alarm in engineering units.**
39	HI_LIMX	Float	OUT_SCALE, +INF	+INF	OUT	D/RO	The setting for high alarm in engineering units.
40	LO_PRI	Unsigned8	0 to 15	0		S	Priority of the low alarm.
41	**LO_LIM**	**Float**	**OUT_SCALE, -INF**	**-INF**	**OUT**	**S**	**The setting for low alarm in engineering units.**
42	LO_LIMX	Float	OUT_SCALE, -INF	-INF	OUT	D/RO	The setting for low alarm in engineering units.
43	LO_LO_PRI	Unsigned8	0 to 15	0		S	Priority of the low alarm.
44	**LO_LO_LIM**	**Float**	**OUT_SCALE, -INF**	**-INF**	**OUT**	**S**	**The setting for low alarm in engineering units.**
45	LO_LO_LIMX	Float	OUT_SCALE, -INF	-INF	OUT	D/RO	The setting for low alarm in engineering units.
46	HI_HI_ALM	DS-71			OUT	D	The status for high alarm and its associated time stamp.
47	HI_ALM	DS-71			OUT	D	The status for high alarm and its associated time stamp.
48	LO_ALM	DS-71			OUT	D	The status for low alarm and its associated time stamp.
49	LO_LO_ALM	DS-71			OUT	D	The status for low low alarm and its associated time stamp.
50	OUT_D **(*)**	DS_66				D/RO	True: Indicate if the IN input is unusable with bad or uncertain status.
51	INVERT_OPTS **(*)**	Bitstring(2)				S/O/S	Parameter for inversion of the block discrete outputs.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":
The required mode for writing is the actual mode, regardless the target mode: OUT

ISEL - Input Selector

Description

The signal selector block provides selection of up to four inputs and generates an output based on the configured action. This block would normally receive its input from an AI or another block and not directly from a transducer. In addition to signal selection the block can also perform max, min, mid, avg and first good selection. With the combination of parameter configuration options the block can function as 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 switch toggle information from both the connected inputs or from an operator input. The block also supports the concept of a middle selection. Logic is provided for handling of dubious 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 and is not intended to receive signals from the output of a controller, therefore, no back calculation support is provided.

The algorithm has the following actions, choose by the SELECT_TYPE parameter:

- Max = select the max from all the connected and good inputs
- Min = select the min from all the connected and good inputs
- Mid = select the middle value from all the connected and good inputs, if less than MIN_GOOD inputs are connected then an error code is generated. An error code is also generated if less than MIN_GOOD values have good status. Not intended for use with 2 or 4 inputs. Although the normal configuration for this feature would be with three signals the block will 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 on one of the inputs.
- First Good = determine the first good input encountered based on ascending evaluation of the inputs, see text for further discussion
- Avg = compute the average for all the connected and good inputs, if less than two inputs are connected then set the output equal to the input an generate an error code. An error code is also generated if less than MIN_GOOD inputs have good status.

The processing of the block is as follows:

- If DISABLE_n is true then the respective input IN_n is not used.
- Inputs whose status is bad are ignored. Process the dubious option.
- MIN_GOOD specifies the minimum available signals for OUT status to be good. If there are no inputs left, or fewer that MIN_GOOD inputs then set the status of OUT to Bad and the value of SELECTED to zero. Do not do selection processing.
- For Average ("Avg") the status of OUT is set to worst of inputs considered, then average of the useable inputs is calculated, if none are useable then the output status is bad.
- When SELECT_TYPE is "Mid", "First Good", "Max", or "Min", set the status of OUT to the status of the selected input. The "First Good" option starts at the first input then the second until it encounters an input whose DISABLE_n is not set and its status is Good, and then transfers this value to the output of the block.
- If OP_SELECT is non-zero, the OP_SELECT value will override the SELECT_TYPE selection.
- SELECTED is a second output which will indicate which input has been selected by the algorithm for all SELECT_TYPE except "Avg", when it reflects the number of inputs used in the average. The SELECTED output always has a good status, unless the block is out of service.

BLOCK_ERR

The BLOCK_ERR of the ISEL block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when the SELECT_TYPE parameter has an invalid value;
- Out of Service – it occurs when the block is in O/S mode.

Supported Modes

O/S, MAN and AUTO.

Status Handling

The status of OUT will be a copy of the selected input, but if the output is an average of inputs the status will be Good Non-cascade – Non-specific.

Schematic

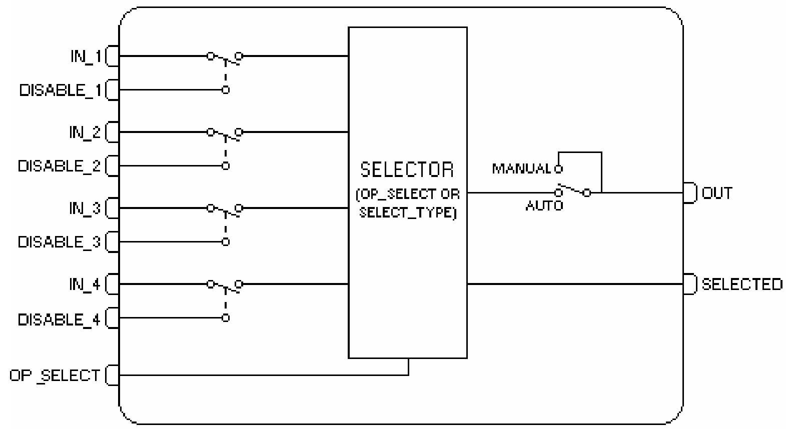


Figure 2.23 – ISEL Schematic

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	**OUT**	**DS-65**	**XD_SCALE**		**OUT**	**D / Man**	**The primary analog value calculated as a result of executing the function.**
8	OUT_UNITS	Unsigned16		0	E	S	The engineering units of the output for display.
9	GRANT_DENY	DS-70		0	Na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
10	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
11	**IN_1**	**DS-65**				**D**	**Numbered input parameter 1.**
12	**IN_2**	**DS-65**				**D**	**Numbered input parameter 2.**
13	**IN_3**	**DS-65**				**D**	**Numbered input parameter 3.**
14	**IN_4**	**DS-65**				**D**	**Numbered input parameter 4.**
15	DISABLE_1	DS-66				D	Parameter to switch off the input from being used. If this parameter is true then don't use this input IN_1 determining the output.
16	DISABLE_2	DS-66				D	Parameter to switch off the input from being used. If this parameter is true then don't use this input IN_2 determining the output.
17	DISABLE_3	DS-66				D	Parameter to switch off the input from being used. If this parameter is true then don't use this input IN_3 determining the output.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
18	DISABLE_4	DS-66				D	Parameter to switch off the input from being used. If this parameter is true then don't use this input IN_4 determining the output.
19	**SELECT_TYPE**	**Unsigned8**	**1=First good** **2=MIN** **3=MAX** **4=MID** **5=AVG**	**0**	**E**	**S**	**selector action** **max = select the max from all the connected and good inputs** **min = select the min from all the connected and good inputs** **mid = select the mid value from all the connected and good inputs, if less than min_good inputs are connected then an error code is generated. An error code is also generated if less than min_good values have good status. Not intended for use with 2 or 4 inputs.** **First Good = determine the first good input encountered based on ascending evaluation of the inputs, see text for further discussion** **avg = compute the average for all the connected and good inputs, if less than two inputs are connected then set the output equal to the input an generate an error code. An error code is also generated if less than min_good inputs have good status**
20	**MIN_GOOD**	**Unsigned8**	**0 through 4**	**0**		**S**	**If the number of inputs which are good is less than the value of MIN_GOOD then set the out status to bad.**
21	**SELECTED**	**DS-66**	**None,** **1= 1** **2= 2** **3= 3** **4= 4**			**D / RO**	**An integer indicating which input has been selected.**
22	**OP_SELECT**	**DS-66**	**0 = Normal Operation** **1= Selects IN1** **2= Selects IN2** **3= Selects IN3** **4= Selects IN4**		**None**	**D**	**An operator adjustable parameter to force a given input to be used. Selecting 0 will indicate normal operation while choosing 1 to 4 will indicate the input to be used.**
23	UPDATE_EVT	DS-73			na	D	This alert is generated by any change to the static data.
24	BLOCK_ALM	DS-72			na	D	The block alarm is used for all configuration, hardware, 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.

Legend: ***E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile; S – Static;***

Gray Background Line: Default Parameters in Syscon

If DIAG.BEHAVIOR parameter is "Adapted":
The default value of SELECT_TYPE is First good.
The required mode for writing is the actual mode, regardless the target mode : OUT

SPG - Setpoint Ramp Generator

Description

The Setpoint generator block is normally used to generate a Setpoint to a PID block in applications like temperature control, batch reactors, etc. In those applications, the Setpoint shall follow a certain profile in function of the time.

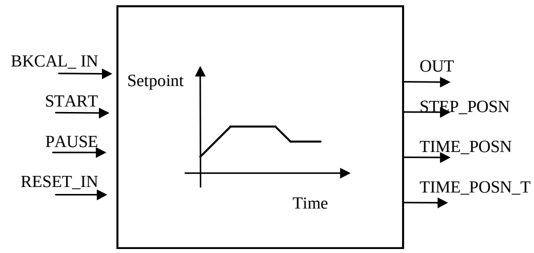


Figure 2.24 – The Block Inputs and Outputs

The block algorithm shall comply with the following:

1) The profile is determined by up to ten segments or steps. Each segment is defined by a starting value [START_VAL] and a time duration [DURATION].The starting value of the next segment determines if the previous segment ramps up, down or remains constant. The profile is given by two parallel arrays and a parameter for the time unit:

START_VAL (Starting value) - Eleven floating point values defining the initial value of each step, in engineering units.

DURATION (Time duration) - Ten floating point values defining the duration, in seconds, of each step. A null value defines the last step.

TIME_UNITS **-** A contained unsigned-eight parameter used to specify the time units used for display.

2) The two arrays define the Setpoint value (y-axis) in function of the time (t-axis). Between two given points, the Setpoint is calculated by interpolation. As each segment is defined by $[START\_VAL]_i$, $[DURATION]_i$ and $[START\_VAL]_{i+1}$, a profile with "**n**" segments will need **n+1** starting values and **n** time durations. As example, the two following arrays define the profile shown on Figure 2.25.

	1	2	3	4	5	6
START_VAL	25	50	50	100	100	25
DURATION	60	60	120	60	60	0

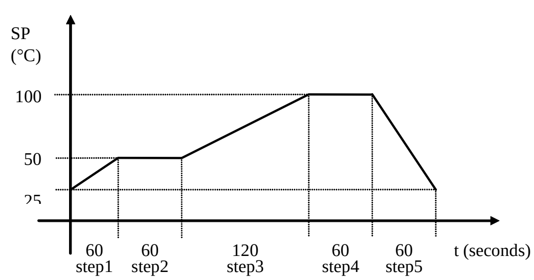


Figure 2.25 – Configuration Example

3) The timer is started by a transition from false to true at input START.

4) The timer may be interrupted at any time by changing the discrete signal PAUSE from false to true. It will resume running when PAUSE is set to false. The PAUSE <u>will not</u> force *manual* mode.

5) The timer is also interrupted by a PAUSE caused by the deviation between BKCAL_IN and the generated Setpoint. If the deviation exceeds DV_HI_LIM or DV_LO_LIM, an alarm is indicated in DV_HI_ALM or DV_LO_ALM, respectively. Both alarms stop the timer and resume normal operation when the deviation is within the prescribed limits.

6) The Setpoint is in the "y" axis, while the time is in the "t" axis. The Setpoint value is available at output OUT. It is also available in PRE_OUT even when the block is in Man mode. For display purpose, the engineering unit of OUT is given by OUT_SCALE.

7) Three outputs inform the current point of the profile:

STEP_POSN - Informs the current segment or step.

TIME_POSN - Informs the time elapsed since the beginning of the current step.

TIME_POSN_T - Informs the time elapsed since the beginning of the profile.

8) With the block in manual, the operator can write on the outputs STEP_POSN, TIME_POSN and TIME_POSN_T in order to select a particular point of the profile. When the block is switched back to auto, the profile will start from that point. The timer is restarted by activating the input START.

9) With the block in manual, the operator can also modify OUT. As the adjusted value may correspond to more than one point on the profile or to none, if the operator adjusts a value beyond the profile limits, the OUT value goes from the last adjusted value to the point before mode switching following a ramp defined by BAL_TIME.

10) Another operation that can be done with the block in manual, is to advance or return the time through the following operator commands (OP_CMD_SPG):

ADVANCE - sets the time to the beginning of the next step.
REPEAT - sets the time to the beginning of the current step.

11) The outputs can only be modified with the block is in manual mode.

12) The operator can give a RESET command using OP_CMD_SPG with the block in any mode. The timer is set to zero, i.e., to the beginning of the profile. In this case the operator must give a new start, by switching the input START from false to true. Therefore the block may be started even though the OP_CMD_SPG remains with RESET value.

13) The input RESET_IN allows a discrete signal coming from another block to set the timer to zero. While this input parameter has value TRUE, the block will remain in reset, therefore it will be able to start only after this input parameter goes to FALSE.

14) When the time reaches the last point of the profile, it will automatically return to zero (RESET) and restart (START) automatically, if the parameter AUTO_CYCLE is set to true.

15) The operation status is given by the parameter SPG_STATE

READY - When the profile is at the beginning, waiting for the starting signal.
ACTIVE - When the timer is "on".
PAUSE - When the PAUSE signal stopped the timer.
AT_END - When the time reaches the last point of the profile.

16) The parameter PAUSE_CAUSE enumerates the cause of the PAUSE state:

1 = Operator Pause
2 = Logic Pause
3 = Operator & Logic
4 = Deviation pause
5 = Operator & Deviation
6 = Logic & Deviation
7 = Operator & Logic & Deviation

Logic Pause happens when the deviation limits are exceeded or the PID block is not in Cascade mode.

17) Sometimes there is a large deviation between the controlled variable (available in BKCAL_IN) and the profile initial value. In this situation, the timer may not be started or the control will start with a large upset. In order to avoid these problems, the parameter START_TYPE offers the following options:

a - USE_CURVE- The curve starts as specified by START_VAL and DURATION.
b - USE_DUR- The curve starts at BKCAL_IN value and use the duration specified.
c - USE_RATE- The curve starts at BKCAL_IN value and use the rate specified by the first two START_VAL values and the first DURATION value.

18) The input BKCAL_IN can be connected to the output of an Analog Input block or to the BKCAL_OUT of a PID control block. If a PID is connected, the CONTROL_OPTS of the PID should be configured to use PV for BKCAL_OUT. If the PID is not in Cas mode when the operation status is READY (see 15), initialization will occur as described in 17. If the operation status is ACTIVE, the block will go to IMan mode and behave as described in 9 to make the value of OUT equal the value OF BKCAL_IN.

Schematic

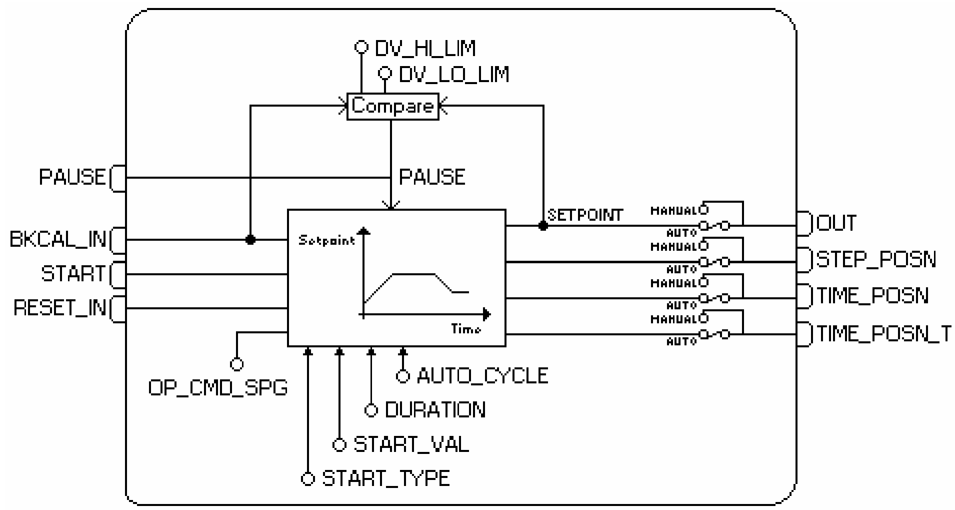


Figure 2.26 – Setpoint Ramp Generator Schematic

BLOCK_ERR
The BLOCK_ERR of the SPG block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when the START_TYPE parameter has an invalid value;
- Out of Service – it occurs when the block is in O/S mode.

Supported Modes
O/S, IMAN, MAN and AUTO.

Status Handling
The input BKCAL_IN provides status.
If the status of BKCAL_IN is bad and the option Use uncertain of STATUS_OPTS is set to true, the deviation alarms are not considered.
If the status of any used input becomes bad or uncertain and the respective option Use bad or Use uncertain of STATUS_OPTS is not set, the block actual mode will be forced to manual.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**OUT**	**DS-65**	**OUT_SCALE +/- 10%**		**OUT**	**N / Man**	**The analog value calculated as a result of executing the function.**
8	OUT_SCALE	DS-68		0-100%	OUT	S / Man	The high and low scale values to the OUT parameter.
9	GRANT_DENY	DS-70		0	na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
10	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
11	**START_VAL**	**11 Floats**					**An array of up to eleven points defines the starting point of each segment of the Setpoint profile, in engineering units.**
12	**DURATION**	**10 Floats**		**0's**	**Sec**	**S**	**An array of up to ten points defines the duration of each segment of the Setpoint profile, in seconds.**
13	TIME_UNITS	Unsigned8	1=seconds 2=minutes 3=hours 4=days 5=[day-[hr:[min[:sec]]]]	0		E	Display Time Units for TIME_POSN and TIME_POSN_T.
14	**BKCAL_IN**	**DS-65**			**OUT**	**N**	**The value and status from a lower block's BKCAL_OUT that is used to prevent reset windup and to initialize the control loop.**
15	**START**	**DS-66**			**On/Off**	**D**	**A leading edge at this input or a transition from false to true starts the timer.**
16	**START_TYPE**	**Unsigned8**	**1=Use Curve 2=Use Duration 3=Use Rate**	**0**	**E**	**S**	**This parameter selects the starting point option.**
17	**PAUSE**	**DS-66**				**D**	**Stops the timer when set to *true*. Resume time running when set back to *false*.**
18	**PAUSE_CAUSE**	**Unsigned8**	**0=Not paused 1=Operator Pause 2=Logic Pause 4=Deviation Pause 3=Operator & Logic 5=Operator & Deviation 6=Logic & Deviation 7=Operator & Logic & Deviation**			**E**	**This parameter enumerates the causes of PAUSE.**

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
19	AUTO_CYCLE	Unsigned8	1:Auto cycle	0	E	S	When set to *true*, automatically resets the time to the beginning of the first step and restarts the timer.
20	**STEP_POSN**	**DS-66**	**0=none** **1=step1** **2=step 2** **n=step n**	**0**	**E**	**D / Man**	**Determine the current step or segment of the profile in auto mode. Direct the timer to the step specified by the operator when in manual mode.**
21	**TIME_POSN**	**DS-65**			**Sec**	**D / Man**	**Determine the time elapsed since the beginning of the step in auto mode. The operator can set the time since the beginning of the current step when operating in manual.**
22	TIME_POSN_T	DS-65			Sec	N / Man	Determine the time elapsed since the beginning of the curve in auto mode. The operator can set the time since the beginning of the curve when operating in manual.
23	**OP_CMD_SPG**	**Unsigned8**	**0=UNDEFINED** **1=RESET_IN** **2=ADVANCE** **3=REPEAT**	**0**	**E**	**D**	**Enable the positioning in the profile. Enumerations are:, RESET, ADVANCE*, REPEAT*. (*only valid with the block in manual).**
24	**SPG_STATE**	**Unsigned8**	**0=UNDEFINED** **1=READY** **2=ACTIVE** **3=PAUSE** **4=AT_END**		**E**	**N**	**Define the operating state of the block. Enumerations are: READY, ACTIVE, PAUSE and AT_END.**
25	PRE_OUT	DS-65				D	Displays what would be the OUT value and status if the mode was Auto or lower.
26	**RESET_IN**	**DS-66**	**0:Off** **1:Reset**		**E**	**D**	**Resets the timer.**
27	BAL_TIME	Float	Positive	0	sec	S	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds.
28	OUTAGE_LIM	Float	Positive	0	Sec	S	The maximum tolerated duration for power failure. This feature is not supported.
29	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
30	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.
31	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
32	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
33	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. In order to clear the alarm the amount the PV must return within the alarm limit plus hysteresis.
34	DV_HI_PRI	Unsigned8	0 to 15			S	Priority of the high deviation alarm.
35	DV_HI_LIM	Float	+(OUT_SCALE) or +(INF)	+INF	OUT	S	The setting for high deviation alarm in engineering units.
36	DV_LO_PRI	Unsigned8	0 to 15			S	Priority of the low deviation alarm.
37	DV_LO_LIM	Float	-(OUT_SCALE) or –(INF)	-INF	OUT	S	The setting for low deviation alarm in engineering units.
38	DV_HI_ALM	DS-71			OUT	D	The status for high deviation alarm and its associated time stamp.
39	DV_LO_ALM	DS-71			OUT	D	The status for low deviation alarm and its associated time stamp.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is “Adapted”:

The default value of START_TYPE is “Use Curve”.
The required mode for writing is the actual mode, regardless the target mode: OUT, TIME_POSN,TIME_POSN_T and STEP_POSN

ESPG – Enhanced Setpoint Ramp Generator

Additional Features

Schematic

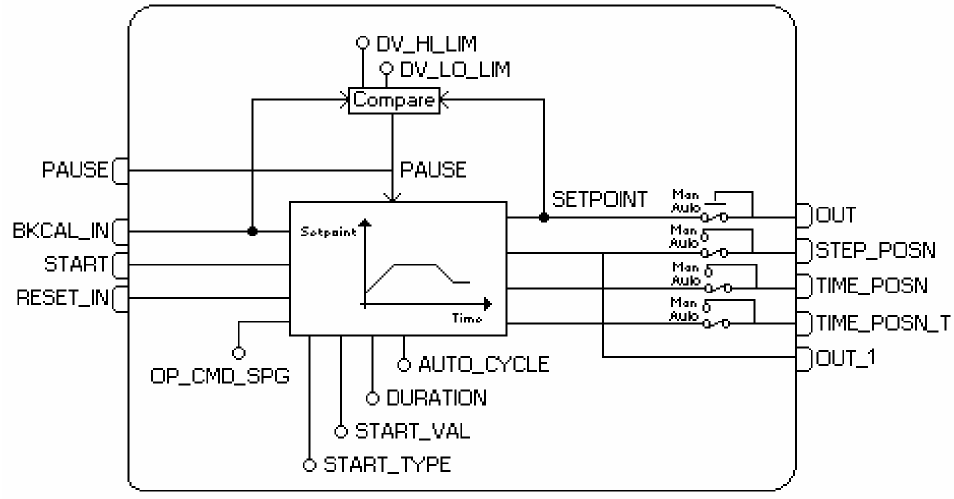


Figure 2.27 – ESPG Schematic

Description

The Enhance Setpoint Ramp Generator has an additional output parameter as it is possible to see in the schematic above. The OUT_1 output indicates the current step or segment of profile like the SPG parameter STEP_POSN. But the OUT_1 format is float.

Parameters

It has all parameters of the SPG block added of the

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
40	OUT_1	DS-65	0=None 1= Step1 2= Step2 3= Step 3 4= Step 4	0	E	D/RO	This parameter identifies the current step or segment of profile. Similar to the STEP_POSN parameter but the format in this case is float.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

TIME – Timer and Logic

Description

The Timer and Logic function block provides logic combination and timing functions including the following:

- Combine multiple inputs as OR, AND, vote, or EXACTLY count.
- Measure the duration of the combined discrete input signal
- Accumulate, until reset, the duration of the combined input signal
- Count changes of the combined discrete input signal
- Set a discrete output if the duration of the combined input signal exceeds a limit
- Extend, Delay, Pulse, or Debounce the combined input as an output
- Provide outputs indicating amount of time expired and amount of time remaining
- Selectively invert any connected discrete input or output
- Reset timer

Up to four inputs may be combined logically (ANDed, ORed), voted (any 2 or more true, any 3 or more true), or counted (exactly 1 true, exactly 2 true, exactly 3, odd count, or even count). The combined input value is specified by the combination type (COMB_TYPE) enumeration. Choices are indicated in the table below.

Connected inputs may have the values of true, false, or undefined. Undefined connected inputs are treated with status bad(out-of-service). Non-connected inputs may have the values of true, false, or undefined. Undefined non-connected inputs (operator/engineer enterable) are ignored.

COMB_TYPE Enumeration	PV_D value
OR	true if one or more used inputs are true
ANY2	true if two or more used inputs are true
ANY3	true if three or more used inputs are true
AND	true if all used inputs are true
EXACTLY1	true if exactly 1 used input is true
EXACTLY2	true if exactly 2 used inputs are true
EXACTLY3	true if exactly 3 used inputs are true
EVEN	true if exactly 0, 2 or 4 used inputs are true
ODD	true if exactly 1 or 3 used inputs are true

The timer processing type is specified by TIMER_TYPE. It may operate to produce a measurement, delay, extension, pulse (non-re-triggerable or re-triggerable) or debounce, of the combined input signal.

TIMER_SP is the specification for the time duration of delay, extension, pulse, debounce filter, or comparison limit. It may either be configured as an operator/engineer-entered constant or may be connected as an input, determined by another block. In either case the block will, on each execution, check to see if the current duration of the delay, extension, pulse, debounce, or time comparison exceeds the current TIMER_SP.

OUT_EXP indicates the amount of time expired in the measurement, comparison, delay, extension, debounce, or pulse. See TIMER_TYPE for details.

OUT_REM indicates the amount of time remaining in the comparison, delay, extension, debounce, or pulse. See TIMER_TYPE for details.

OUT_D parameter will be the PRE_OUT_D value when the block is in Auto mode.

QUIES_OPT allows the configurer to select the behavior for OUT_EXP and OUT_REM when the timer is quiescent-- that is, not timing and not in a triggered condition. The following table lists the definition of quiescent state for each TIMER_TYPE enumeration:

Definition of quiescent state start and end as a function of TIMER_TYPE		
TIMER_TYPE	Quiescence state **starts** when combined input (PV_D):	Quiescence state **ends** when combined input (PV_D):
MEASURE	returns to false	changes from false-to-true
ACCUM	[QUIES_OPT does not apply]	[QUIES_OPT does not apply]
COMPARE	returns to false	changes from false-to-true
DELAY	returns to false	changes from false-to-true
EXTEND	returns to true	changes from true-to-false
DEBOUNCE	has changed <u>and</u> timer has expired	changes
PULSE	has returned to false <u>and</u> timer has expired	changes from false-to-true
RT_PULSE	has returned to false <u>and</u> timer has expired	changes from false-to-true

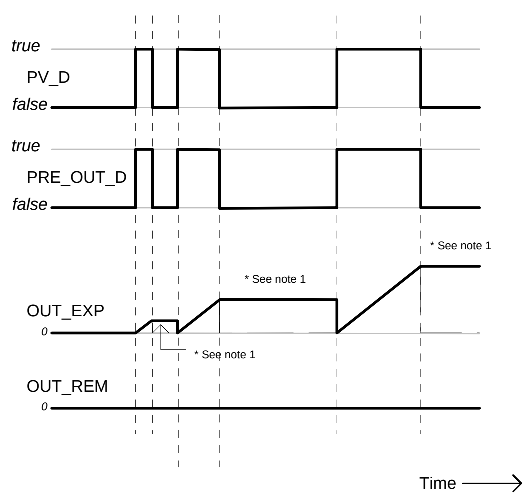
The CLEAR enumeration of QUIES_OPT will cause both OUT_EXP and OUT_REM to be set to zero during quiescence. The LAST enumeration of QUIES_OPT will cause both OUT_EXP and OUT_REM to be held to their values when the block becomes quiescent. That is, the time expired and time remaining will remain available until the quiescence ends with the start of the next activation. Note that a false-to-true transition on RESET_IN will also reset OUT_EXP and OUT_REM.

N_START is a count of the number of starts (false-to-true) transitions of the combined input, PV_D, since the last false-to-true change seen on RESET_IN.

TIMER_TYPE may be one of the following, operating on the combined input signal:

- MEASURE Indicate the duration of the most recent true signal
- ACCUM Accumulate the durations of a true signal
- COMPARE Compare a true signal duration to specified duration
- DELAY Delay a false-to-true transition, eliminating it if short
- EXTEND Extend a true-to-false transition, eliminating it if short
- DEBOUNCE Delay any transition, eliminating it if short
- PULSE Generate a true pulse on a false-to-true transition, non-retriggerable
- RT_PULSE Generate a true pulse on a false-to-true transition, retriggerable

- If TIMER_TYPE is **MEASURE**, PRE_OUT_D will be the same as the combined input, PV_D. OUT_EXP indicates the length of time, in seconds, that the combined signal is true. OUT_REM is set to 0.



* Note 1: Returns to zero if QUIES_OPT = CLEAR

Figure 2.28 - Timer Example when TIMER_TYPE = MEASURE

- If TIMER_TYPE is **ACCUM**, PRE_OUT_D will be the same as the combined input, PV_D. OUT_EXP indicates the accumulated length of time, in seconds, that the combined signal has been true. Unlike TIMER_TYPE = MEAS, it will not be automatically reset by the time of the next occurrence of a false-to-true change of PV_D. Instead, it will continue to accumulate "on" time or "run" time until reset to 0 by a false-to-true change on RESET_IN. OUT_REM is unused (set to 0.0) for this timer type.

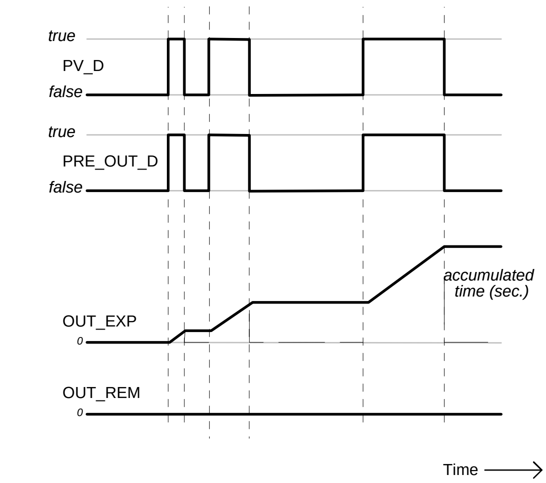


Figure 2.29 - Timer Example when TIMER_TYPE = ACCUM

- If TIMER_TYPE is **COMPARE**, the block will measure the time since a false-to-true change on the combined input, PV_D. The current duration will be indicated by OUT_EXP. OUT_REM will indicate the time remaining between the current expired duration, OUT_EXP, and current limit, TIMER_SP. If OUT_EXP does not exceed TIMER_SP, PRE_OUT_D will be set to false. If OUT_EXP equals or exceeds TIMER_SP, PRE_OUT_D will be set to true and OUT_REM will be set to zero. When the combined input returns to false, either with or without exceeding the limits specified by TIMER_SP, OUT_D will be set to false. [Note that this type of behavior is the same as TIMER_TYPE = DELAY. The difference is merely in the application perspective.

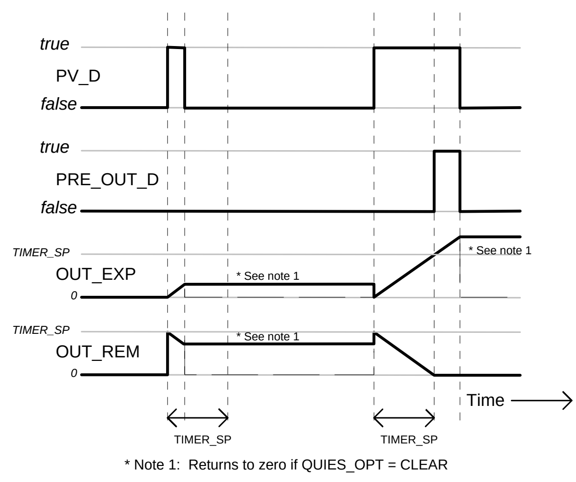


Figure 2.30 - Timer Example when TIMER_TYPE = COMPARE

- If TIMER_TYPE is **DELAY**, a false-to-true change on the combined input, PV_D, will be delayed at the output, PRE_OUT_D, until the amount of time specified by TIMER_SP has been expired. If the combined input returns to false before the time expires, the output will remain as false, concealing the input transitions. If the PRE_OUT_D output has been set to true because the time has expired, a true-to-false transition in the combined input will be presented to PRE_OUT_D immediately. [Note that this type of behavior is the same as TIMER_TYPE = COMPARE. The difference is merely in the application perspective.

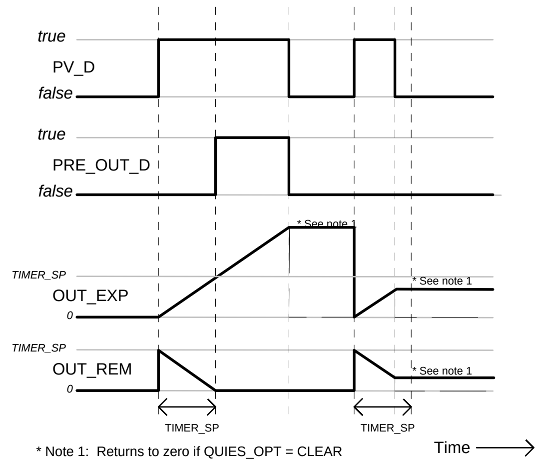


Figure 2.31 - Timer Example when TIMER_TYPE = DELAY

- If TIMER_TYPE is **EXTEND**, a true-to-false change on the combined input, PV_D, will be delayed at the output, PRE_OUT_D, until the amount of time specified by TIMER_SP has been expired. If the combined input returns to true before the time expires, the output will remain as true, concealing the input transitions. If the PRE_OUT_D output has been set to false because the time has expired, a false-to-true transition in the combined input will be presented to PRE_OUT_D immediately.

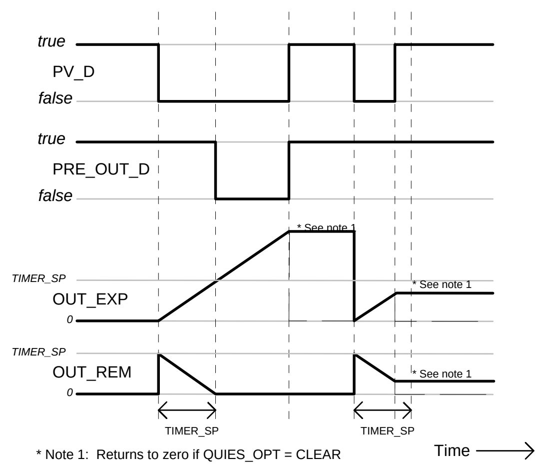


Figure 2.32 - Timer Example when TIMER_TYPE = EXTEND

- If TIMER_TYPE is **DEBOUNCE**, and if PRE_OUT_D is false, a false-to-true change on the combined input, PV_D, will be delayed at the output, PRE_OUT_D, until the amount of time specified by TIMER_SP has been expired. If the combined input returns to false before the time expires, the output will remain as false, concealing the input transitions. If PRE_OUT_D is true, a true-to-false change on the combined input, PV_D, will be delayed at the output, PRE_OUT_D, until the amount of time specified by TIMER_SP has been expired. If the combined input returns to true before the time expires, the output will remain as true, concealing the input transitions. This both delays true initiations and extends true terminations, acting as a filter for intermittent state changes.

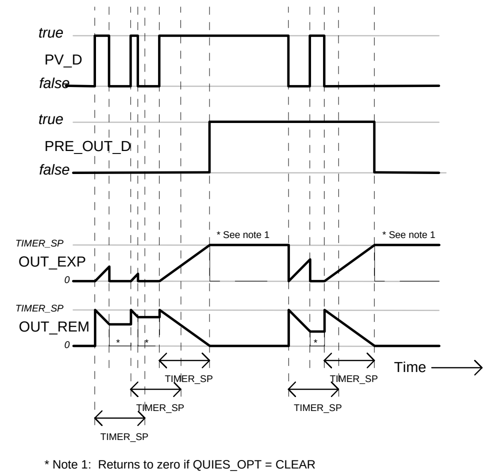


Figure 2.33 - Timer Example when TIMER_TYPE = DEBOUNCE

- If TIMER_TYPE is **PULSE**, a false-to-true change on the combined input, PV_D, will initiate a true pulse at PRE_OUT_D whose duration is determined by the TIMER_SP value. At the end of the time duration, the output, will return to false. Further false-to-true transitions of the combined input while PRE_OUT_D is true will be ignored.

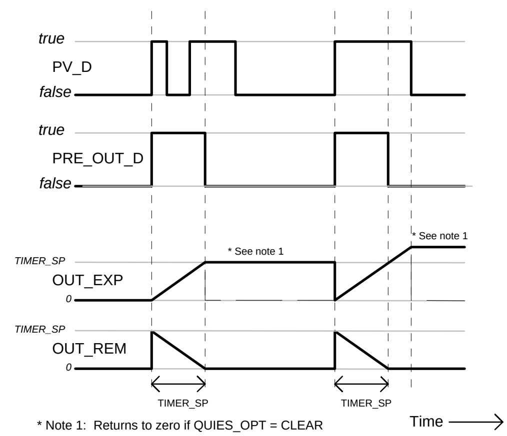


Figure 2.34 - Timer Example when TIMER_TYPE = PULSE

- If TIMER_TYPE is **RT_PULSE**, (Re-Triggerable pulse type) a false-to-true change on the combined input, PV_D, will initiate a true pulse at PRE_OUT_D whose duration is determined by the TIMER_SP value. At the end of that time duration PRE_OUT_D will return to false. If the combined input returns to false and presents a subsequent false-to-true transition while the timer is timing, the timer shall be reinitialized and PRE_OUT_D shall continue to be true.

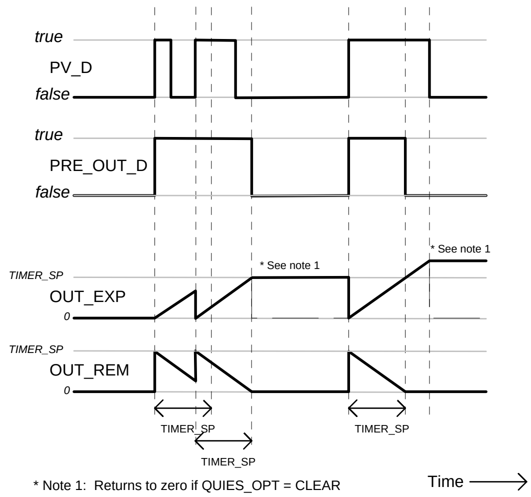


Figure 2.35 - Timer Example when TIMER_TYPE = RT_PULSE

RESET_IN is a discrete input which, on a false-to-true transition, resets the timer. OUT_EXP is set to 0.0, and then the timer follows processing described under "Initial Value Handling" regarding the value of PRE_OUT_D and OUT_REM. If RESET_IN is not connected, an operator/engineer may set it to true. In this case, the block logic will reset it to false on its next execution.

TIME_UNITS allows the user to specify to the HMI the units of time in which TIMER_SP, OUT_EXP and OUT_REM are to be displayed.
Each bit in INVERT_OPTS, if set, indicates that the corresponding discrete-with-status input or output parameter is inverted. That is, input values are inverted prior to use by the block and outputs are inverted after the value is determined by the block.

Initialization

The following table summarizes the values of PRE_OUT_D, OUT_EXP and OUT_REM after the initial execution, as a function of TIMER_TYPE and the initial value of the combined input, PV_D:

TIMER_TYPE	PV_D	PRE_OUT_D	OUT_EXP	OUT_REM	Timer Status
MEASURE	False	False	0.0	0.0	Inactive
MEASURE	True	True	0.0	0.0	Inactive
ACCUM	False	False	0.0	0.0	Inactive
ACCUM	True	True	0.0	0.0	Inactive
COMPARE	False	False	TIMER_SP †	0.0	Inactive
COMPARE	True	False	0.0	TIMER_SP †	Active
DELAY	False	False	TIMER_SP †	0.0	Inactive
DELAY	True	False	0.0	TIMER_SP †	Active
EXTEND	False	True	0.0	TIMER_SP †	Active
EXTEND	True	True	TIMER_SP †	0.0	Inactive
DEBOUNCE	False	False	TIMER_SP †	0.0	Inactive
DEBOUNCE	True	True	TIMER_SP †	0.0	Inactive
PULSE	False	False	0.0	0.0	Inactive
PULSE	True	False	TIMER_SP †	0.0	Inactive
RT_PULSE	False	False	0.0	0.0	Inactive
RT_PULSE	True	False	TIMER_SP †	0.0	Inactive

† Initialize to TIMER_SP value if QUIES_OPT = LAST, initialize to 0.0 if QUIES_OPT = CLEAR.

BLOCK_ERR

The BLOCK_ERR of the TIME block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when the TIME_UNITS or QUIES_OPT parameters have an invalid value;
- Out of Service – it occurs when the block is in O/S mode.

Modes Supported

O/S, MAN and AUTO.

Schematic

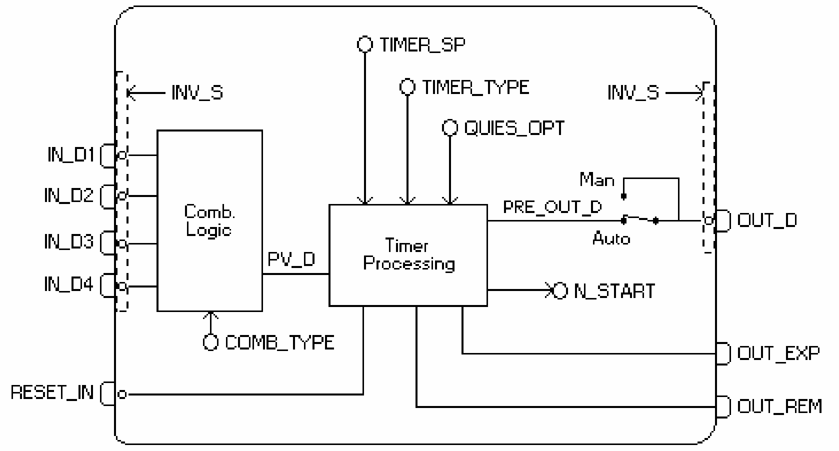


Figure 2.36 - Timer and Logic Schematic

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	**This is the timer duration used by the timer block for delay, extension, debouncing, and pulse time-processing.**
7	**PV_D**	**DS-66**				**RO**	**Either the primary discrete value for use in executing the function, or a process value associated with it.**
8	**OUT_D**	**DS-66**				**D**	**The primary discrete value calculated as a result of executing the function.**
9	TIMER_SP	Float	Positive	0	Sec	S	
10	PV_STATE	Unsigned16		0		S	Index to the text describing the states of a discrete PV.
11	OUT_STATE	Unsigned16		0		S	Index to the text describing the states of a discrete output.
12	GRANT_DENY	DS-70		0	Na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
13	**INVERT_OPTS**	**Bitstring(2)**	**See Block Options**	**0**	**Na**	**S / O/S**	**See Block Options**
14	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
15	**IN_D1**	**DS-66**				**D**	**Numbered discrete input parameter 1.**
16	**IN_D2**	**DS-66**				**D**	**Numbered discrete input parameter 2.**
17	**IN_D3**	**DS-66**				**D**	**Numbered discrete input parameter 3.**
18	**IN_D4**	**DS-66**				**D**	**Numbered discrete input parameter 4.**
19	**COMB_TYPE**	**Unsigned8**	**0=AND 1=OR 2=ANY2 3=ANY3 21=EXACTLY1 22=EXACTLY2 23=EXACTLY3 40=EVEN 41=ODD**	**1**	**E**	**S**	**Determines how the multiple IN_D[i] values are combined.**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
20	**TIMER_TYPE**	**Unsigned8**	**0=MEASURE 1=ACCUM 2=COMPARE 3=DELAY 4=EXTEND 5=DEBOUNCE 6=PULSE 7=RT_PULSE**	**0**	**E**	**S**	**Type of time-processing applied to PV_D to determine the PRE_OUT_D.**
21	PRE_OUT_D	DS-66				RO	This parameter is the combined and time-processed output of the timer block.
22	N_START	Unsigned16			None	D/RO	Count of *false*-to-*true* transitions of the combined input, PV_D. Reset by *false*-to-*true* transition of RESET_IN.
23	OUT_EXP	DS-65			Sec	N / RO	This is the time expired. Stops when TIMER_SP is reached. Reset to zero (1) by RESET_IN, (2) at start of next timer event if QUIES_OPT = LAST, or (3) when block becomes quiescent if QUIES_OPT = CLEAR.
24	OUT_REM	DS-65			Sec	N / RO	This is the time remaining if the timer is active. Stops when event ceases (block becomes quiescent). Reset to 0.0 if QUIES_OPT = CLEAR, and the timer is inactive.
25	RESET_IN	DS-66	0=Off 1=Reset				Resets the timer.
26	QUIES_OPT	Unsigned8	1=CLEAR 2=LAST	0	E	S / O/S	Behavior option for OUT_EXP and OUT_REM during quiescence. CLEAR resets them to zero. LAST causes last values to be held.
27	TIME_UNITS	Unsigned8	1=seconds 2=minutes 3=hours 4=days 5=[day-[hr:[min[:sec]]]]	0	E	S	This parameter has fixed unit: seconds. TIME_UNITS is not used.
28	UPDATE_EVT	DS-73			na	D	This alert is generated by any change to the static data.
29	BLOCK_ALM	DS-72			na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is “Adapted”:
The default value of TIME_UNITS is “Seconds”.
The default value of QUIES_OPT is “CLEAR”.

LLAG - Lead Lag

Description

The LLAG block provides dynamic compensation of the IN parameter. The block can function as a lead or lag device. The user would configure the LEAD_TIME and LAG_TIME parameters to obtain the desired input/output relationship. This block would normally be used in a feedforward portion of a control scheme or used to implement some special initialization functions required by a control scheme. This block will normally participate in a feedforward path. The FOLLOW parameter is used to cause the block to perform tracking functions whereby the output is forced to track the input whenever the FOLLOW parameter is set true.

The LAG_TIME parameter specifies the time constant for the block. Based on a step change to the input this is the time to reach 63.2% of the final value. Normally, it requires five time constants to reach the final value based on a first order function applied to the input. The LEAD_TIME parameter specifies the gain or impulse applied to the input parameter. The generalized form of the equation describing the action is as follows:

$(T_1 s+1)/(T_2 s+1)$

where:
T_1 = Lead time Constant
T_2 = Lag Time Constant

Supported Modes

O/S, MAN and AUTO.

Schematic

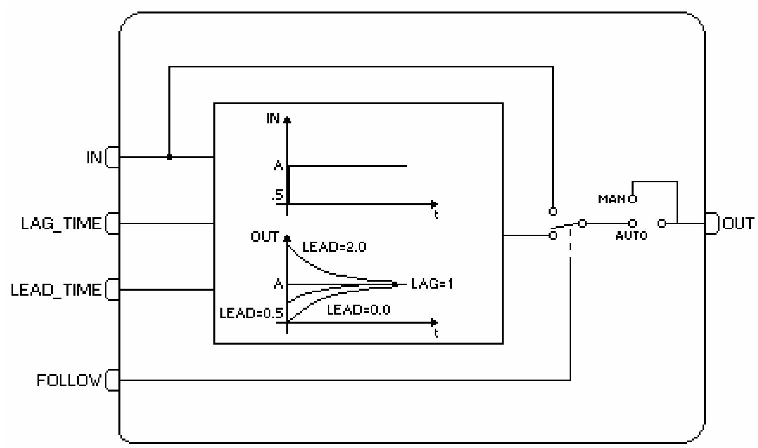


Figure 2.37 - LLAG Schematic

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	**OUT**	**DS-65**			**OUT**	**D**	**The primary analog value calculated as a result of executing the function.**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
8	OUT_UNITS	Unsigned16		0	E	S	The maximum tolerated duration for power failure.
9	GRANT_DENY	DS-70		0	Na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
10	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
11	**IN**	**DS-65**				**D**	**The primary input value of the block, required for blocks that filter the input to get the PV.**
12	FOLLOW	DS-66	True=follow		Na	D	Tracking input, when true causes the output to track the input.
13	**LAG_TIME**	**DS-65**			**Sec**	**D**	**Specifies the lag time constant for the block. Based on a step change to the input this is the time to reach 63.2% of the final value.**
14	**LEAD_TIME**	**DS-65**			**Sec**	**D**	**Specifies the lead time constant applied to the input parameter.**
15	BAL_TIME	Float	Positive	0	Sec	S	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds.
16	OUTAGE_LIM	Float	Positive	0	Sec	S	The maximum tolerated duration for power failure. This feature is not supported.
17	UPDATE_EVT	DS-73			na	D	This alert is generated by any change to the static data.
18	BLOCK_ALM	DS-72			na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":
The required mode for writing is the actual mode, regardless the target mode: OUT.

OSDL - Output Signal Selector and Dynamic Limiter

Description
The output signal selector and dynamic limiter block (OSDL) provides two different algorithms types:

As Output Selector the cascade input may be routed for one of two outputs based on the value of the OP_SELECT input parameter. The output not selected may have two ways: keeping the last value when not selected, or receive a internal value.

As Dynamic Limiter the cascade input is transferred to both output, but it is limited by the secondary inputs multiplied by a gain, plus a bias. The Dynamic LIMITER is extremely useful in one of its most important applications: combustion control with double cross limits.

The OSDL_TYPE parameter determines the algorithm used by the OSDL block. In order to change the OSDL_TYPE the block must be in Out of Service mode.

Output Signal Selector
The SP value may be controlled by an operator (Auto mode) or through a cascade control (Cas mode). In the cascade control the SP is supplied by another function block through the CAS_IN parameter. The inputs IN and IN_1 are not applied to this algorithm. It means that the block ignores the status and values of IN and IN_1 when the OSDL_TYPE is Output Selector.

The OP_SELECT is a discrete input parameter that selects one of two outputs to receive SP parameter. When the OP_SELECT is zero, the OUT parameter receives the SP parameter. Otherwise the OUT_1 parameter receives the SP parameter.
When the OP_SELECT status is not usable, the block changes to Auto, but the algorithm goes on working with the unusable value.

Most of the times, the SP is transferred to the selected output whatever is the status. Therefore, an unusable value and status in the CAS_IN will be reflected to the selected output. Only the status of upper cascade initialization will not be copied to the selected output.

Handling the non-selected output
There are two ways to handle the non-selected output, if the “Keep last value if not selected” bit in OSDL_OPTS parameter is true, the non-selected output will keep the last value. Otherwise, the outputs OUT and OUT_1 will receive the value contained in the NOT_SEL_VAL and NOT_SEL_VAL_1, respectively.

The non-selected output receives the uncertain status indicating to the downstream block that it is not selected any more. The configuration of the STATUS_OPTS in the downstream block will define how to deal with it.

IFS status propagation
If the “IFS only for selected output” bit in OSDL_OPTS parameter is true, the fault state status will be propagated only to selected output. Otherwise the status GoodCascade -IFS is propagated to both outputs, that is the default configuration.

Downstream block is not in cascade
If the downstream block of the selected output is not in cascade mode, the OSDL block goes to Iman mode. And the status of BKCAL_OUT will be GoodCascade – Not Invited, it will force the upstream block to Iman mode too.

If the downstream block of the non-selected output is not in cascade mode, the OSDL block will ignore it.

Dynamic Limiter
As a dynamic limiter algorithm, the outputs are the value of the “CAS_IN” parameter limited by the following values:

OUT:
High limit = HI_GAIN_1 * IN_1 + HI_BIAS_1
Low limit = LO_GAIN_1 * IN_1 - LO_BIAS_1
OUT_1:
High limit = HI_GAIN * IN + HI_BIAS
Low limit = LO_GAIN * IN - LO_BIAS

After the limitation, the parameters GAIN and GAIN_1 are applied as gain for the outputs OUT and OUT_1, respectively.

The normal mode of operation for the OSDL block is Cas, as well the two downstream blocks. If one downstream block is not in cascade mode, indicated by not invited status (NI) on its BKCAL_OUT, the OSDL block still continues in cascade mode. Only if both downstream blocks are not in cascade, then the OSDL changes to Iman mode and its BKCAL_OUT output changes to NI.

If the OSDL block is in Iman mode, when the cascade is initialized with a IR by a downstream block, the respective output (OUT or OUT_1) sends a IA for the downstream block and the BKCAL_OUT of the OSDL block receive the value of the respective BKCAL_IN. The OSDL block remains in IMAN mode until the downstream cascade is initialized. Then OSDL block goes to Auto mode and it sends an IR to upstream block to initialize the cascade.

After a downstream cascade initialization, the corresponding output must ramp from the last BKCAL_IN to the calculated value in BAL_TIME seconds.
The required actions as a dynamic limiter algorithm are summarized in the following table:

Mode target/actual	BKCAL_ IN	BKCAL_ IN1	BKCAL_ OUT	ACTION
Cas/Iman	NI or IR	NI or IR	NI	
Cas/Cas	NI or IR	OK	OK	BKCAL_OUT receive the CAS_IN value
Cas/Cas	OK	NI or IR	OK	BKCAL_OUT receive the CAS_IN value.
Cas/Cas	OK	OK	OK	BKCAL_OUT receive the CAS_IN value.

Legend: NI-not invited; IR-initialization request; OK-working in cascade

(*) Optionally, when the block is working as "Dynamic Limiter, it can choose if the return value for the upper block through the BKCAL_OUT output will be SP, Out or OUT_1, as showed below:

- BKCAL_OUT = SP (default)
- BKCAL_OUT = OUT (when OSDL_OPTS = "Use OUT for BKCAL_OUT").
- BKCAL_OUT = OUT_1 (When OSDL_OPTS = "Use OUT_1 for BKCAL_OUT_1").

IMPORTANT
All parameters and features with **(*)** are available only in transmitters with version 3.52 (DD 0601) or higher, and DF51 with version 3.8.0 (DD 04xx) or higher

BLOCK_ERR
The BLOCK_ERR of the OSDL block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when the OUT_TYPE parameter has an invalid value.
- Out of Service – When the block is in O/S mode.

Schematic

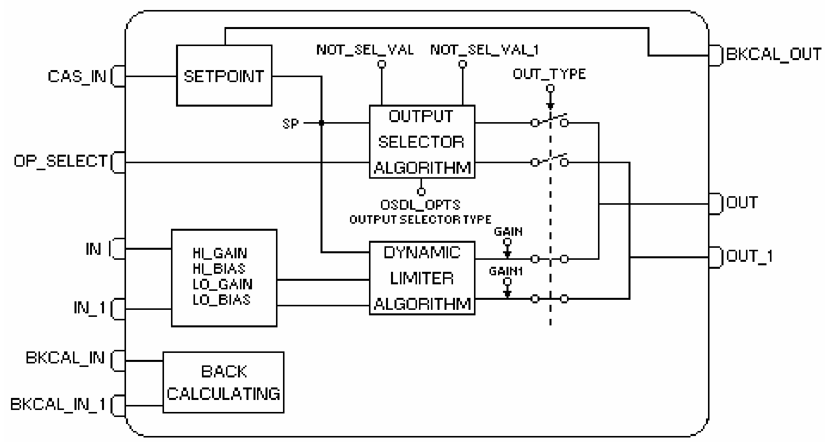


Figure 2.38 - Output Signal Selector and Dynamic Limiter Schematic

Supported Modes

O/S, IMAN, AUTO and CAS.

Status Handling

Standard, plus the following:

When one or both of the IN's input are Bad, special limiting action must be taken. If the "IFS if Bad IN_x " or "IFS if Bad CAS_IN " bit is true in the OSDL_OPTS parameter and the respective input is Bad, both output status go to "good IFS". If the bit is not true, the block goes to AUTO mode.

Sub-Status values received in CAS_IN will be passed onto both outputs, except for those used in the cascade initialization. An IFS will go to both the selected and the non-selected output.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	**CAS_IN**	**DS-65**				**D**	**This parameter is the remote setpoint value, which must come from another Fieldbus block, or a DCS block through a defined link.**
8	**SP**	**DS-65**				**N / Auto**	**The analog set point.**
9	**IN**	**DS-65**				**D**	**The primary input value of the block.**
10	**IN_1**	**DS-65**				**D**	**Numbered input parameter 1.**
11	OP_SELECT	DS-66	0 thru 4		None	D	An operator adjustable parameter to force a given input to be used.
12	**OUT**	**DS-65**				**D / RO**	**The primary analog value calculated as a result of executing the function.**
13	**OUT_1**	**DS-65**				**D / RO**	**Numbered output parameter 1.**
14	GRANT_DENY	DS-70		0	Na	S / O/S	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
15	**OUT_TYPE**	**Unsigned8**	**0 : Invalid Value** **1 : Output Selector** **2 : Dynamic Limiter**	**0**	**E**	**S / Man**	**This parameter specifies the algorithm type that will be calculated.**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
16	OSDL_OPTS	Bitstring(2)		0	Na	S / O/S	Option bit string for handling the block processing.
17	HI_GAIN	Float		1.1	None	S	It is used to calculate the high limit for OUT_1. This gain multiplies IN before adding HI_BIAS.
18	HI_BIAS	Float	Positive	0		S	It is used to calculate the high limit for OUT_1. This bias is added to IN after multiplying by HI_GAIN.
19	LO_GAIN	Float		0.9	None	S	It is used to calculate the low limit for OUT_1. This gain multiplies IN before subtracting LO_BIAS.
20	LO_BIAS	Float	Positive	0		S	It is used to calculate the low limit for OUT_1. This bias is subtracted of IN after multiplying by LO_GAIN.
21	HI_GAIN_1	Float		1.1	None	S	It is used to calculate the high limit for OUT. This gain multiplies IN_1 before adding HI_BIAS_1.
22	HI_BIAS_1	Float	Positive	0		S	It is used to calculate the high limit for OUT. This bias is added to IN_1 after multiplying by HI_GAIN_1.
23	LO_GAIN_1	Float		0.9	None	S	It is used to calculate the low limit for OUT. This gain multiplies IN_1 before subtracting LO_BIAS_1.
24	LO_BIAS_1	Float	Positive	0		S	It is used to calculate the low limit for OUT. This bias is subtracted of IN_1 after multiplying by LO_GAIN_1.
25	GAIN	Float		1	None	S	Gain applied to OUT after limiting.
26	GAIN_1	Float		1	None	S	Gain applied to OUT_1 after limiting.
27	**BKCAL_IN**	**DS-65**				**N**	**The value and status from a lower block's BKCAL_OUT that is used to prevent reset windup and to initialize the control loop.**
28	**BKCAL_IN_1**	**DS-65**				**N**	**The back calculated input required to initialize a lower cascade 1.**
29	**BKCAL_OUT**	**DS-66**				**D**	**The value and status required by an upper block's BKCAL_IN so that the upper block may prevent reset windup and provide bumpless transfer to closed loop control.**
30	BAL_TIME	Float		0	Sec	S	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds.
27	NOT_SEL_VAL	Float		0		S	Contained parameter that will set the respective output when OUT is not selected by the OP_SELECT.
28	NOT_SEL_VAL_1	Float		0		S	Contained parameter that will set the respective output when OUT_1 is not selected by the OP_SELECT.
33	UPDATE_EVT	DS-73			na	D	This alert is generated by any change to the static data.
34	BLOCK_ALM	DS-72			na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":
The default value of OUT_TYPE is "Dynamic limiter".
The required mode for writing is the actual mode, regardless the target mode: SP.

DENS - Density

Overview
This function block has an algorithm to calculate density in different kinds of engineering units, as Plato degree, Brix, TC and INPM.

Schematic

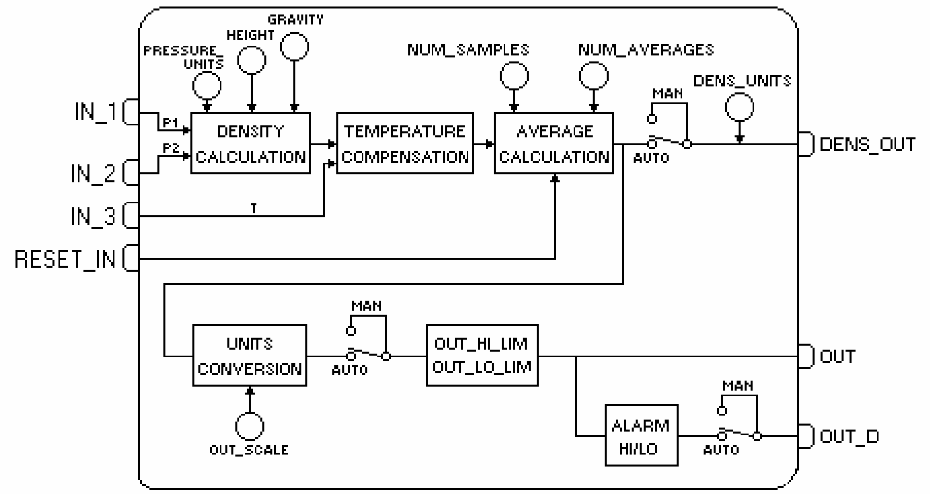


Figure 2.39 - Density Schematic

Description
The algorithm to calculate the density is based on the pressure in two points of the tank in a known difference height. The calculation is done using the average from the sensor pressure samples (the number of the samples is determined by the NUM_SAMPLES parameter). Then, the previous density is calculated using the following formula:

$$D = \frac{Conv\_factor * (\overline{P\_1} - \overline{P\_2})}{HEIGHT * GRAVITY} \left[g \big/ cm^3 \right]$$

Where in the formula above the average pressure is given by:

$$\overline{P\_i} = \frac{\sum_{j=1}^{NUM\_SAMPLES} IN\_i}{NUM\_SAMPLES} \left[PRESSURE\_UNITS \right]$$

Conv_Factor is a factor to transform the formula coefficients in the same units.

HEIGHT and *GRAVITY* ≠ 0

The temperature is compensated in the density calculation. The DENS_OUT parameter is the compassed density in g/cm^3. The OUT parameter is the compensated density in a different engineering unit for chosen by the EU_SEL parameter.

The density block provides alarm condition and the discrete alarm output to be used any block. If the density exceeds HI_LIM or LO_LIM an alarm is indicated in HI_ALM or LO_ALM and the output OUT_D will be set to true. If one or both of the limit parameters are set +/- INF this indicate that this alarm is disabled.

The RESET_IN is a discrete input, which on a false-to-true transition resets the density block, including the previous density, the round buffer and all outputs of the block. The status will be the same as the last cycle.

BLOCK_ERR

The BLOCK_ERR of the DENS block will reflect the following causes:

- Out of Service – it occurs when the block is in O/S mode.

Supported Modes

O/S, MAN and AUTO.

Mode Handling

Manual mode disconnects the outputs from the algorithm and permits manual substitution of the OUT, DENS_OUT, OUT_D values for test or other purposes. Although the OUT_D parameter is also disconnected from the alarm, the alarm and the limits (OUT_HI_LIM and OUT_LO_LIM) continue to check the output.

Status Handling

The primary input status (IN_1 and IN_2 parameters) are propagated to the outputs.

If the status of any primary input becomes bad or uncertain and their respective option "use uncertain" of STATUS_OPTS is not set, the actual mode block will be forced to manual and the algorithm stops the calculation.

If the secondary input (IN_3 parameter) is unusable, the algorithm uses the last usable value and the output status will be Uncertain.

A bad status in RESET_IN input does not stop the algorithm.

If target mode is Man then the output status is Good.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
4	ST_REV	Unsigned16		0	None	S/RO	
5	TAG_DESC	OctString(32)		Spaces	Na	S	
6	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**OUT**	**DS-65**	**OUT_SCALE +/- 10%**		**OUT**	**D / Man**	**The analog value calculated as a result of executing the function.**
8	OUT_SCALE	DS-68		0-100%	OUT	S / Man	The high and low scale values to the OUT parameter.
9	**EU_SEL**	**Unsigned8**	**0:Plato degree 1:Brix 2:TC 3:INPM**	**0**	**E**	**S / Man**	**Selection of engineering unit for density.**
10	GRANT_DENY	DS-70		0	na	D	
11	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
12	**IN_1**	**DS-65**				**D**	**The first input (pressure P1) must have the same engineering units of IN_2.**
13	**IN_2**	**DS-65**				**D**	**The second input (pressure P2) must have the same engineering units of IN_1.**
14	**IN_3**	**DS-65**				**D**	**The third input. (Temperature T in Degrees Celsius)**
15	**PRESSURE_UNITS**	**Unsigned16**	**See valid pressure units**	**1144 (g/cm^2)**	**E**	**S**	**This is the pressure engineering unit of IN_1 and IN_2.**
16	**HEIGHT**	**Float**	**Positive**	**1000.0**	**mm**	**S**	**Distance between the two pressure transmitters. The engineering units must be compatible to the inputs IN_1 and IN_2. If it is mmH20, the EU of HEIGHT is mm.**
17	**GRAVITY**	**Float**	**Positive**	**9.80665**	**m/s^2**	**S**	**The gravity acceleration used in the density calculation, the EU of GRAVITY is m/s^2.**

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
18	NUM_SAMPLES	Unsigned16	1-1000	10	Na	S	Number of samples.
19	NUM_AVERAGES	Unsigned16	1-30	10	Na	S	Number of averages in the round buffer.
20	**DENS_OUT**	**DS-65**			**g/cm^3**	**D / Man**	**The density compensated by the temperature.**
21	DENS_UNITS	Unsigned16		1100	g/cm^3	S / RO	This is the engineering unit of DENS_OUT that is fixed in g/cm^3.
22	OUT_D	DS-66				D	This is a discrete output parameter to indicate alarm state.
23	RESET_IN	DS-66				D	When it is true, it resets the average calculation and it clears the round buffer of averages.
24	OUT_HI_LIM	Float		100	OUT	S	High limit for OUT.
25	OUT_LO_LIM	Float		0	OUT	S	Low limit for OUT.
26	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
27	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.
28	ALARM_SUM	DS-74			Na	S	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
29	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged
30	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. In order to clear the alarm the amount the PV must return within the alarm limit plus hysteresis.
31	HI_PRI	Unsigned8	0 to 15			S	Priority of the high alarm.
32	HI_LIM	Float	OUT_SCALE, +INF	+INF	OUT	S	The setting for high alarm in engineering units.
33	LO_PRI	Unsigned8	0 to 15			S	Priority of the low alarm.
34	LO_LIM	Float	OUT_SCALE, -INF	-INF	OUT	S	The setting for low alarm in engineering units.
35	HI_ALM	DS-71			OUT	D	The status for high alarm and its associated time stamp.
36	LO_ALM	DS-71			OUT	D	The status for low alarm and its associated time stamp.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is “Adapted”:

The required mode for writing is the actual mode, regardless the target mode : OUT, DENS_OUT,

Valid Pressure Units

Index	Unit
1130	PA
1133	KPA
1132	MPA
1137	BAR
1138	MBAR
1139	TORR
1140	ATM
1141	PSI
1144	GCM2
1145	KGCM2
1148	INH20
1147	INH204C
1151	MMH20
1150	MMH204C
1154	FTH20
1156	INHG
1158	MMHG

CT – Constant

Overview

The Constant function block generates constant values to use in input parameters of other blocks. It can also read/write in contained parameters of other blocks into the same device.

IMPORTANT
All parameters and features with **(*)** are available only in transmitters with version 3.52 (DD 0601) or higher, and DF51 with version 3.8.0 (DD 04xx) or higher

Schematic

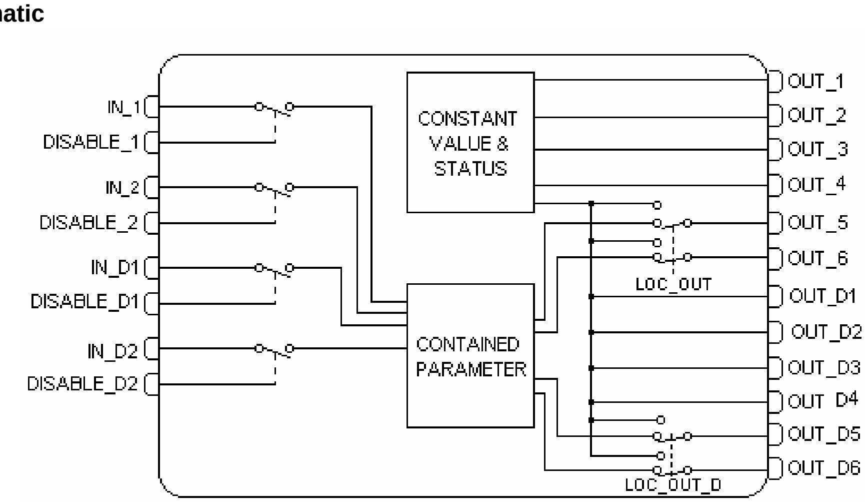


Figure 2.40 - Constant Schematic

Description

The Constant function block has two functions:

- As Constant:

It generates constant values to use in input parameters of other blocks. This block allows up to 6 discrete constant and 6 analogical constant.

- As Contained RW **(*):**

The input writes in contained parameters of any other block into the same device.
The output reads data of the contained parameters of any other block into the same device.

➢ **Generating Constant Values for other Blocks (*)**

This block can generate up to six discrete outputs and 6 analogic outputs, where:

- The OUT_1 to OUT_4 and OUT_D1 to OUT_D4 outputs become available in the output the constant values of CT_VALxx and CT_STATUS_xx.
- The OUT_5, OUT_6, OUT_D5 and OUT_D6 outputs have the feature Reading of Contained Parameter of other blocks and are associated with the LOC_OUT_xx parameter. If these parameters are not configured, the output will show the CT_VAL_xx abd CT_STATUS_xx constant values.

If the Mode is Man, it is allowed the manual substitution of all ouput values. In the Auto mode, the output values are the respective constant values.

➢ **Reading or Writing from/to Contained Variables of other blocks (*)**

The writing and/or reading in the contained parameters of other blocks is associated to the block execution in the Auto mode.

o **Input Treatment – Writing in Contained Parameters (*)**

During the block execution in the Auto mode, the block writes the value of the IN_xx parameter in a parameter[1] of any other block in the same device.
The value will be written in the parameter configured in the following situations:

- While the value had a usable valuein the IN_xx input (i.e., IN_xx Status was Good or Uncertain and the option “Use Uncertain as Good” in STATUS_OPTS was set).
- The DISABLE_IN_xx input is usable and with FALSE value, or when the IN_xx input was with an usable value.
- For the IN_Dx inputs will just be done the writing when the actual value was different of the previous. This avoids cyclical writing in static parameters which causes a cyclical increment of the ST_REV and event generation by the UPD_EVT.
- For the IN_x inputs will just be done the writing when the actual value was upper or lower that DEAD_BAND_x. In this range would not have writing in the parameter. When the DEAD_BAND_X parameter is equal zero, it means continued writing.

If the writing does not accomplish in the desired block, the input with failure will be indicated in the BAD_STATUS parameter.

o **Output Treatment – Reading of the Contained Parameters (*)**

During the block execution in the Auto mode, the block reads the parameter[1] value of any other block in the same device and become available in the OUT_xx. VALUE parameter (where xx is only for the OUT_5, OUT_6, OUT_D_5 and OUT_D_6 outputs). The Ouput status will be GoodNonCascade in this case.

If the block does not read the parameter, the correspondet output with failure will be indicated in the BAD_STATUS parameter, and also OUT_xx.STATUS = Bad No Comm.

When the LOC_OUT_xx parameter was not configured (BLOCK_TAG = Spaces or the RelativeIndex is equal a zero and the SubIndex is equal zero), thus the OUT_xx output makes available the correspondent constatnt value and status (CT_VAL_xx and CT_STATUS_xx).

o **Configuration of Contained Parameter to be Read/Write (*)**

To address the contained parameter, the respective input or output will have a LOC_xxx parameter composed of the following structure (DS-262):

E	Element Name	Data Type	Size	Description
1	BlockTag	VisibleString(32)	32	Block Tag for monitoring (this tag is case sensitive).
2	RelativeIndex	Unsigned16	2	Relative Index of parameter.
3	SubIndex	Unsigned8	1	Parameter subindex started by 1. When the parameter is a structure (DS_xxx), it indicates the number of the structure element. When it was a Bitstring parameter, it indicates the byte of the parameter to be considered. In simple parameters, this sub index is not considered.

The input/output is considered **NOT CONFIGURED** when the **BlockTag** was **blank** or the **RelativeIndex** and the SubIndex was equal **zero**.

When there was a configuration error in the contained parameter, the correspondent bit of the input/output in CONFIG_STATUS will be set and the BLOCK_ERR will indicate "Configuration Error".

[1]The reading or writing is not supported in all parameter types. The table below summarizes the operations supported by the block:

Parameter Input/Output	Data Type	Direction		Data Type of/ Parameter of Other Supported Block
		From	To	
IN_x	Float	In_x	Other Block Parameter	Boolean * Float Integer8 * Integer16 * Integer32 Unsigned8 * Unsigned16 * Unsigned32 Bitstring *
In_Dx	Unsigned8	In_Dx	Other Block Parameter	Boolean Float Integer8 Integer16 Integer32 Unsigned8 Unsigned16 Unsigned32 Bitstring *
Out_x	Float	Other Block Parameter	Out_x	Boolean Float Integer8 Integer16 Integer32 Unsigned8 Unsigned16 Unsigned32 Bitstring
Out_Dx	Unsigned8*	Other Block Parameter	Out_Dx	Boolean Float Integer8 Integer16 Integer32 Unsigned8 Unsigned16 Unsigned32 Bitstring

Note 1: The data type assigned with * means the block will cut the values out of range of the correspondent type:
- Unsigned 8 / Bitstring – 0 to 255
- Integer 8 – (-127) a (+127)
- Boolean – 0 and 1
- Unsigned16 – 0 to 65535
- Integer16 – (-32767) to (+32767)

Note 2: For the BitString type, the Subindex identifies the correspondent Byte.

Note 3: The reading or writing in contained parameters are not supported in the same block Constant.

Supported modes
O/S, MAN, AUTO

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	OUT_1	DS-65				N / Man	This output is determined by the constant CT_VAL_1. It can not be used to read contained parameters.
8	OUT_2	DS-65				D / Man	This output is determined by the constant CT_VAL_2. It can not be used to read contained parameters.
9	OUT_3	DS-65				D / Man	This output is determined by the constant CT_VAL_3. It can not be used to read contained parameters.
10	OUT_4	DS-65				D / Man	This output is determined by the constant CT_VAL_4. It can not be used to read contained parameters.
11	OUT_5	DS-65				D / Man	This output can have the value of a constant CT_VAL_5 or the value of a contained parameter from another block depends on LOC_OUT_5.
12	OUT_6	DS-65				D / Man	This output can have the value of a constant CT_VAL_6 or the value of a contained parameter from another block depends on LOC_OUT_6.
13	OUT_D1	DS-66				N / Man	This output is determined by the constant CT_VAL_D1. It can not be used to read contained parameters.
14	OUT_D2	DS-66				D / Man	This output is determined by the constant CT_VAL_D2. It can not be used to read contained parameters.
15	**CT_VAL_1**	**Float**		**0**		**S**	**Analog constant value transferred to the output OUT_1.**
16	**CT_VAL_2**	**Float**		**0**		**S**	**Analog constant value transferred to the output OUT_2.**
17	**CT_VAL_3**	**Float**		**0**		**S**	**Analog constant value transferred to the output OUT_3.**
18	**CT_VAL_4**	**Float**		**0**		**S**	**Analog constant value transferred to the output OUT_4.**
19	**CT_VAL_5**	**Float**		**0**		**S**	**Analog constant value transferred to the output OUT_5.**
20	**CT_VAL_6**	**Float**		**0**		**S**	**Analog constant value transferred to the output OUT_6.**
21	**CT_VAL_D1**	**Unsigned8**		**0**		**S**	**Discrete constant value transferred to the output OUT_D1.**
22	**CT_VAL_D2**	**Unsigned8**		**0**		**S**	**Discrete constant value transferred to the output OUT_D2.**
23	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
24	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.
25	CT_VAL_D3	Unsigned8		0		S	Discrete constant value transferred to the output OUT_D3.
26	CT_VAL_D4	Unsigned8		0		S	Discrete constant value transferred to the output OUT_D4.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
27	CT_VAL_D5	Unsigned8		0		S	Discrete constant value transferred to the output OUT_D5.
28	CT_VAL_D6	Unsigned8		0		S	Discrete constant value transferred to the output OUT_D6.
29	CT_STATUS_1	Unsigned8		GNC		S	Constant Status transferred to the output OUT_1.
30	CT_STATUS_2	Unsigned8		GNC		S	Constant Status transferred to the output OUT_2.
31	CT_STATUS_3	Unsigned8		GNC		S	Constant Status transferred to the output OUT_3.
32	CT_STATUS_4	Unsigned8		GNC		S	Constant Status transferred to the output OUT_4.
33	CT_STATUS_5	Unsigned8		GNC		S	Constant Status transferred to the output OUT_5.
34	CT_STATUS_6	Unsigned8		GNC		S	Constant Status transferred to the output OUT_6.
35	CT_STATUS_D1	Unsigned8		GNC		S	Constant Status transferred to the output OUT_D1.
36	CT_STATUS_D2	Unsigned8		GNC		S	Constant Status transferred to the output OUT_D2.
37	CT_STATUS_D3	Unsigned8		GNC		S	Constant Status transferred to the output OUT_D3.
38	CT_STATUS_D4	Unsigned8		GNC		S	Constant Status transferred to the output OUT_D4.
39	CT_STATUS_D5	Unsigned8		GNC		S	Constant Status transferred to the output OUT_D5.
40	CT_STATUS_D6	Unsigned8		GNC		S	Constant Status transferred to the output OUT_D6.
41	OUT_D_3	DS-66				D/Man	This output is determined by the constant CT_VAL_D3. It can not be used to read contained parameters.
42	OUT_D_4	DS-66				D/Man	This output is determined by the constant CT_VAL_D4. It can not be used to read contained parameters.
43	OUT_D_5 **(*)**	DS-66				D/Man	This output can have the value of a CT_VAL_D5 or the value of a contained parameter from another block depends on LOC_OUT_D5.
44	OUT_D_6 **(*)**	DS-66				D/Man	This output can have the value of a CT_VAL_D6 or the value of a contained parameter from another block depends on LOC_OUT_D6.
45	IN_1 **(*)**	DS-65				D	Analog input that writes to a contained parameter configured in the LOC_IN_1.
46	DISABLE_1 **(*)**	DS-66				D	Disable the IN_1 writing in the correspondent contained parameter.
47	LOC_IN_1 **(*)**	DS-262				S / OOS	Indicate which the contained parameter will be written by the IN_1 input.
48	DEAD_BAND_1	Float		1.0	IN_1	S	Dead band for the IN_1 input where the variation into this range would not cause writing in the block parameter.
49	IN_2 **(*)**	DS-66				D	Analog input that writes to a contained parameter configured in the LOC_IN_2.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
50	DISABLE_2 **(*)**	DS-66				D	Disable the IN_2 writing in the correspondent contained parameter.
51	LOC_IN_2	DS-262				S / OOS	Indicate which the contained parameter will be written by the IN_2 input.
52	DEAD_BAND_2	Float		1.0	IN_2	S	Dead band for the IN_2 input where the variation into this range would not cause writing in the block parameter.
53	IN_D_1 **(*)**	DS-66				D	Discrete input that writes to a contained parameter configured in the LOC_IN_D1.
54	DISABLE_D1 **(*)**	DS-66				D	Disable the IN_D1 writing in the correspondent contained parameter
55	LOC_IN_D1 **(*)**	DS-262				S / OOS	Indicate which the contained parameter will be written by the IN_D1 input.
56	IN_D_2 **(*)**	DS-66				D	Discrete input that writes to a contained parameter configured in the LOC_IN_D2.
57	DISABLE_D2 **(*)**	DS-66				D	Disable the IN_D2 writing in the correspondent contained parameter
58	LOC_IN_D2 **(*)**	DS-262				S / OOS	Indicate which the contained parameter will be written by the IN_D2 input.
59	LOC_OUT_5 **(*)**	DS-262				S / OOS	Indicates which contained parameter will be read for the OUT_5 output.
60	LOC_OUT_6 **(*)**	DS-262				S / OOS	Indicates which contained parameter will be read for the OUT_6 output.
61	LOC_OUT_D5 **(*)**	DS-262				S / OOS	Indicates which contained parameter will be read for the OUT_D_5 output.
62	LOC_OUT_D6 **(*)**	DS-262				S / OOS	Indicates which contained parameter will be read for the OUT_D_6 output
63	BAD_STATUS **(*)**	Bitstring(2)				D/RO	Writing/reading status of the parameter. The set bit indicates the algorithm does not get read/write the specified “Block.Parameter”.
64	CONFIG_STATUS **(*)**	Bitstring(2)				D/RO	Indicates which input or outpt is with configuration error.
65	STATUS_OPTS **(*)**	Bitstring(2)				S/ OOS	See the parameter description in “Function Block Options”.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static
Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is “Adapted”:

The required mode for writing is the actual mode, regardless the target mode: OUT_1, OUT_2, OUT_3, OUT_4, OUT_5, OUT_6, OUT_D1 and OUT_D2.

BAD_STATUS and CONFIG_STATUS Bitstring (*)

BIT	DESCRIPTION
0	IN_1
1	IN_2
2	IN_D1
3	IN_D2
4	OUT_5
5	OUT_6
6	OUT_D5
7	OUT_D6

FFET - Flip-Flop and Edge Trigger

Overview

It can be configured to work as:

- SR flip-flop
- RS flip-flop
- D-latch
- Rising edge trigger
- Falling edge trigger
- Bi-directional edge trigger

Schematic

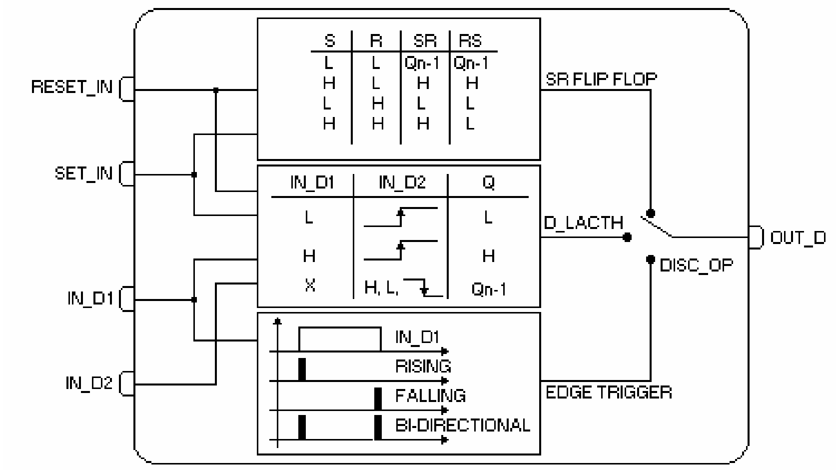


Figure 2.41 - Flip-Flop and Edge Trigger Schematic

Description

The following tables summarize the block behavior:

RESET_IN	SET_IN	OUT_D (SR flip-flop)	OUT_D (RS flip-flop)
L	L	Q_{n-1}	Q_{n-1}
H	L	L	L
L	H	H	H
H	H	H	L

RESET_IN	SET_IN	IN_D1	IN_D2	OUT_D (D-latch)
L	H	X	X	H
H	L	X	X	L
H	H	X	X	H
L	L	Rising	L	L
L	L	Rising	H	H
L	L	H,L or Falling	X	OUT_D_{n-1}

RESET_IN	SET_IN	IN_D1	OUT_D (Rising Edge)	OUT_D (Falling Edge)	OUT_D (Bi-directional)
L	L	Rising	H	L	H
L	L	Falling	L	H	H
L	L	No transition	L	L	L
X	H	X	H	H	H
H	L	X	L	L	L

BLOCK_ERR

The BLOCK_ERR of the FFET block will reflect the following causes:

- Out of Service – When the block is in O/S mode.

Supported Modes
O/S, MAN and AUTO.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**DISC_OP**	**Unsigned8**	**0 : SR flip-flop** **1 : RS flip-flop** **2 : D-latch** **3 : rising edge** **4 : falling edge** **5 : bi-directional edge**		**E**	**S / Man**	**Selection of discrete operation.**
8	**STATUS_OPTS**	**Bitstring(2)**				**S / O/S**	
9	**IN_D1**	**DS-66**				**D**	**Numbered discrete input 1.**
10	**IN_D2**	**DS-66**				**D**	**Numbered discrete input 2.**
11	**SET_IN**	**DS-66**	**0 : Off** **1 : set**			**D**	**The set input.**
12	**RESET_IN**	**DS-66**	**0 : Off** **1 : reset**			**D**	**The reset input.**
13	**OUT_D**	**DS-66**				**N / Man**	**The output of flip-flop.**
14	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
15	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is “Adapted”:
The required mode for writing is the actual mode, regardless the target mode : OUT_D.

AEQU – Advanced Equations

Overview
This block was specially designed to support specific calculations.

Schematic

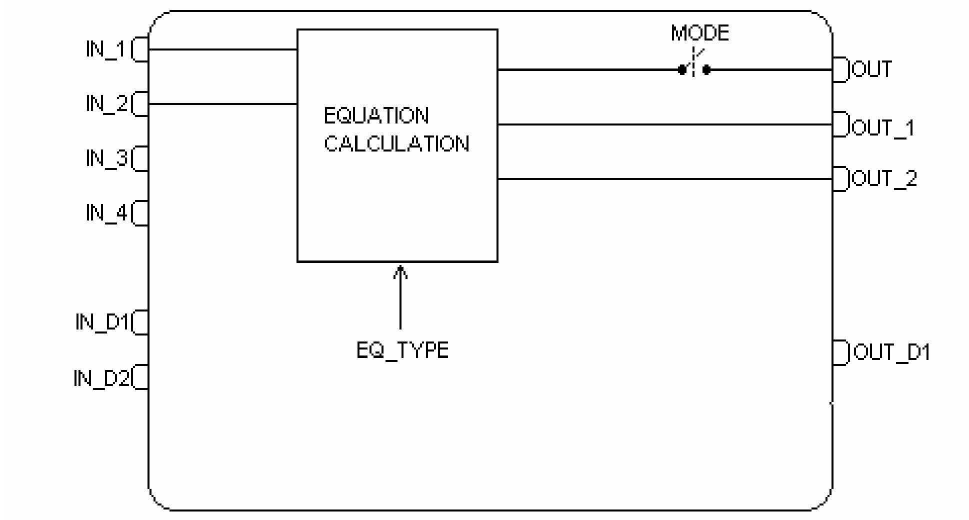


Figure 2.42 - Advanced Equations Schematic

Description
As this block has a general purpose, some parameters may not be used by a selecteled equation. It follows a description of each equation type, as well the meaning of used parameters:

Parameter	Description	Inputs	Configurable Parameters	Outputs
Ln x	It calculates the natural logarithm	**IN_1:** input to the function, x	None	**OUT:** result of natural logarithm
Log x	It calculates base 10 logarithm	**IN_1:** input to the function, x	None	**OUT:** result of base 10 logarithm
Exp x	It calculates e to power of x	**IN_1:** input to the function, x	None	**OUT:** result of e to power of x
Dew point temperature	It calculates the dew point temperature, water vapor saturation pressure (psia) and water vapor pressure (pw)	**IN_1:** dry bulb temperature (F) **IN_2:** relative humidity (percent)	None	**OUT:** dew point temperature **OUT_1:** water vapor saturation pressure (psia) **OUT_2:** water vapor pressure (pw) **Especial:** Reserved option

BLOCK_ERR
The BLOCK_ERR of the AEQU block will reflect the following causes:

- Out of Service – When the block is in O/S mode.
- Block Configuration Error – When an abnormal result occurs (+/- INF, NaN).

Supported modes
O/S, MAN, AUTO.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	**EQ_TYPE**	**Unsigned8**	**0 : Ln x** **1 : Log x** **2 : Exp x** **3 : Dew Point Temperature** **255 : Special**	**0**	**E**	**S / Man**	**Equation type**
8	**IN_1**	**DS-65**				**D**	**Numbered input 1.**
9	**IN_2**	**DS-65**				**D**	**Numbered input 2.**
10	IN_3	DS-65				D	Numbered input 3.
11	IN_4	DS-65				D	Numbered input 4.
12	IN_D1	DS-66				D	Numbered discrete input 1.
13	IN_D2	DS-66				D	Numbered discrete input 2.
14	**OUT**	**DS-65**				**D / Man**	**Primary output.**
15	OUT_D1	DS-66				D / Man	Numbered discrete output 1.
16	**OUT_1**	**DS-65**				**D / RO**	**Numbered output 1.**
17	**OUT_2**	**DS-65**				**D / RO**	**Numbered output 2.**
18	CT_VAL_1	Float		0		S	Constant value 1.
19	CT_VAL_2	Float		0		S	Constant value 2.
20	CT_VAL_3	Float		0		S	Constant value 3.
21	CT_VAL_4	Float		0		S	Constant value 4.
22	CT_VAL_5	Float		0		S	Constant value 5.
23	CT_VAL_6	Float		0		S	Constant value 6.
24	CT_VAL_D1	Unsigned8		0		S	Integer constant value 1.
25	CT_VAL_D2	Unsigned8		0		S	Integer constant value 2.
26	OUT_HI_LIM	Float		100	OUT	S	High limit for OUT.
27	OUT_LO_LIM	Float		0	OUT	S	Low limit for OUT.
28	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

PRED – Smith Predictor

Schematic

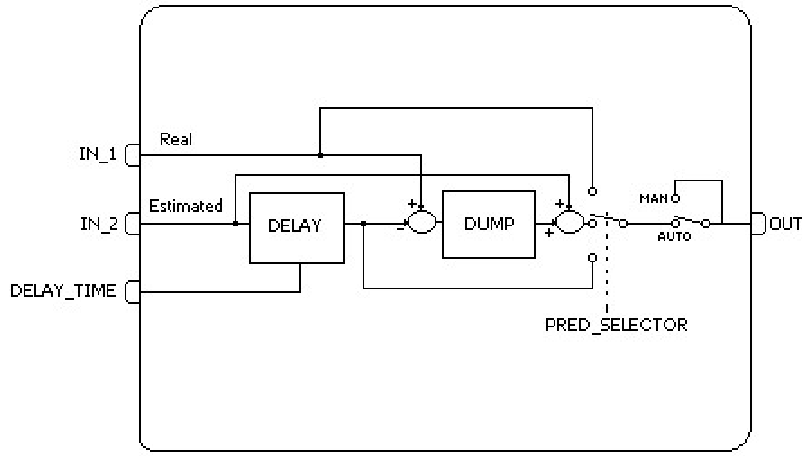


Figure 2.43 - Smith Predictor Schematic

Description

The Predictor block is an implementation of the scheme below:

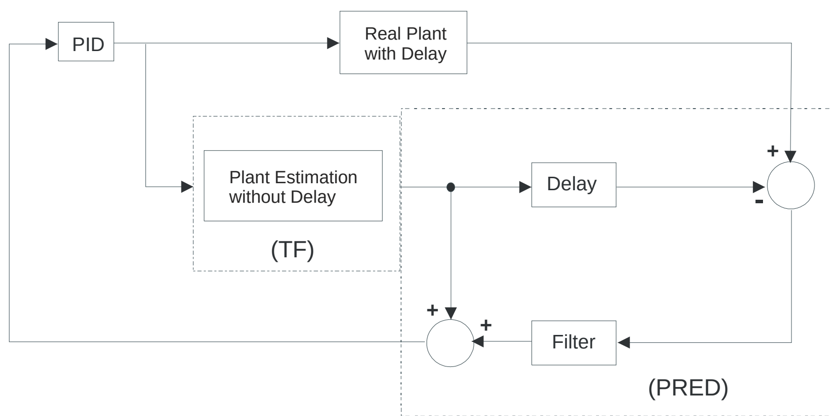


Figure 2.44 - Scheme using Predictor and Transfer Function Blocks

The Predictor block working with the Transfer Function block allow to the user to develop the control strategy using the PID block for controlling systems with respectable delays.

This block has three inputs and one output:

- **<u>In_1</u>** – Input for the Real system with delay.
- **<u>In_2</u>** – Input for the Plant Estimation without delay.
- **<u>Delay_Time</u> –** Input providing the delay value, in seconds. This value can not be higher than the *Sample time*.
- **<u>Out</u>** – Block configurable output.

The block output can be configured by three different ways, according to the PRED_SELECTOR parameter:

- ***<u>Bypass</u>*** – Output will have the same value of the IN_1 input.
- ***<u>Delay</u>*** – Block will have only the delay function, if the signal was received by IN_2 input.
- ***<u>Smith Predictor</u>*** – Block will have the Smith Predictor function.

The filter indicated above has the following configuration:

$$G(s) = \frac{1}{Ts + 1}$$

In the equation above, T coefficient is configured by user through the FILTER parameter.
OS → Auto Transition

When a block transition from OS to Auto occurs and the block is configured in Smith Predictor, this block will need a time (the same of the DELAY_TIME) to store data, while this the block will work in the Bypass option.

Supported Modes

O/S, MAN and AUTO.

Parameters

Idx	Parameter	Data type (lenght.)	Valid Range / Options	Default Value	Unids	Store /Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	MODE_BLK	DS-69	O/S,MAN,AUTO	O/S	Na	S	See Mode parameter.
6	BLOCK_ERR	Bitstring(2)			E	D	
7	IN_1	DS-65				D	Input for the Real system with delay.
8	IN_2	DS-65				D	Input for the Plant Estimation without delay.
9	DELAY_TIME	DS-65			Sec	D	Input providing the delay value, in seconds.
10	OUT	DS-65				D / Man	Block configurable output.
11	PRED_SELECTOR	Unsigned8	0 = *Bypass* 1 = Delay 2 = Smith Preditor	0	E	S	Output selector: ***<u>Bypass</u>*** – Output will have the same value of the IN_1 input; **<u>Delay</u>** – The output will be the signal of the IN_2 input with delay. **<u>Smith Predictor</u>** – The output will be according to the Smith Predictor algorithm.
12	FILTER	float	Positive	0	Sec	S	Parameter to configure the block filter.
13	PRED_SAMPLE_TIME	float	Positive	1	Sec	S	Sample time to collect data.
14	STATUS_OPTS	Bitstring(2)	Bit 2 – Uncertain as Good	0	Na	S / OOS	See Block Option.
15	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
16	BLOCK_ALM	DS-72			Na	D	

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

TF – Transfer Function

Schematic

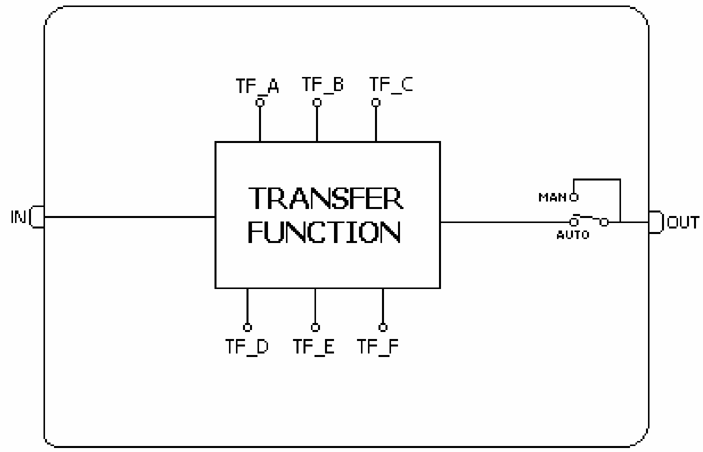


Figure 2.45 - Transfer Function Schematic

Description
The Transfer Function block (TF) must represent systems up to 2nd order, through the configuration of the coefficients A, B, C, D, E and F of the transfer function as:

$$G(s) = \frac{As^2 + Bs + C}{Ds^2 + Es + F}$$

This block has one output and one input.

System Representation
A system to be accomplished should have the denominator degree higher than the numerator degree, thus when D parameter was equal zero, A parameter must be zero too.

The parameters D and E can not be zero.

TF Block Application
For systems with delay is difficult to control the system using only the PID controller. It is necessary to make a scheme that supplies to the PID the value of the process variable without delay. A scheme used is the *Predictor Smith* and its configuration is showed below:

To represent the plant estimation without delay, it is necessary to use the TF block.

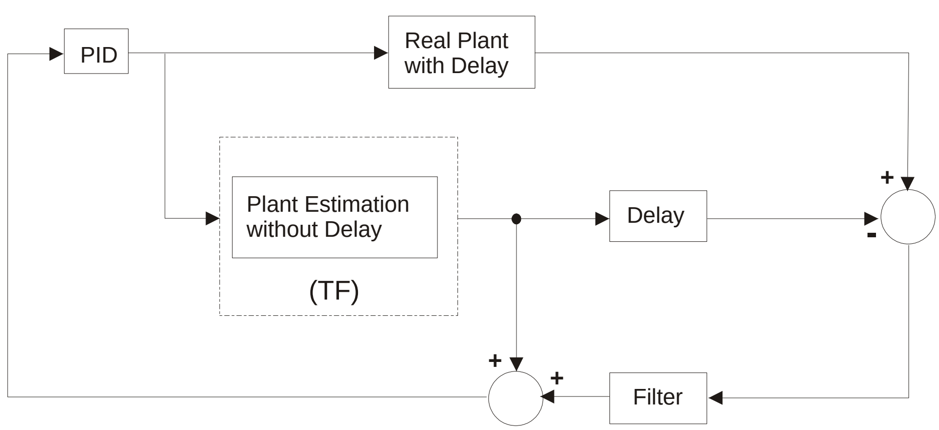


Figure 2.46 - Scheme using TF and Predictor Blocks

Another application which the TF block can be used is using the Constant block to make multimodel systems. One example of this application type is the conic tank, where it is possible to determine its operation points and for each point is possible to configure different transfer functions.

Supported Modes
O/S, MAN and AUTO.

Parameters

Idx	Parameter	Data type (lenght)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	MODE_BLK	DS-69	O/S,MAN,AUTO	O/S	Na	S	See Mode parameter.
6	BLOCK_ERR	Bitstring(2)			E	D	
7	IN	DS-65				D	System analog input.
8	OUT	DS-65				D / Man	System analog output.
9	TF_A	Float		0.0		S	Transfer function coefficient.
10	TF_B	Float		0.0		S	Transfer function coefficient.
11	TF_C	Float		0.0		S	Transfer function coefficient.
12	TF_D	Float		0.0		S	Transfer function coefficient.
13	TF_E	Float		0.0		S	Transfer function coefficient.
14	TF_F	Float		0.0		S	Transfer function coefficient.
15	TF_BAL_TIME	Float	Positive	0.0	Sec	S	Specifies the time from the last output value returning to the calculate algorithm value when the block is changing from Manual to Automatic Mode, providing bumpless start up.
16	STATUS_OPTS	Bitstring(2)	Bit 2 : Uncertain as Good	0	Na	S / OOS	See Block options.
17	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
18	BLOCK_ALM	DS-72			Na	D	

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S - static

Gray Background Line: Default Parameters of Syscon

LCF – Liquid Correction Factors

Schematic

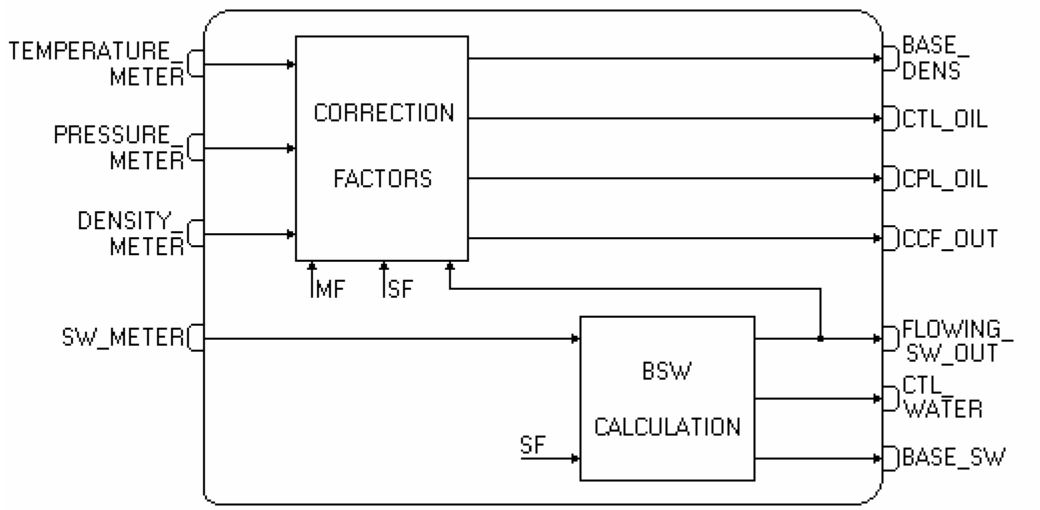


Figure 2.47 - Liquid Correction Factors Schematic

Description
This block calculates the correction factors (CTL, CPL and BSW in operation temperature) for liquid measurement.

Identification of the measurement number – STRATEGY
It is mandatory to configure the STRATEGY parameter, because this block identifies the number of the measured flow which the calculated correction factor is related.

The quantity of the block instantiations is **not** limited to the maximum number of measured flows.

Product Configuration
Using the PRODUCT_TYPE parameter is possible to select the product type to be used in the calculation. There is also the selection of the density type in the DENSITY_TYPE parameter, the application of the correction for the glass density mester (HYDROMETER_CORRECTION) and the coefficient of Thermal Expansion in base temperature or equilibrium absolute pressure.

CCF Calculation
If the FLOWING_TEMP and DENSITY_METER inputs are connected, the CTL_OUT factor will be calculated. And if the FLOWING_PRES input is also connected, the CPL_OUT factor will be calculated too.

If the CALL_BSW parameter is configured to accomplish the BSW calculation, thus:
$CCF = CTL * CPL * MF * (1 - X_{w,m}) * SF$

Block Inputs

Input	Link Necessity	Description
TEMPERATURE_METER	mandatory	Liquid flow temperature If the system has an online density meter, the temperature which the density measurement is being accomplished must be lower than the variation of the acceptable limits related to the flow temperature in the flow meter.
PRESSURE_METER	Optional	Flow manometric pressure If this input is not connected, CPL = 1.
DENSITY_METER	mandatory	Density of the measured product (emulsão), which can be in the flow conditions or in base conditions, it depends on the DENSITY_TYPE configuration

Block Outputs

This block provides four outputs described below. In the applications which the CPL factor is not calculated and the PRESSURE_METER input is not connected, thus the CPL_OUT output will indicate 1.

Output	Description	Value in the exception condition (*)
BASE_DENS	Density in base condition. It is defined by the LKD block.	DENSITY_METER
CTL_OUT	Temperature Correction Factor	1.0000
CPL_OUT	Pressure Correction Factor	1.0000
CCF_OUT	Combined Correction Factor	1.0000

(*) Situation which is impossible to accomplish the calculation. It can be because of the input status or it is out of range specified by the correspondent standard.

TEMPERATURE_METER and DENSITY_METER	PRESSURE_METER	CALC_BSW	CCF
No connected	-	-	1
Connected	No connected	None	CTL * MF
Connected	Connected	None	CTL * CPL * MF
Connected	No connected	Dual range / Lab analysis	MF * (1 - $X_{w,m}$) * CTL * SF
Connected	Connected	Dual range / Lab analysis	MF * (1 - $X_{w,m}$) * CTL * CPL * SF

The CCF_OUT output results of the three factors multiplication (CTL, CPL and MF), if any calculation of these factors is impossible, thus the value in the exception conditions must be used.

Temperature Correction Factor for Liquid Hydrocarbon (CTL_OIL)

The density used in the CTL calculation depends on the configuration, as indicated below:

Density used	Configuration	Comments
DENSITY_METER	There are two conditions: • CALC_BSW set to Dual range and LO_SW is 100%. • CALC_BSW set to None.	The dry oil density in operation or base conditions (configured in DENSITY_TYPE) indicated in DENSITY_METER input is used in the CTL_OIL calculation.
LAB_DENS_OIL	CALC_BSW set to Dual range and LO_SW is different of 100%.	The DENSITY_METER input is the emulsion density (not compliant for the CTL_OIL calculation CTL_OIL), which is used for the DWS calculation in operation condition
	CALC_BSW set to Lab analysis.	The DENSITY_METER input is not used because the dry oil density must be obligatorily supplied for the BSW calculation.

For the measurement of crude oil, general products, MTBE and lubrificant oil is used API-11.1 standard. For the measurement of light liquid hydrocarbon are used GPA-TP25 and GPA-TP15 standards.

Compressibility Factor – F

The Compressibility Factor for the measured liquid is calculted using the base density and flow temperature. If it is impossible to calculate the compressiblity factor, the F parameter will be zero.

The CPL factor is calculted using compressibility factor, flow manometric pressure and equilibrium pressure.

If the selected product is water, the compressibility factor will be zero and the CPL factor is 1.

The standards used for the compressibility factor calculation are API-11.2.1 and API-11.2.1.M for crude oil, general products, MTBE and lubrificant oil. For the measurement of light hydrocarbon liquid are used API-11.2.2 and API-11.2.2.M standards.

Meter factor – MF
If the meter is submitted to the proving, thus the meter factor value obtained must be written in the MF parameter. Otherwise, the default value of the MF parameter must be keept, that is, 1.

BSW Calculation– Dual range
If the CALC_BSW parameter is set to "Dual range", the FLOWING_SW_OUT paremeter is the SW_METER input, if this input was lower than LO_SW. Otherwise, the BSW will be calculated using the result of laboratory analysis and emulsion density in flow condition.

If LO_SW = 0.0, thus BSW will be always calculated
If LO_SW = 100.0, thus the FLOW_SW_IN input will be always used.

Block Inputs
The inputs used are indicated below:

Input	Link Necessity	Descrição
TEMPERATURE_METER	mandatory	Liquid flow temperature
DENSITY_METER	mandatory	Density of the measured product which is must be in flow condition obligatorily for the Dual range option.
SW_METER	Optional	Input with the value of the BSW measured online for values lower than the configured values in LO_SW parameter, up to the value of BSW will be used. If this input is not connected, it will be ignored, thus the BSW will be always calculated.

Output Blocks

Outputs	Description
FLOWING_SW_OUT	If the value of the SW_METER input is lower than the LO_SW parameter, this output will follow the FLOW_SW_IN input. Otherwise, it will be calculated the value.
CTL_WATER	Temperature correction factor for water.
BASE SW	BSW calculated for base temperature condition

BSW Calculation– LAB_DENS_OIL and LAB_DENS_WATER
The BSW is calculated using the dry oil and water densities in laboratory analysis condition, the density in flow condition and the flow temperature. All factors are measured online.

These calculations assume constant features (base density) of the oil and water made.

FLOWING_SW_OUT Calculation:

- It calculates : $DENS_{óleo,T} = f(DENS_{óleo,Tlab}, T)$

Where :
$DENS_{óleo,T}$: dry oil density in flow temperature
$DENS_{óleo,Tlab}$ = LAB_DENS_OIL : dry oil density in laboratory analysis temperature
T : flow temperature

- It calculates : $DENS_{água,T} = f(DENS_{água,15/60}, T)$

Where :
$DENS_{água,T}$: water density in flow temperature
$DENS_{água,lab}$ = LAB_DENS_WATER: water temperature in laboratory analysis temperature
T : flow temperature

- It calculates BSW_T (FLOWING_SW_OUT parameter).

Where :
BSW_T : BSW in flow temperature

$$BSW_T = \frac{DENS_{emulsão,T} - DENS_{óleo,T}}{DENS_{água,T} - DENS_{óleo,T}}$$

BASE_SW Calculation:

- $CTL_A = f(DENS_{água,15/60}, Tb)$ is the CTL_WATER parameter, which converts the volume in flow temperature to base temperature.

- $CTL_o = f(DENS_{óleo,Tlab}, Tlab,Tb)$, which converts the volume in laboratory analysis temperature to flow temperature

- It calculates BSW_{Tb} (BASE_SW parameter).

$$BSW_{Tb} = \frac{BSW_T * CTL_A}{BSW_T * CTL_A + (1 - BSW_T) * CTL_o}$$

BSW Calculation – Lab analysis

If the CALC_BSW parameter is set to "Lab analysis", the value of the FLOWING_SW_OUT output will be calculated using only the laboratory analysis results. This assumes the stability/regularity of the oil base density and BSW (changes occurred from the temperature changes and the difference of the water thermal expansion and oil thermal expansion coefficients).

This equation is calculated as indicated in the API-201 standard. – Allocation measurement, located in the B Appendix

Block Inputs

The input is :

Input	Link Necessity	Description
TEMPERATURE_METER	mandatory	Liquid flow temperature.

Block Outpus

Outputs	Description
FLOWING_SW_OUT	Value calculated for the BSW parameter in flow condition.
CTL_WATER	Temperature correction factor for water.
BASE SW	BSW calculated for base temperature condition

BSW – LAB_DENS_OIL, LAB_DENS_WATER and XWS Calculations

The BSW is calculated using the laboratory analysis results: dry oil density, water density and BSW in laboratory analysis temperature. These calculations assume constant features (base density) for oil and water made.

FLOWING_SW_OUT Calculation:

The equation below must be calculated:

$$X_{w,m} = \frac{X_{w,lab} * (CTL_{w,lab} / CTL_{w,m})}{X_{w,lab} * (CTL_{w,lab} / CTL_{w,m}) + (1 - X_{w,lab}) * (CTL_{o,lab} / (CTL_{o,m} * SF))}$$

Where :
$X_{w,m}$: BSW in flow condition
$X_{w,lab}$: BSW in laboratory analysis condition
$CTL_{w,lab}$: Temperature correction factor for water, from the temperature of the laboratory analysis to to a 15 ºCelsius temperature (LD_UNITS= Kg/m^3); or to a 60 Fahrenheit temperature (LD_UNITS=API/SG).
$CTL_{w,m}$: Temperature correction factor for water, from the flow temperature to a 15 ºCelsius temperature (LD_UNITS= Kg/m^3), or to a 60 Fahrenheit temperature (LD_UNITS=API/SG).
$CTL_{o,lab}$: Temperature correction factor for oil, from the temperature of laboratory analysis to a 15 ºCelsius temperature (LD_UNITS= Kg/m^3), or to a 60 Fahrenheit temperature (LD_UNITS=API/SG).

$CTL_{o,m}$: Temperature correction factor for oil, from the flow temperature to a15 ºCelsius temperature (LD_UNITS= Kg/m^3), or to a 60 Fahrenheit temperature (LD_UNITS=API/SG).
SF : oil shrinkage temperature

Diagnosing and Correcting Problems

1. BLOCK_ERR. Block configuration: The Temperature or Density Inputs are not connected.
2. BLOCK_ERR. Out of Service: LCF block can continue in Out of service mode, although the target mode is Auto, because the Resource block is in O/S.

Special Indications for BATCH_STATUS
"Abnormal Conditions" – Problems in the BSW calculation.
The input values for SW are out of range 0-100 % (caso CALC_BSW ="**Dual Range").**

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store./ Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	If this parameter is configured with a string other than blank spaces, then this parameter will replace the block tag in the QTR report.
3 (A2)	4	STRATEGY	Unsigned16	0 to 4	0	None	S	This parameter identifies the number of the measured flow.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1)	**1,3**	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode parameter.**
6	**1,3**	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7 (A2)	I,1,3	TEMPERATURE_METER	DS-65			T_UNITS	N / RO	Temperature used to calculate the correction factor for the thermal expansion of a liquid.
8 (A2)	I,1,3	PRESSURE_METER	DS-65			P_UNITS	N / RO	Manometric pressure used to calculate the correction factor for the liquid compressibility.
9 (A2)	I,1,3	DENSITY_METER	DS-65			LD_UNITS	N / RO	Density used to calculate the factors CPLm and CTLm.
10 (A2)	I,1,3	SW_METER	DS-65			%	N / RO	Percentage of sand and water mixed in the oil.
11	O,1,3	BASE_DENS	DS-65			LD_UNITS	N / RO	Base density of the dry oil. This parameter is calculated.
12	**O,1,3**	**CTL_OIL**	**DS-65**				**N / RO**	**Temperature Corrention Factor.**
13	**O,1,3**	**CPL_OIL**	**DS-65**				**N / RO**	**Pressure Correction Factor.**
14	**O,1,3**	**CCF_OUT**	**DS-65**				**N / RO**	**Combined Correction Factor.**
15	O,1,3	FLOWING_SW_OUT	DS-65			%	N / RO	Percentage calculated of sand and water mixed in the oil.
16	O,1,3	CTL_WATER	DS-65				N / RO	Temperature Correction Factor.
17	O,1,3	BASE_SW	DS-65			%	N / RO	Percentage of sand and water mixed in the oil calculated in base conditions.
18 (A1)	**4**	**BASE_PRESSURE**	**Float**	**101.325 kPa or 14.696 psi**	**101.325 kPa**	**P_UNITS**	**S**	**Base pressure for the fluid according to the selected unit in the P_UNITS parameter.**
19 (A1)	**4**	**BASE_TEMPERATURE**	**Float**	**15.0 °C or 20.0 °C or 60.0 °F**	**15.0 °C**	**T_UNITS**	**S**	**Base temperature for the fluid according to the selected unit in the T_UNITS parameter.**

Idx	Type/ View	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store./ Mode	Description
20 (A1)	4	T_UNITS	Unsigned16	1000=Kelvin 1001=Celsius 1002=Fahrenheit 1003=Rankine	Celsius	E	S	Engineering Unit for temperature.
21 (A1)	4	P_UNITS	Unsigned16	1130=Pa 1132=Mpa 1133=kPa 1137=bar 1138=mbar 1139=torr 1140=atm 1141=psi 1144=g/cm^2 1145=kgf/cm^2 1147=inH2O 4°C 1148=inH2O 68 °F 1150=mmH2O 4°C 1151= mmH2O 68 °F 1154=ftH2O 68 °F	KPa	E	S	Engineering Unit for static pressure
22 (A1)	4	LD_UNITS	Unsigned16	1097= Kg/m^3 1113=API 1599 = relatve density/SG	Kg/m^3	E	S	Engineering Unit for liquid density. The selection of this unit indicates which table uses for the correction factor calculations (CTL and CPL).
23 (A2)	4	PRODUCT_TYPE	Unsigned8	0=Crude oil(Table suffix A) 1=Generalized products (Table suffix B) 2=MTBE (Table suffix C) 3=Lubricating oil (Table suffix D) 4=Water 5=Light hydrocarbon (NGL&LPG)	0	E	S	Product type.
24 (A2)	4	DENSITY_TYPE	Unsigned8	1=Density at base 2=Measured density	1	E	S	Density type.
25 (A2)	4	HYDROMETER_CORRECTION	Unsigned8	0=No correction 1=Correction is done	0	E	S	Hydrometer correction.
26 (A2)	4	COEF_OF_THERMAL_EXP	Float	>= 0.0	0.0		S	If the selected product is MTBE, the thermal expansion coefficient is in base temperature. If the selected product is Light hydrocarbon, the absolute equilibrium pressure is at 100 °F.
27 (A2)	**2**	**MF**	**Float**	**0.8 to 1.2**	**1.0**	**Na**	**S**	**MF used for the combined correction factor (CCF).**
28 (A2)	4	CALC_BSW	Unsigned8	0=None 1=Dual range 2=Lab analysis	0	Na	S	It selects one of the ways of calculating the BSW.

Idx	Type/ View	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store./ Mode	Description
29 (A2)	2	LO_SW	Float	0.0 to 100.0 0.0 = Always calculated 100.0 = Never calculated	0.0	%	S	Lower limit to calculate the BSW, if the "Dual range" option is selected in CALC_BSW.
30(A2)	2	LAB_TEMP	Float		15	T_UNITS	S	Temperature which the laboratory analysis is accomplished to obtain the XWS.
31 (A2)	2	LAB_DENS_WATER	Float	>= 0.0	1000	LD_UNITS	S	Water density in laboratory analysis condition (LAB_TEMP).
32 (A2)	2	LAB_DENS_OIL	Float	>= 0.0	900	LD_UNITS	S	Oil density in laboratory analysis condition (LAB_TEMP).
33 (A2)	2	LAB_SW	Float	0 to 100	0	%	S	BSW value obtained in laboratory analysis condition (LAB_TEMP).
34 (A2)	2	SF	Float	1=disabled 0< SF <= 1	1	Na	S	Shrinkage factor obtained in laboratory analysis.
35	**3**	**F**	**Float**			**1/P_UNITS**	**N / RO**	**Compressibility factor**
36	3	STATUS_CURRENT	Bitstring[2]	See Block Options	0	Na	N/ RO	Current status. Similar to BATCH_STATUS.
37		PE_TF	Float			P_UNITS	N / RO	Equilibrium pressure in flow conditions.
38		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
39		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware and connection failure, or system problems in the block. The cause of the alert is indicated in the subcode field. The first active alert will set the Active status in the Status attribute. When the Unreported status is removed by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has been changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile; S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction at Administration; R1 – Restriction Level 1; R – Restriction Level 2

Gray Background Line: Default Parameters in Syscon

Modbus Function Blocks

MBCF – ModBus Configuration

Overview
This block allows configuration of several communication parameters of the Modbus protocol.

Description
This block allows setting parameters of the communication between DFI302 and Modbus slave devices through Ethernet and serial (EIA232). User defines rate of transference of data of the serial ports, parity, timeout and number of retransmissions.

NOTE
Every time a MODBUS parameter is changed it is necessary to set the ON_APPLY parameter of the MBCF block to "Apply". Otherwise these alterations will not be effective.

User must set ONLY one MBCF block for each device.

MODBUS Addresses
User must attribute a Modbus address to the DFI302. However this address cannot be the same of any other device in the Modbus network to whom it is connected in the serial and Ethernet mean. In this case user must set the parameter DEVICE_ADDRESS. The default value of this parameter is 247.

In applications where the DFI302 acts as master TCP/IP user will have also to inform the IP address of the devices in the parameter SLAVE_ADRESSES.

Parameters MASTER_SLAVE and MEDIA
These parameters set the DFI302 behavior and media where the communication is done. In the MASTER_SLAVE parameter is defined if the DFI302 will work as a slave or master MODBUS device. MEDIA may be serial or TCP/IP. It is necessary that DEVICE_ADDRESS is unique within the MODBUS network.

Rate of transference of the serial ports
It is possible to select the baud rate of data in the serial ports. They may be set through the parameter BAUD_RATE. It allows the selection among the following baud rates:

- 0:100 bps
- 1:300 bps
- 2:600 bps
- 3:1200 bps
- 4:2400 bps
- 5:4800 bps
- 6:9600 bps (default)
- 7:19200 bps
- 8:38400 bps
- 9:57600 bps
- 10:115200 bps

Parity
Parameter PARITY defines the type o parity to the serial ports.
- 0: No parity
- 1: Even Parity
- 2: Odd parity

Timeout, number of retransmissions
Timeout is the time waited for answer from a slave after a message having been sent to the serial port or Ethernet. The default value is 1000 ms, this parameter is directly connected with the parameter NUMBER_RETRANSMISSIONS.

Number of retransmissions is the number of times the DFI302 will retry to establish communication with the slave device after not getting a reply. The time waited for this answer is set by the TIME_OUT parameter. The number of retransmissions is chosen through the NUMBER OF RETRANSMISSIONS parameter. User may select a value in the range 0 to 255 to this parameter. The default value is 1.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	**ST_REV**	**Unsigned16**		**0**	**None**	**S/RO**	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**MEDIA**	**Unsigned8**	**0:Serial, 1:TCP/IP**	**Serial**	**E**	**S**	**Define the type of Modbus channel.**
8	**MASTER_SLAVE**	**Unsigned8**	**0:Master, 1:Slave**	**Slave**	**E**	**S**	**Define if DFI is master or slave.**
9	**DEVICE_ADDRESS**	**Unsigned8**	**0-247**	**1**	**E**	**S**	**Define the DFI Modbus address (only for DFI slave).**
10	**BAUD_RATE**	**Unsigned8**	**0:110, 1:300, 2:600, 3:1200, 4:2400, 5:4800, 6:9600, 7:19200, 8:38400, 9:57600, 10:115200**	**19200**	**E**	**S**	**Define the baud rate (only for media serial).**
11	**STOP_BITS**	**Unsigned8**	**0:1, 1:2**	**1**	**E**	**S**	**Define the number of stop bits (only for media serial).**
12	**PARITY**	**Unsigned8**	**0:None, 1:Even, 2:Odd.**	**Even**	**E**	**S**	**Define the parity (only for media serial).**
13	**TIMEOUT**	**Unsigned16**	**0-65535**	**1000**	**ms**	**S**	**Time value to wait a response from a slave (for DFI master), or time to wait the OUTs are updated (for DFI slave).**
14	NUMBER_RETRANSMISSIONS	Unsigned8	0-255	1		S	Number of retransmission if DFI doesn't receive response from slave.
15	SLAVE_ADDRESSES	DS-263				S	IP number and Modbus addresses of slaves (only for DFI master in TCP/IP media);
16	RESTART_MODBUS	Boolean		FALSE		S	Not used.
17	TIME_TO_RESTART	Unsigned16	1-65535	1	ms	S	When the device is working as master, it is the time between the periodic scan that commands.
18	RTS_CTS	Boolean		FALSE		S	Enable or not handshaking.
19	**ON_APPLY**	**Unsigned8**	**0:None, 1: Apply**	**None**	**E**	**S**	**Apply the changes made in the Modbus blocks.**
20	CHECK_COMM_STANDBY	Unsigned8	0 ~ 255	0	NA	S / RW	It configures for the Standby if it will test the Modbus communication with the slave devices. 0: Disable test. 1 – 255: Enable test defining the time interval between each test (s).

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

MBCS – ModBus Control Slave

Overview

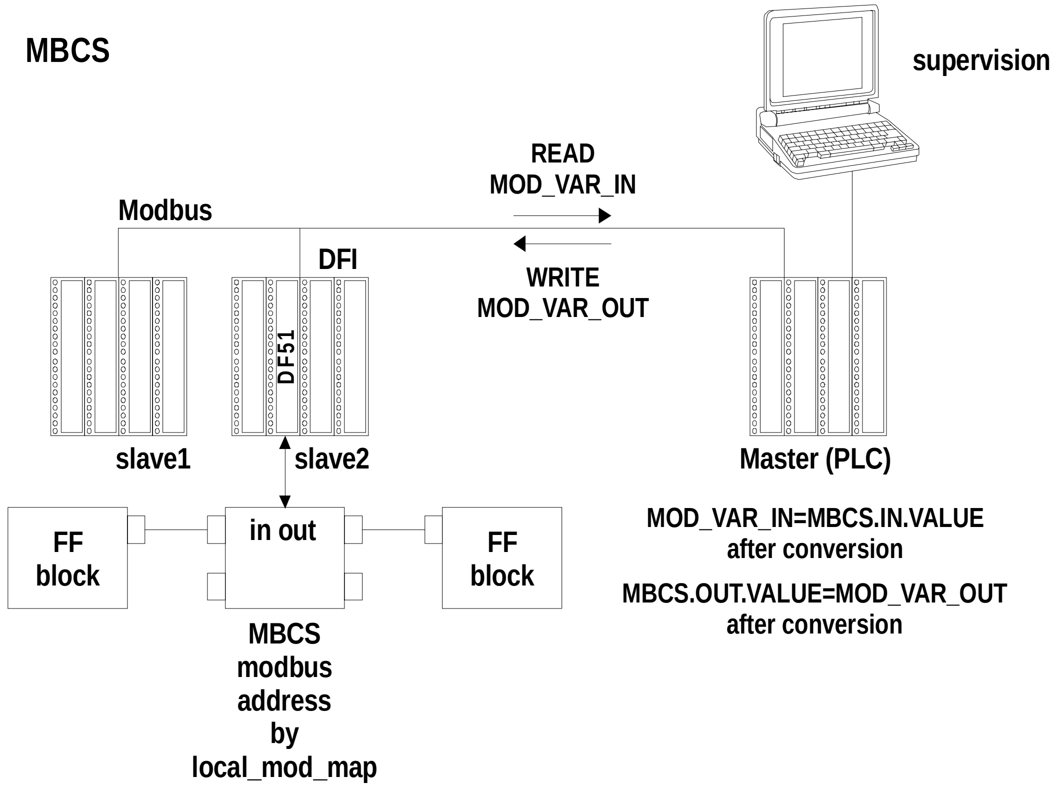


Figure 2.48 - ModBus Control Slave

Description

MBCS block generates a communication strategy between a MODBUS master and a FIELDBUS FOUNDATION slave. In the present case, the slave is the Smar's linking device DFI302 that has slave behavior for the MODBUS network. It allows MODBUS variables to be associated with FIELDBUS variables and data between these two "worlds" to be exchanged through DFI302.

Note
Every time a MODBUS parameter is changed it is necessary to set the ON_APPLY parameter of the MBCF block to "Apply". Otherwise these alterations will not be effective.

Inputs and Outputs

This block has 4 digital inputs, 4 analog inputs, 4 digital outputs and 4 analog outputs that may be connected to other FIELDBUS function blocks or to the MODBUS world.

- IN1, IN2, IN3 and IN4 are analog inputs.
- IN_D1, IN_D2, IN_D3 and IN_D4 are digital inputs.
- OUT1, OUT2, OUT3 and OUT4 are analog outputs.
- OUT_D1, OUT_D2, OUT_D3 and OUT_D4 are digital outputs.

Digital outputs and Digital inputs are of the DS-66 data type. Thus they contain both a Status and a value (both Unsigned 8). The analog outputs and inputs are of the DS-65 data type, containing status and value as well. Type of values is Float. For more details (see on Chapter 1, "Data Type and Data Structure Definition")

Parameter LOCAL_MOD_MAP

This parameter defines the address range of the MODBUS addresses attributed to the input and output FIELDBUS variables of the MBCS block. In order to set this parameter properly user needs first to check the tables below:

LOCAL_MOD_MAP (MBCS)		
PARAMETER	LOCAL_MOD_MAP = x OFFSET = 40 * x x = 0 ~ 15	e.g. LOCAL_MOD_MAP =1
IN1-Value	40001+ OFFSET 40002+ OFFSET	40041 40042
IN2-Value	40003+ OFFSET 40004+ OFFSET	40043 40044
IN3-Value	40005+ OFFSET 40006+ OFFSET	40045 40046
IN4-Value	40007+ OFFSET 40008+ OFFSET	40047 40048
OUT1-Value	40009+ OFFSET 40010+ OFFSET	40049 40050
OUT2-Value	40011+ OFFSET 40012+ OFFSET	40051 40052
OUT3-Value	40013+ OFFSET 40014+ OFFSET	40053 40054
OUT4-Value	40015+ OFFSET 40016+ OFFSET	40055 40056
IN1-Status	40017+ OFFSET	40057
IN2-Status	40018+ OFFSET	40058
IN3-Status	40019+ OFFSET	40059
IN4-Status	40020+ OFFSET	40060
OUT1-Status	40021+ OFFSET	40061
OUT2-Status	40022+ OFFSET	40062
OUT3-Status	40023+ OFFSET	40063
OUT4-Status	40024+ OFFSET	40064
IN_D1-Status	40025+ OFFSET	40065
IN_D2-Status	40026+ OFFSET	40066
IN_D3-Status	40027+ OFFSET	40067
IN_D4-Status	40028+ OFFSET	40068
OUT_D1-Status	40029+ OFFSET	40069
OUT_D2-Status	40030+ OFFSET	40070
OUT_D3-Status	40031+ OFFSET	40071
OUT_D4-Status	40032+ OFFSET	40072
IN_D1-Value	1+ OFFSET	41
IN_D2-Value	2+ OFFSET	42
IN_D2-Value	3+ OFFSET	43
IN_D2-Value	4+ OFFSET	44
OUT_D1-Value	5+ OFFSET	45
OUT_D2-Value	6+ OFFSET	46
OUT_D3-Value	7+ OFFSET	47
OUT_D4-Value	8+ OFFSET	48

Note in the table that:

LOCAL_MOD_MAP= X
OFFSET = 40*X

The second column of the table above shows the values that are attributed to the Inputs and Outputs of the MBCS block according to the value set for LOCAL_MOD_MAP. For example, if LOCAL_MOD_MAP is set equal to 1 it will result in the MODBUS range of addresses showed in the third column. It must be clear that when this parameter is set, a whole range is selected, not a specific address.

INn and OUTn values use two MODBUS registers (for example IN1, 40041 and 40042) because their data type is float. IN_Dn and OUT_Dn values use one MODBUS register (for example IN_D1, 41). Status values also use only one register.

Once this MODBUS range is defined, it is possible to set how the MODBUS master will read them.

This block allows Modbus Scale Conversion, to do the conversion procedure see the item "Modbus Scale Conversion" in the Chapter 1 for more details.

Output Status
Output Status can be set in two ways: set by Master Modbus (default), or by user. If the option is set the status by master, Modbus Master should write in the OUT_X.Status parameter. If the status is set by user, master only sends the value (Example: For OUT_1.Status, LOCAL_MOD_MAP equals to 0, the address will be 40021).

If the outputs (OUT) are not updated by Modbus Master during the time interval set in TIMEOUT parameter (TIMEOUT parameter in the MBCF block), a "bad status" will be generated (Bad:NoComm_withusablevalue).

Schematic

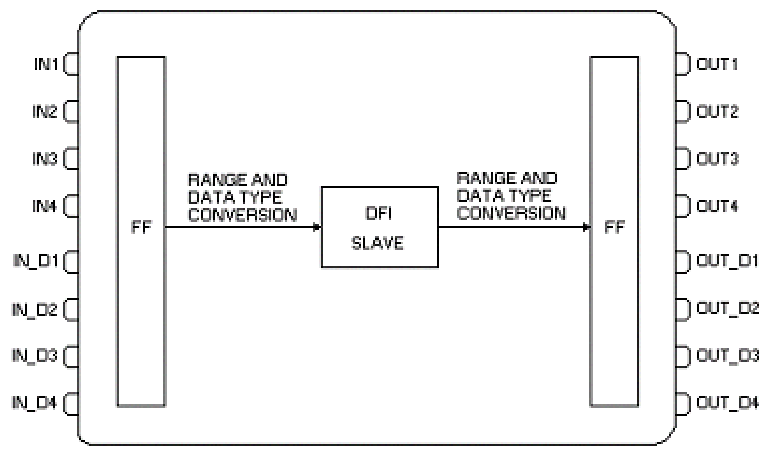


Figure 2.49 - ModBus Control Slave Schematic

BLOCK_ERR
The BLOCK_ERR of the MBCS block will reflect the following causes:

- Other: it occurs when the conversion from Y to DATA_TYPE_IN results in a value out of range of this data type.
- Out of Service: it occurs when the block is in O/S mode.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter.**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**LOCAL_MOD_MAP**	**Unsigned8**	**0 to 15**	**0**		**S / O/S**	**Define the Modbus addresses.**
8	IN1	DS-65				N	Analog input 1
9	SCALE_CONV_IN1	DS-256				S / O/S	Information to generate constants A and B in equation Y=A*X+B.
10	IN2	DS-65				N	Analog input 2

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
11	SCALE_CONV_IN2	DS-256				S / O/S	Information to generate constants A and B in equation Y=A*X+B.
12	IN3	DS-65				N	Analog input 3
13	SCALE_CONV_IN3	DS-256				S / O/S	Information to generate constants A and B in equation Y=A*X+B.
14	IN4	DS-65				N	Analog input 4
15	SCALE_CONV_IN4	DS-256				S / O/S	Information to generate constants A and B in equation Y=A*X+B.
16	IN_D1	DS-66				N	Discrete input 1
17	IN_D2	DS-66				N	Discrete input 2
18	IN_D3	DS-66				N	Discrete input 3
19	IN_D4	DS-66				N	Discrete input 4
20	OUT1	DS-65				N / Man	Analog output 1
21	SCALE_CONV_OUT1	DS-257				S / O/S	Information to generate constants A and B in equation Y=A*X+B plus output status.
22	OUT2	DS-65				N / Man	Analog output 2
23	SCALE_CONV_OUT2	DS-257				S / O/S	Information to generate constants A and B in equation Y=A*X+B plus output status.
24	OUT3	DS-65				N / Man	Analog output 3
25	SCALE_CONV_OUT3	DS-257				S / O/S	Information to generate constants A and B in equation Y=A*X+B plus output status.
26	OUT4	DS-65				N / Man	Analog output 4
27	SCALE_CONV_OUT4	DS-257				S / O/S	Information to generate constants A and B in equation Y=A*X+B plus output status.
28	OUT_D1	DS-66				N / Man	Discrete output 1
29	STATUS_OUT_D1	Unsigned8				S / O/S	Status to OUT_D1 if master will not update.
30	OUT_D2	DS-66				N / Man	Discrete output 2
31	STATUS_OUT_D2	Unsigned8				S / O/S	Status to OUT_D2 if master will not update.
32	OUT_D3	DS-66				N / Man	Discrete output 3
33	STATUS_OUT_D3	Unsigned8				S / O/S	Status to OUT_D3 if master will not update.
34	OUT_D4	DS-66				N / Man	Discrete output 4
35	STATUS_OUT_D4	Unsigned8				S / O/S	Status to OUT_D4 if master will not update.
36	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
37	BLOCK_ALM	DS-72			Na	D	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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

MBSS – ModBus Supervision Slave

Overview

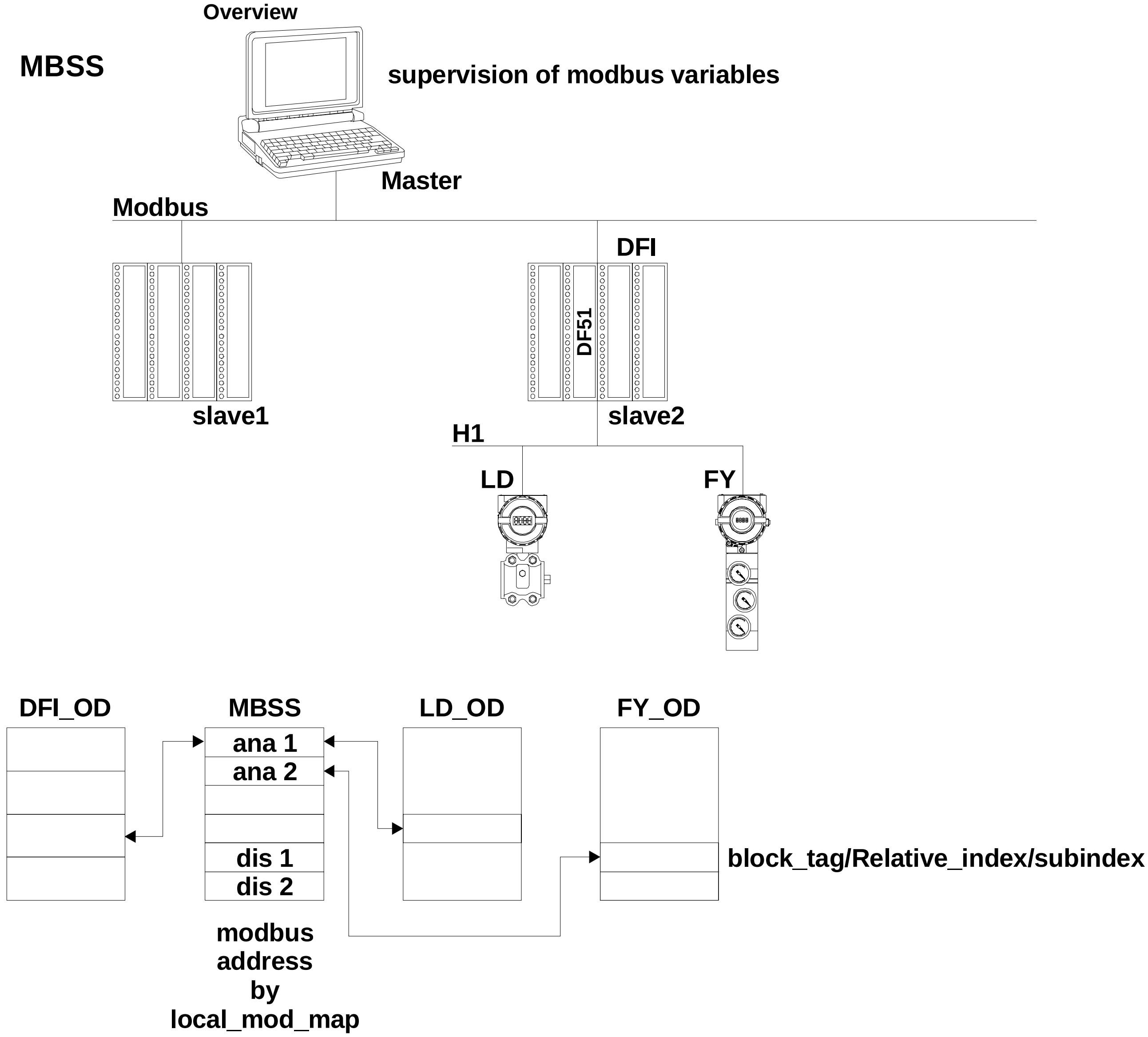


Figure 2.50 - ModBus Supervision Slave

Description

MBSS block generates a communication strategy between a MODBUS master and a FIELDBUS FOUNDATION slave. In the present case, the slave is the Smar’s linking device DFI302 that has slave behavior for the MODBUS network. The MBSS block allows that FIELDBUS variables are monitored. Unlike the MBCS block, the MBSS does not have inputs or outputs that may be connected. In another words, links to other function blocks cannot be made. It will allow only the MODBUS master to monitor specific variables set. For example, suppose there is a PID function block in a FIELDBUS control strategy and it is required to visualize this value in the MODBUS master. With the MBSS this value may be monitored.

Note
Every time a MODBUS parameter is changed it is necessary to set the ON_APPLY parameter of the MBCF block to “Apply”. Otherwise these alterations will not be effective.

I_IDn, F_IDn, B_IDn parameters

I_IDn are integer variables, F_IDn are float variables and D_IBn refers to Boolean variables.
These parameters are of the DS-262 data type, which has 3 elements, and their descriptions are in the Chapter 1 “Data Type and Structure Definitions”.

LOCAL_MOD_MAP parameter

This parameter will attribute MODBUS address to the variables you need to monitor. See table below:

LOCAL_MOD_MAP (MBSS)		
PARAMETER	LOCAL_MOD_MAP = x OFFSET = 40 * x x = 0 ~ 15	e.g. LOCAL_MOD_MAP =1
FVALUE1	42601+ OFFSET 42602+ OFFSET	42641 42642
FVALUE2	42603+ OFFSET 42604+ OFFSET	42643 42644
FVALUE3	42605+ OFFSET 42606+ OFFSET	42645 42646
FVALUE4	42607+ OFFSET 42608+ OFFSET	42647 42648
FVALUE5	42609+ OFFSET 42610+ OFFSET	42649 42650
FVALUE6	42611+ OFFSET 42612+ OFFSET	42651 42652
FVALUE7	42613+ OFFSET 42614+ OFFSET	42653 42654
FVALUE8	42615+ OFFSET 42616+ OFFSET	42655 42656
IVALUE1	42617+ OFFSET 42618+ OFFSET	42657 42658
IVALUE2	42619+ OFFSET 42620+ OFFSET	42659 42660
IVALUE3	42621+ OFFSET 42622+ OFFSET	42661 42662
IVALUE4	42623+ OFFSET 42624+ OFFSET	42663 42664
BVALUE1	2601+ OFFSET	2641
BVALUE2	2602+ OFFSET	2642
BVALUE3	2603+ OFFSET	2643
BVALUE4	2604+ OFFSET	2644
BAD_STATUS	42625+OFFSET	42665

LOCAL_MOD_MAP= X
OFFSET = 40*X

Once values for LOCAL_MOD_MAP are set, MODBUS ADDRESSES are given to the variables you wish to monitor. So, each integer, float or Boolean variable will have a MODBUS address associated.

For example, suppose LOCAL_MOD_MAP = 1 and a float value will be monitored. Picking the F_ID1 and setting its parameters, we have:

F_ID1.Tag = Tag of the float parameter necessary to monitor
F_ID1.Index= Index of the first column of the parameter necessary to monitor.
F_ID1.subindex = The sub index is used for parameters that have a structure. In this case it is necessary to indicate which element of the structure is being referred.

See the table above The MODBUS addresses given to this parameter (remember, float values use two MODBUS registers) are 42641 and 42642.

BAD_STATUS Parameter

This parameter indicates if the Fieldbus communication is OK or no. If the correspondent bit is in logic level 1 this means there was an error during writing/reading of the respective parameter. The table below presents the values for these status values.

Relation between the bits in BAD_STATUS and Modbus addresses

BIT	PARAMETER
0	FVALUE1
1	FVALUE2
2	FVALUE3
3	FVALUE4
4	FVALUE5
5	FVALUE6
6	FVALUE7
7	FVALUE8
8	IVALUE1
9	IVALUE2
10	IVALUE3
11	IVALUE4
12	BVALUE1
13	BVALUE2
14	BVALUE3
15	BVALUE4

BLOCK_ERR

The BLOCK_ERR of the MBSS block will reflect the following causes:

- Block Configuration Error: If it is requested a tag with a data type different from permitted or invalid or not found block tag;
- Out of Service: it occurs when the block is in O/S mode.

Remarks

BVALUEx parameters can address FF block parameters of the following data types: Boolean, integer8 and unsigned8. Those data types are automatically converted to bit (0 or 1) and vice versa for Modbus supervision and also converted to Boolean parameter (BVALUEx).

IVALUEx parameters can address FF block parameters of the following data types: Integer8, Integer16, Integer32, Unsigned8, Unsigned16 and Unsigned32.

Each analog parameter (IVALUEx) is mapping as two analog registers in Modbus, i.e., four bytes. Thus, when addressing a FF block parameter with one or two bytes, such parameter will be promoted to Unsigned32 or Integer32.

If Relative Index = 5 (MODE_BLK) e Sub Index = 0, it is performed a writing in Sub Index 1 and a reading in Sub Index 2.

Data Type and Supported Structures by MBSS

The Modbus supervision blocks (MBSS) used in the controllers configured as slave, have some restrictions about data types and structures that they support when supervising the block parameters tags. In such case, the next table shows the data types and structures which can be monitored by the MBSS block.

DATA TYPE *
Boolean
Float
Unsigned 8
Unsigned 16
Unsigned 32

STRUCTURE TYPES
DS-65
DS-66
DS-68
DS-69
DS-71

DATA TYPE *
Integer8
Integer16
Integer32

STRUCTURE TYPES
DS-72
DS-74
DS-159 (DC302)
DS-160 (DC302)

*For the DF51 controller the data types Swapped Float and Swapped Integer can be obtained by setting the RTS_CTS parameter to TRUE value in the MBSS block.

For further information about the blocks parameters and their data and structures types, as mentioned in the previous table, please see in this manual the DataType field of each table presented.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**LOCAL_MOD_MAP**	**Unsigned8**	**0 to 15**	**0**		**S / O/S**	**Define the ModBus addresses.**
8	F_ID1	DS-262				S / O/S	Information to locate float parameter.
9	**FVALUE1**	**Float**		**0**		**N**	**Value from requested float parameter.**
10	F_ID2	DS-262				S / O/S	Information to locate float parameter.
11	**FVALUE2**	**Float**		**0**		**N**	**Value from requested float parameter.**
12	F_ID3	DS-262				S / O/S	Information to locate float parameter.
13	**FVALUE3**	**Float**		**0**		**N**	**Value from requested float parameter.**
14	F_ID4	DS-262				S / O/S	Information to locate float parameter.
15	**FVALUE4**	**Float**		**0**		**N**	**Value from requested float parameter.**
16	F_ID5	DS-262				S / O/S	Information to locate float parameter.
17	FVALUE5	Float		0		N	Value from requested float parameter.
18	F_ID6	DS-262				S / O/S	Information to locate float parameter.
19	FVALUE6	Float		0		N	Value from requested float parameter.
20	F_ID7	DS-262				S / O/S	Information to locate float parameter.
21	FVALUE7	Float		0		N	Value from requested float parameter.
22	F_ID8	DS-262				S / O/S	Information to locate float parameter.
23	FVALUE8	Float		0		N	Value from requested float parameter.
24	I_ID1	DS-262				S / O/S	Information to locate integer parameter.
25	**IVALUE1**	**Integer32**		**0**		**N**	**Value from requested integer parameter.**
26	I_ID2	DS-262				S / O/S	Information to locate integer parameter.
27	**IVALUE2**	**Integer32**		**0**		**N**	**Value from requested integer parameter.**
38	I_ID3	DS-262				S / O/S	Information to locate integer parameter.
29	**IVALUE3**	**Integer32**		**0**		**N**	**Value from requested integer parameter.**
30	I_ID4	DS-262				S / O/S	Information to locate integer parameter.
31	**IVALUE4**	**Integer32**		**0**		**N**	**Value from requested integer parameter.**
32	B_ID1	DS-262				S / O/S	Information to locate boolean parameter.
33	**BVALUE1**	**Boolean**		**TRUE**		**N**	**Value from requested boolean parameter.**
34	B_ID2	DS-262				S / O/S	Information to locate boolean parameter.
35	**BVALUE2**	**Boolean**		**TRUE**		**N**	**Value from requested boolean parameter.**
36	B_ID3	DS-262				S / O/S	Information to locate boolean parameter.
37	**BVALUE3**	**Boolean**		**TRUE**		**N**	**Value from requested boolean parameter.**
38	B_ID4	DS-262				S / O/S	Information to locate boolean parameter.
39	**BVALUE4**	**Boolean**		**TRUE**		**N**	**Value from requested boolean parameter.**

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
40	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
41	BLOCK_ALM	DS-72			Na	D	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.
42	BAD_STATUS	BitString (2)				D/RO	This parameter indicates if the status of correspondent variable is bad or not.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

MBCM – ModBus Control Master

Overview

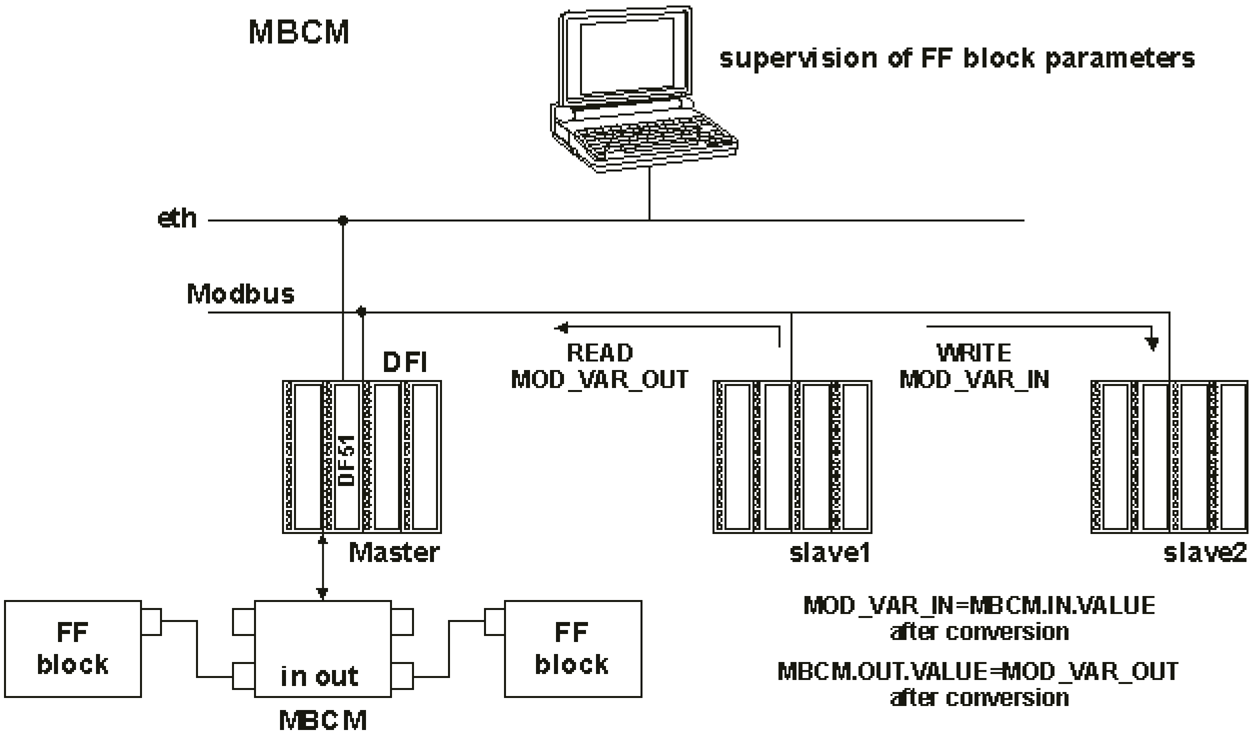


Figure 2.51 - ModBus Control Master

Description

This block allows control of communication in a strategy where the DFI302 is a MODBUS master and the slaves may exchange data between them and with the DFI302. With this block it is not only possible to read MODBUS variables, but also writing variables in the MODBUS world, exchange data and interact with the FIELDBUS FOUNDATION control strategy.

Note
Every time a MODBUS parameter is changed it is necessary to set the ON_APPLY parameter of the MBCF block to “Apply”. Otherwise these alterations will not be effective.

LOCAL_MOD_MAP parameter

All MBCM blocks added to the strategy must have different values for LOCAL_MOD_MAP. Otherwise the block will not work properly**.**

Inputs and Outputs

This block has 4 digital inputs and outputs and 4 analog inputs and outputs. These inputs and outputs may be connected to other FIELDBUS function blocks in order to be connected to MODBUS I/O modules or registers.

- INn: Analog input. DS-65 Data type. Value and Status. (See on Chapter 1, “Data Type and Data Structure Definition”). In this parameter user will visualize the value of the parameter set for this input and its status.
- IN_Dn: Digital input. DS-66 Data type. Value and Status. (See on Chapter 1, “Data Type and Data Structure Definition”). In this parameter user will visualize the value of the parameter set for this input and its status
- OUTn: Analog output. DS-65 Data type. Value and Status. (See on Chapter 1, “Data Type and Data Structure Definition”). In this parameter user will visualize the value of the parameter set for this output and its status.
- OUT_Dn: Digital output. DS-66 Data type. Value and Status. (see on Chapter 1, “Data Type and Data Structure Definition”).In this parameter user will visualize the value of the parameter set for this output and its status

SCALE_LOC_INn and SCALE_LOC_OUTn

These parameters are of the DS-259 data type. They both convert the value to Engineering Units and address the variable in the MODBUS network. The INn and OUTn inputs and outputs have SCALE_LOC_INn and SCALE_LOC_OUTn parameters associated. It is necessary to set these parameters so the monitoring and data exchanges are properly made.

Each one of these parameters consists of the following elements:

√ From Eu 100 %
√ From Eu 0 %
√ To Eu 100 %
√ To Eu 0 %
√ Data Type
√ Slave Address
√ Modbus Address of Value
√ Modbus Address of Status

This block allows Modbus Scale Conversion, to do the conversion procedure see the item “Modbus Scale Conversion” in the Chapter 1 for more details.

The Modbus status is related with the Modbus value. Thus, when the “MODBUS_ADDRESS_OF_STATUS” parameter was configured, it is necessary to configure also “MODBUS_ADDRESS_OF_VALUE”.

The treatment of inputs and outputs are described in the table below:

Input/Output	*Status Configured* (MODBUS_ADDRESS_OF_STATUS ≠ 0)	*Status Not Configured* (MODBUS_ADDRESS_OF_STATUS = 0)
Inputs (IN_n , IN_Dn)	The block sends to the ModBus slave device the status corresponding of its input.(The status has the FF standard format)	No status information is sent to the slave device.
Outputs (OUT_n, OUT_Dn)	The block reads from the slave device the corresponding status. (The block make the interpretation that the ModBus variable is the same format of FF Status)	- The block updates the status to “Good Non Cascade” when the communication with the ModBus slave device is ok. - The block update the status to “Bad No Communication with last value” when the communication with the ModBus slave device is not ok.

Float values use two MODBUS registers, but it is necessary only to inform the first one.

Setting the inputs and outputs of the MBCM block

To read a MODBUS variable, connect it to an output of the MBCM function block. To write in a MODBUS register connect it to an input of the MBCM block.

Generally MODBUS addresses are:

The standard of the Modbus protocol specifies the division of the address range to the variables.

- 0001 to 9999 => Digital Outputs
- 10001 to 19999 => Digital Inputs.
- 30001 to 39999 =>Analog Inputs.
- 40001 to 49999 => Analog Outputs

Once the variables required to be mapped are defined and referenced in the MBCM block it is now possible to set the strategy.

It is possible to connect the variables to other FIELDBUS function blocks (Connect the output or input of the block to blocks in the strategy), to write in MODBUS registers (Connect the Input of the MBCM block to a MODBUS register). Exchanging data between two slaves (set the input of the MBCM block with the slave address and specific MODBUS address where the value will be written and set the output of the MBCM block with the slave address and MODBUS address of the variable where the value will be read). This last application is showed below:

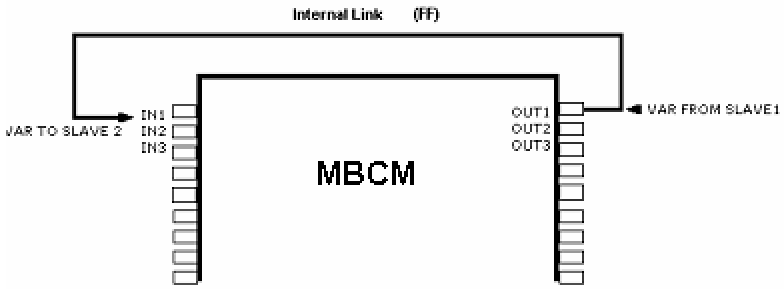


Figure 2.52 – MBCM Application

BAD_STATUS Parameter

This parameter indicates if the communication between slaves was established properly. If the correspondent bit is in logic level 1 this means there was an error during writing/reading of the respective parameter. The table below presents the values for these status values.

Relation between the bits in BAD_STATUS and Modbus addresses

BIT	PARAMETER
0	IN1
1	IN2
2	IN3
3	IN4
4	IN_D1
5	IN_D2
6	IN_D3
7	IN_D4
8	OUT1
9	OUT2
10	OUT3
11	OUT4
12	OUT_D1
13	OUT_D2
14	OUT_D3
15	OUT_D4

Remarks

Each bit corresponds to an OR between the value and status, indicating if communication with slave is good or bad.

- If it is only used the value, the status is considered zero.
- If it is only used the status, the value is considered zero.

Schematic

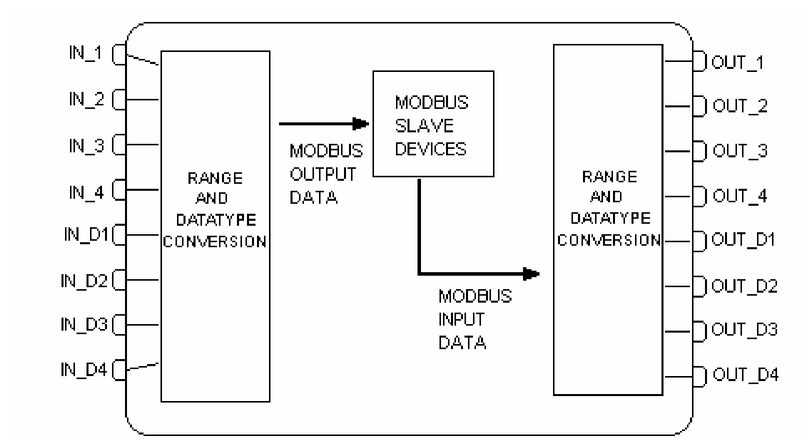


Figure 2.53 - ModBus Control Master Schematic

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**LOCAL_MOD_MAP**	**Unsigned8**	**0 to 15**	**0**		**S / O/S**	**Define the Modbus addresses.**
8	**BAD_STATUS**	**Bitstring(2)**		**0**	**E**	**D / RO**	**Indicate if communication from slave is good or not (each bit corresponds to a Modbus variable).**
9	**IN1**	**DS-65**				**N**	**Analog input 1**
10	**SCALE_LOC_IN1**	DS-259				S / M	Information to generate constants A and B in equation Y=A*X+B plus the addresses in a slave device.
11	**IN2**	**DS-65**				**N**	**Analog input 2**
12	**SCALE_ LOC_IN2**	DS-259				S / M	Information to generate constants A and B in equation Y=A*X+B plus the addresses in a slave device.
13	**IN3**	**DS-65**				**N**	**Analog input 3**
14	**SCALE_ LOC_IN3**	DS-259				S / M	Information to generate constants A and B in equation Y=A*X+B plus the addresses in a slave device.
15	**IN4**	**DS-65**				**N**	**Analog input 4**
16	SCALE_ LOC_IN4	DS-259				S / M	Information to generate constants A and B in equation Y=A*X+B plus the addresses in a slave device.
17	**IN_D1**	**DS-66**				**N**	**Discrete input 1**
18	**LOCATOR_IN_D1**	DS-261				S / O/S	Addresses in a slave device.
19	**IN_D2**	**DS-66**				**N**	**Discrete input 2**
20	**LOCATOR_IN_D2**	DS-261				S / O/S	Addresses in a slave device.
21	**IN_D3**	**DS-66**				**N**	**Discrete input 3**
22	LOCATOR_IN_D3	DS-261				S / O/S	Addresses in a slave device.
23	**IN_D4**	**DS-66**				**N**	**Discrete input 4**
24	LOCATOR_IN_D4	DS-261				S / O/S	Addresses in a slave device.
25	**OUT1**	**DS-65**				**N / Man**	**Analog output 1**
26	SCALE_ LOC_OUT1	DS-259				S / M	Information to generate constants A and B in equation Y=A*X+B plus the addresses in a slave device.
27	**OUT2**	**DS-65**				**N / Man**	**Analog output 2**
28	SCALE_ LOC_OUT2	DS-259				S / M	Information to generate constants A and B em equation Y=A*X+B plus the addresses in a slave device.
29	**OUT3**	**DS-65**				**N / Man**	**Analog output 3**
30	SCALE_ LOC_OUT3	DS-259				S / M	Information to generate constants A and B in equation Y=A*X+B plus the addresses in a slave device.
31	**OUT4**	**DS-65**				**N / Man**	**Analog output 4**
32	SCALE_ LOC_OUT4	DS-259				S / M	Information to generate constants A and B in equation Y=A*X+B plus the addresses in a slave device.
33	**OUT_D1**	**DS-66**				**N / Man**	**Discrete output 1**

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
34	LOCATOR_OUT_D1	DS-261				S / O/S	Addresses in a slave device.
35	**OUT_D2**	**DS-66**				**N / Man**	**Discrete output 2**
36	LOCATOR_OUT_D2	DS-261				S / O/S	Addresses in a slave device.
37	**OUT_D3**	**DS-66**				**N / Man**	**Discrete output 3**
38	LOCATOR_OUT_D3	DS-261				S / O/S	Addresses in a slave device.
39	**OUT_D4**	**DS-66**				**N / Man**	**Discrete output 4**
40	LOCATOR_OUT_D4	DS-261				S / O/S	Addresses in a slave device.
41	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
42	BLOCK_ALM	DS-72			Na	D	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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

MBSM – ModBus Supervision Master

Overview

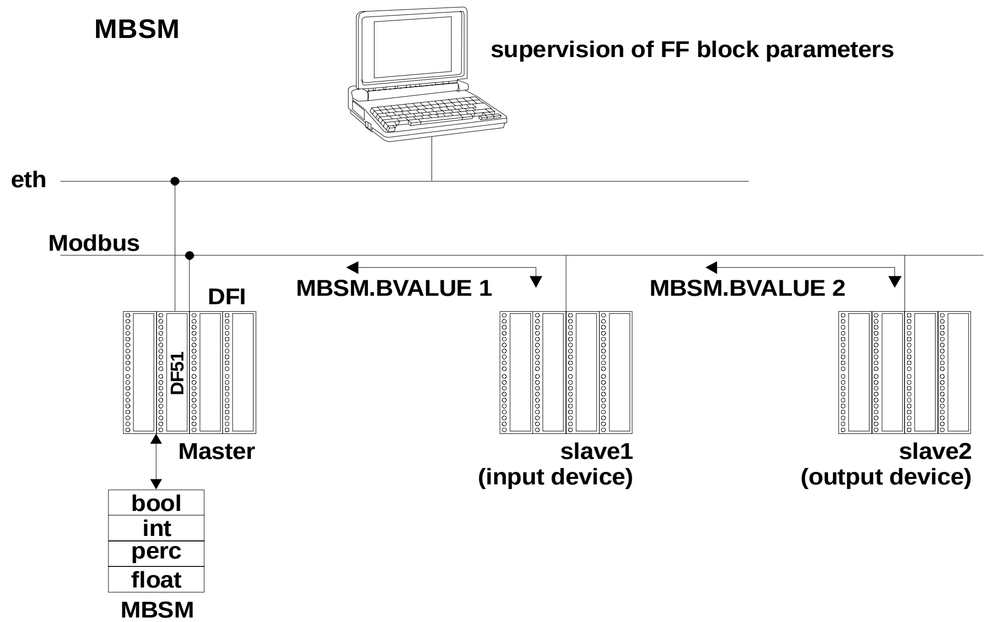


Figure 2.54 - ModBus Supervision Master

Description

This block enables the DFI302 to monitor MODBUS variables. The DFI302 is the master the slaves contain the MODBUS variables desired to be read. Unlike the MBCM this block does not have inputs and outputs that may be connected.

Note
Every time a MODBUS parameter is changed it is necessary to set the ON_APPLY parameter of the MBCF block to "Apply". Otherwise these alterations will not be effective.

LOCAL_MOD_MAP

All MBCM blocks you add to your strategy must have different values for LOCAL_MOD_MAP. Otherwise the block will not work properly.

Parameters FVALUEn, PVALUEn, IVALUEn and BVALUEn

User may select these parameters according to his needs. If the variable required to be monitored is a float it is necessary to use a FVALUE parameter. If it is a percentage, the PVALUEn will work. IVALUE refers to Integer values and BVALUE refers to Boolean values.

To each of these parameters are associated parameters to address them in the MODBUS network so that the MBSM block knows their location.

Parameter FLOCATORn

It refers to the FVALUEn parameter.
This parameter is of the data type DS-260, so it is required to set two elements for this parameter (see on Chapter 1, "Data Type and Data Structure Definition"):

The FVALUEn parameters will display the values of the variables set in FLOCATORn.
Float values use two MODBUS registers, but it is necessary only to inform the first one.

MODBUS Addresses

- 0001 to 9999 => Digital Outputs
- 10001 to 19999 => Digital Inputs.
- 30001 to 39999 =>Analog Inputs.
- 40001 to 49999 => Analog Outputs

Parameter PLOCATORn

It refers to the PVALUEn parameter.

These parameters are of the DS-258 data type. Each of these parameters consists of the following elements:
- From Eu 100 %
- From Eu 0 %
- To Eu 100 %
- To Eu 0 %
- Data Type:
- Slave Address:
- MODBUS Address of Value:

This block allows Modbus Scale Conversion, to do the conversion procedure see the item “Modbus Scale Conversion” in the Chapter 1 for more details.

Parameter ILOCATORn

It refers to the IVALUEn parameter. (See on Chapter 1, “Data Type and Data Structure Definition”):

- Slave Address:
- Modbus Address OF Value:

The IVALUEn parameters will display the values of the variables set in ILOCATORn.

Parameter BLOCATORn

It refers to the BVALUEn parameter. This parameter is of the data type DS-260, so you will have to set two elements for this parameter (see on Chapter 1, “Data Type and Data Structure Definition”):

- Slave Address:
- Modbus Address OF Value:

The BVALUEn parameters will display the values of the variables set in BLOCATORn.

BAD_STATUS Parameter

This parameter indicates if the communication between slaves was established properly. If the correspondent bit is in logic level 1 this means there was an error during writing/reading of the respective parameter. The table below presents the values for these status values.

Relation between the bits in BAD_STATUS and Modbus addresses

Bit	Mnemonic	Parameter
0	B1	BVALUE1
1	B2	BVALUE2
2	B3	BVALUE3
3	B4	BVALUE4
4	B5	BVALUE5
5	B6	BVALUE6
6	B7	BVALUE7
7	B8	BVALUE8
8	I1	IVALUE1
9	I2	IVALUE2
10	P1	PVALUE1
11	P2	PVALUE2
12	F1	FVALUE1
13	F2	FVALUE2

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**LOCAL_MOD_MAP**	**Unsigned8**	**0 to 15**	**0**		**S / O/S**	**Define the Modbus addresses.**
8	**BAD_STATUS**	**Bitstring(2)**		**0**	**E**	**D / RO**	**Indicate if communication from slave is good or not (each bit corresponds to a Modbus variable).**
9	FLOCATOR1	DS-260				S / O/S	Information to locate float parameter
10	**FVALUE1**	**Float**		**0**		**N**	**Value from requested address.**
11	FLOCATOR2	DS-260				S / O/S	Information to locate float parameter
12	**FVALUE2**	**Float**		**0**		**N**	**Value from requested address.**
13	PLOCATOR1	DS-258				S / O/S	Information to locate percentage parameter
14	**PVALUE1**	**Float**		**0**		**N**	**Value from requested address.**
15	PLOCATOR2	DS-258				S / O/S	Information to locate percentage parameter
16	**PVALUE2**	**Float**		**0**		**N**	**Value from requested address.**
17	ILOCATOR1	DS-260				S / O/S	Information to locate integer parameter
18	ILENGTH1	Integer8	1,2,4	2		S / O/S	Data length.
19	**IVALUE1**	**Interge32**		**0**		**N**	**Value from requested address.**
20	ILOCATOR2	DS-260				S / O/S	Information to locate integer parameter
21	ILENGTH2	Integer8	1,2,4	2		S / O/S	Data length.
22	**IVALUE2**	**Interge32**		**0**		**N**	**Value from requested address.**
23	BLOCATOR1	DS-260				S / O/S	Information to locate boolean parameter
24	**BVALUE1**	**Boolean**		**TRUE**		**N**	**Value from requested addresses.**
25	BLOCATOR2	DS-260				S / O/S	Information to locate boolean parameter
26	**BVALUE2**	**Boolean**		**TRUE**		**N**	**Value from requested addresses.**
27	BLOCATOR3	DS-260				S / O/S	Information to locate boolean parameter
28	**BVALUE3**	**Boolean**		**TRUE**		**N**	**Value from requested addresses.**
29	BLOCATOR4	DS-260				S / O/S	Information to locate boolean parameter
30	**BVALUE4**	**Boolean**		**TRUE**		**N**	**Value from requested addresses.**
31	BLOCATOR5	DS-260				S / O/S	Information to locate boolean parameter
32	**BVALUE5**	**Boolean**		**TRUE**		**N**	**Value from requested addresses.**
33	BLOCATOR6	DS-260				S / O/S	Information to locate boolean parameter
34	**BVALUE6**	**Boolean**		**TRUE**		**N**	**Value from requested addresses.**
35	BLOCATOR7	DS-260				S / O/S	Information to locate boolean parameter
36	**BVALUE7**	**Boolean**		**TRUE**		**N**	**Value from requested addresses.**
37	BLOCATOR8	DS-260				S / O/S	Information to locate boolean parameter
38	**BVALUE8**	**Boolean**		**TRUE**		**N**	**Value from requested addresses.**
39	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
40	BLOCK_ALM	DS-72			Na	D	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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

Output Function Blocks

AO - Analog Output

Overview
The Analog Output Block is a function block used by devices that work as output elements in a control loop, like valves, actuators, positioners, etc. The AO block receives a signal from another function block and passes its results to an output transducer block through an internal channel reference.

Schematic

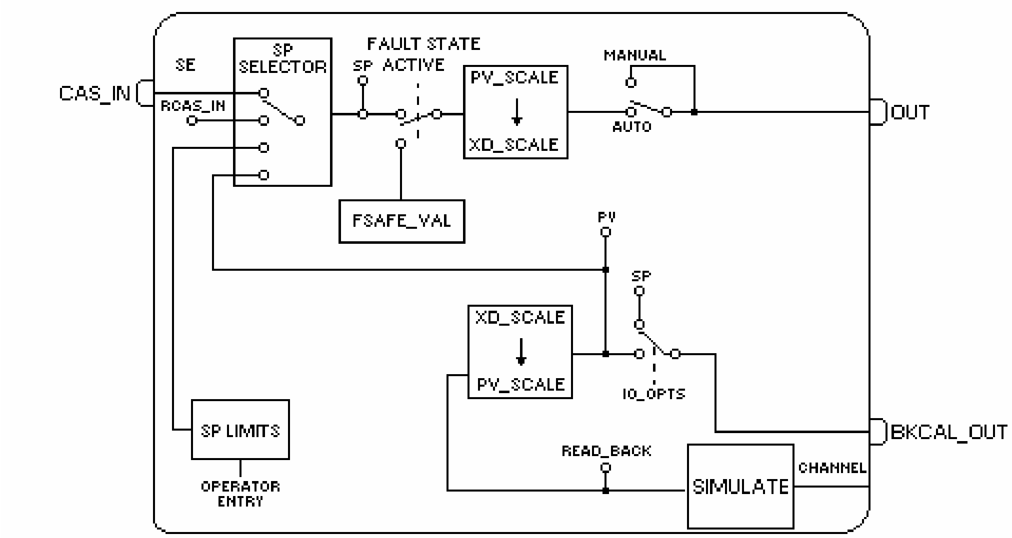


Figure 2.55 - Analog Output Schematic

Description
The AO block is connected to the transducer block through the CHANNEL parameter that must match with the following parameter in the transducer block:
TERMINAL_NUMBER parameter for the FI302

The CHANNEL parameter must be set to 1 (one) if the AO block is running in the FY302 or FP302, and no configuration is necessary in the transducer block to connect it to the AO block.

Treatment of Input Values
The SP value may be controlled automatically through a cascade or remote cascade control or manually by an operator. The PV_SCALE and XD_SCALE are used to do the scaling conversion of the SP.

Treatment of Output Values
The transducer scaling (XD_SCALE) is used to convert percent of span to the number used by the transducer. This allows portions of the SP span to cause full span movement of the output.

OUT = SP% * (EU_100% - EU_0%) + EU_0% [XD_SCALE]
The bit “Increase to Close” in IO_OPTS allows the output to be inverted relative to the span of the input value. For example, if the SP is 100. (PV_SCALE=0-100%; XD_SCALE = 3-15Psi):
If the “Increase to Close” bit in IO_OPTS is clear, SP converted to OUT_SCALE will be15 psi. Therefore the actuator type will be “air to open”.

If the “Increase to Close” bit in IO_OPTS is true, SP converted to OUT_SCALE will be 3 psi. Therefore the actuator type will be “air to close”.

Simulate
The SIMULATE parameter is used for the diagnostics and checkout purposes. When it is active, the transducer value and status will be overridden by the simulate value and status. The SIMULATE can be disabled either by software in the SIMULATE parameter or hardware through the jumper.

The SIMULATE structure is composed by the following attributes:

- Simulate Value and Status
- Transducer Value and Status
- Simulate Enable/Disable

The Transducer Value/Status attributes of SIMULATE parameter are always showing the value that the AO block receives from the corresponding transducer block.

There is a hardware jumper to disable the SIMULATE parameter. If this jumper is placed Off, then the simulation will be disabled. In this case, the user cannot change the ENABLE/DISABLE attribute. This jumper prevents simulation from accidentally being enabled during plant operations. When the jumper is placed ON, it will cause “Simulate Active” attribute in the BLOCK_ERR of Resource block to be true.

If the following conditions exist, simulate will be actived:

- The simulate hardware jumper is not placed Off;
- The SIMULATE.ENABLE/DISABLE parameter is “Active”.

When simulation is active, the READBACK and PV parameters will be calculated based on the attribute Simulate Value/Status of the SIMULATE parameter. Otherwise it will be that one supplied by the transducer block in the Transducer Value/Status attribute of the SIMULATE parameter.

Readback parameter
If the hardware supports a readback value, such as valve position, then the value will be read by the transducer block and it will be provided to the corresponding AO block through the Transducer Value/Status attribute of the SIMULATE parameter. If not supported, the Transducer Value/Status attribute of the SIMULATE parameter is generated from AO.OUT by the transducer block.

The READBACK parameter has a copy of the Transducer Value/Status attribute of the SIMULATE parameter if the simulation is disabled, otherwise it is a copy of the Simulate Value/Status attribute of the SIMULATE parameter
The PV is the READBACK parameter converted to the PV_SCALE, therefore the PV can be simulated through the SIMULATE parameter.

In addition, the block admits safe action as described early in the fault state processing.
The AO block supports the mode-shedding feature as described early in the mode parameter.

BLOCK_ERR
The BLOCK_ERR of the AO block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when one or more of the following situations occur:
    - When the CHANNEL or SHED_OPT parameters have an invalid value;
    - When the XD_SCALE does not have a supported engineering unit and/or range for the respective the transducer block.
    - When the transducer block is in O/S mode.
    - When it is not compatible the CHANNEL parameter and HC configuration (DFI302).
- Simulate Active – When the Simulate is active.
- Local Override – When the block is in LO mode because the fault state is active.
- Output Failure – I/O module failure (DFI302)
- Out of Service – Occur when the block is in O/S mode.

Supported Modes
O/S, IMAN, LO, MAN, AUTO, CAS and RCAS.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	PV	DS-65			PV	D / RO	Process analog value.
8	**SP**	**DS-65**	**PV_SCALE +/- 10%**		**PV**	**N / Auto**	**The analog set point. Can be set manually, automatically through the interface device or another field device.**
9	OUT	DS-65	XD_SCALE		OUT	N / Man	The output value result to the transducer block.
10	SIMULATE	DS-82	1: Disable ; 2: Active are the Enable/Disable options.	Disable		D	Allows the readback value to be manually supplied when simulate is enabled. In this case, the simulate value and status will be the PV value.
11	PV_SCALE	DS-68		0-100%	PV	S / Man	The high and low scale values to the SP parameter.
12	XD_SCALE	DS-68	Depends on the device type. See the corresponding manual for details.	Depends on the Device type. See description for details.	XD	S / Man	The high and low scale values, to transducer for a specified channel. The Default value for each Smar device is showed below: FY302: 0 to 100 [%] FP302 3 to 15 [psi] FI302 4 to 20 [mA] DFI302 0 to 100 [%]
13	GRANT_DENY	DS-70		0	Na	D	
14	**IO_OPTS**	**Bitstring(2)**	**See Block Options**	**0**	**Na**	**S / O/S**	**See Block Options**
15	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
16	READBACK	DS-65			XD	D / RO	Indicate the readback of the actual position of the transducer, in transducer units.
17	**CAS_IN**	**DS-65**				**D**	**This parameter is the remote setpoint value, which must come from another Fieldbus block, or a DCS block through a defined link.**
18	SP_RATE_DN	Float	Positive	+INF	PV/Sec	S	Ramp rate at which upward setpoint changes in PV units per second. It is disable if is zero or +INF. Rate limiting will apply in AUTO, CAS and RCAS modes.
19	SP_RATE_UP	Float	Positive	+INF	PV/Sec	S	Ramp rate at which downward setpoint changes in PV units per second. It is disable if is zero or +INF. Rate limiting will apply in AUTO, CAS and RCAS modes.
20	SP_HI_LIM	Float	PV_SCALE +/- 10%	100	PV	S	The setpoint high limit is the highest setpoint operator entry that can be used for the block.
21	SP_LO_LIM	Float	PV_SCALE +/- 10%	0	PV	S	The setpoint low limit is the lowest setpoint operator entry that can be used for the block.
22	CHANNEL	Unsigned16		0	None	S / O/S	For more details about .the configuration of this parameter, see Chapter 1 “CHANNEL Configuration”.
23	FSTATE_TIME	Float	Positive	0	Sec	S	The time in seconds to ignore the existence of a new fault state condition. If the fault state condition does not persist for FSTATE_TIME seconds and while this time does not elapse, the block will execute in the last actual mode.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
24	FSTATE_VAL	Float	PV_SCALE +/- 10%	0	PV	S	The preset analog SP value to use when fault occurs. This value will be used if the I/O option fault state to value is selected.
25	BKCAL_OUT	DS-65			PV	D / RO	The value and status required by an upper block's BKCAL_IN so that the upper block may prevent reset windup and provide bumpless transfer to close the loop control.
26	RCAS_IN	DS-65			PV	D	Target setpoint and status provided by a supervisory Host to an analog control or output block.
27	SHED_OPT	Unsigned8	1: NormalShed, NormalReturn 2: NormalShed, NoReturn 3: ShedToAuto, NormalReturn 4: ShedToAuto, NoReturn 5: ShedToMan, NormalReturn 6: ShedToMan, NoReturn 7: ShedToRetained Target, NormalReturn 8: ShedToRetained Target, NoReturn	0		S	Defines action to be taken on remote control device timeout.
28	RCAS_OUT	DS-65			PV	D / RO	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.
29	UPDATE_EVT	DS-73			Na	D	
30	BLOCK_ALM	DS-72			Na	D	

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":

The default value of CHANNEL is the lowest available number.
The default value of SHED_OPT is NormalShed/NormalReturn.
The required mode for writing is the actual mode, regardless the target mode: SP and OUT

DO - Discrete Output

Overview

The DO block converts the value in SP_D to something useful for the hardware found at the CHANNEL selection.

Schematic

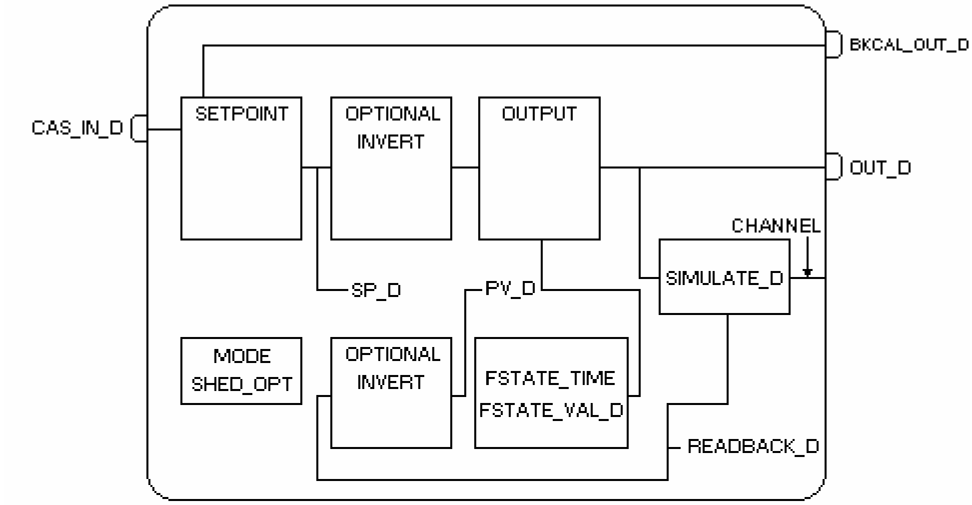


Figure 2.56 – Discrete Output Schematic

Description

The Invert I/O option can be used to do a Boolean NOT function between the SP_D and the hardware.

The SP_D supports the full cascade sub-function. Cas mode must be used to transfer the output of another block to the SP_D of the DO.
There are additional I/O options which will cause the SP_D value to track the PV_D value when the block is in an actual mode of LO or Man.

If the hardware supports a readback value, it is used for READBACK_D, which, after accounting for the Invert I/O option, acts as the PV_D for this block. If not supported, READBACK_D is generated from OUT_D. The OUT_D and READBACK_D parameters both use XD_STATE. The PV_D and SP_D use PV_STATE.

BLOCK_ERR

The BLOCK_ERR of the DO block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when one or more of the following situations occur:
  - When the CHANNEL or SHED_OPT parameters have an invalid value;
  - When it is not compatible the CHANNEL parameter and HC configuration (DFI302).
- Simulate Active – When the Simulate is active.
- Local Override – When the block is in LO mode because the fault state is active.
- Output Failure – I/O module failure (DFI302)
- Out of Service – Occur when the block is in O/S mode.

Supported Modes

O/S, LO, Iman, Man, Auto, Cas, and RCas. The Man mode can be used to force the output, in a PLC sense. It may be that Man mode is not permitted, but it must be supported so that Man mode may be entered when leaving O/S. The IMan mode is used to indicate that there is no path to the final element.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	PV_D	DS-66			PV	D / RO	Either the primary discrete value for use in executing the function, or a process value associated with it. May also be calculated from the READBACK_D value of a DO block.
8	**SP_D**	**DS-66**	**PV_STATE**		**PV**	**N / Auto**	**The discrete setpoint of this block.**
9	OUT_D	DS-66	OUT_STATE		OUT	N / Man	The primary discrete value calculated as a result of executing the function.
10	SIMULATE_D	DS-83	1: Disable ; 2: Active are the Enable/Disable options.	Disable		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.
11	PV_STATE	Unsigned16		0	PV	S	Index to the text describing the states of a discrete PV.
12	XD_STATE	Unsigned16		0	XD	S	Index to the text describing the states of a discrete for the value obtained from the transducer.
13	GRANT_DENY	DS-70		0	Na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
14	**IO_OPTS**	**Bitstring(2)**	**See Block Options**	**0**	**Na**	**S / O/S**	**See Block Options**
15	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
16	READBACK_D	DS-66			XD	D / RO	This indicates the readback of the actual discrete valve or other actuator position, in the transducer state.
17	**CAS_IN_D**	**DS-66**			**PV**	**D / RW**	**This parameter is the remote setpoint value of a discrete block, which must come from another Fieldbus block, or a DCS block through a defined link.**
18	**CHANNEL**	**Unsigned16**		**0**	**None**	**S / O/S**	**For more details about the configuration of this parameter, see Chapter 1 “CHANNEL Configuration”.**
19	FSTATE_TIME	Float	Positive	0	Sec	S	The time in seconds to ignore the existence of a new fault state condition. If the fault state condition does not persist for FSTATE_TIME seconds and while this time does not elapse, the block will execute in the last actual mode.
20	**FSTATE_VAL_D**	**Unsigned8**		**0**	**PV**	**S**	**The preset discrete SP_D value to use when fault occurs. This value will be used if the I/O option Fault State to value is selected.**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
21	**BKCAL_OUT_D**	**DS-66**			**PV**	**D / RO**	**The output value and status provided to an upstream discrete block. This information is used to provide bumpless transfer to closed loop control.**
22	RCAS_IN_D	DS-66			PV	D	Target setpoint and status provided by a supervisory Host to a discrete control or output block.
23	SHED_OPT	Unsigned8	1: NormalShed, NormalReturn 2: NormalShed, NoReturn 3: ShedToAuto, NormalReturn 4: ShedToAuto, NoReturn 5: ShedToMan, NormalReturn 6: ShedToMan, NoReturn 7: ShedToRetainedTarget, NormalReturn 8: ShedToRetainedTarget, NoReturn	0		S	Defines action to be taken on remote control device timeout.
24	RCAS_OUT_D	DS-66			PV	D / RO	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.
25	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
26	BLOCK_ALM	DS-72			Na	D	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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

MAO - Multiple Analog Output

Description

The MAO block makes available to the I/O subsystem its eight input parameters IN_1 through IN_8.

For DFI working with Analog Output, the 4-20mA or 1-5V range must be worked. In this case the input values are in percent from 0 to 100%. If it is necessary to work in another configuration, the AO block must be used.

This function block has the same fault state characteristics as the AO block. It includes option to hold the last value or go to a preset value when fault state active, individual preset values for each point, besides a delay time to go into the fault state.

The actual mode will be LO only due to the resource block, otherwise bad status in input parameter and configuration of MO_STATUS_OPTS will not affect the mode calculation. However the functionality of fault state will be done only for that input parameter.

BLOCK_ERR

The BLOCK_ERR of the MAO block will reflect the following causes:

- Other – the number of MDI, MDO, MAI and MAO blocks or the device tag in FB700 is different from LC700;
- Block Configuration Error – the configuration error occurs when the OCCURRENCE/ CHANNEL has an invalid value;
- Output failure – the CPU of LC700 stopped working (FB700);
- Power up – there is no CPU of LC700 in the rack or the hardware configuration of LC700 has an error (FB700);
- Out of Service – When the block is in O/S mode.

Supported Modes

O/S, LO and AUTO.

Schematic

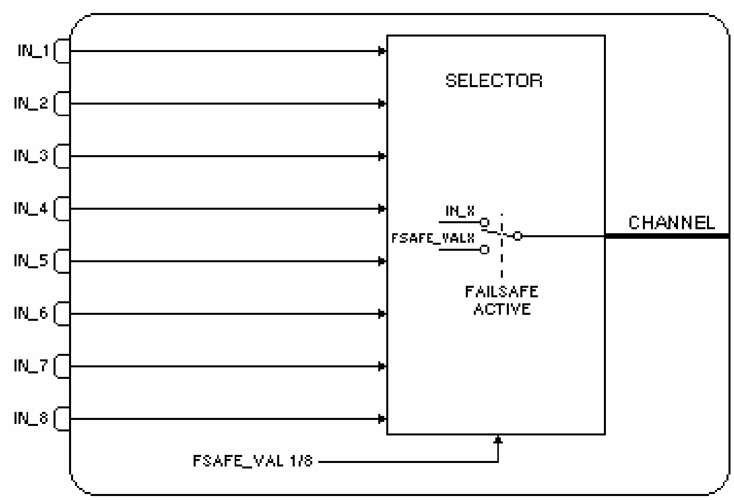


Figure 2.57 - Multiple Analog Output Schematic

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	**OCCURRENCE / CHANNEL**	**Unsigned16**		**0**	**None**	**S / O/S**	**For more details about the configuration of this parameter, see Chapter 1 “CHANNEL Configuration”. It defines the transducer to be used going to or from the physical world. It addresses a group of eight points.**
8	**IN_1**	**DS-65**				**D**	**Numbered input 1.**
9	**IN_2**	**DS-65**				**D**	**Numbered input 2.**
10	**IN_3**	**DS-65**				**D**	**Numbered input 3.**
11	**IN_4**	**DS-65**				**D**	**Numbered input 4.**
12	**IN_5**	**DS-65**				**D**	**Numbered input 5.**
13	**IN_6**	**DS-65**				**D**	**Numbered input 6.**
14	**IN_7**	**DS-65**				**D**	**Numbered input 7.**
15	**IN_8**	**DS-65**				**D**	**Numbered input 8.**
16	MO_OPTS (different bit description in profile revision 1)	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
17	MO_STATUS_OPTS (not available in profile revision 1)	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
18	FSTATE_TIME	Float	Positive	0	Sec	S	The time in seconds to ignore the existence of a new fault state condition. If the fault state condition does not persist for FSTATE_TIME seconds and while this time does not elapse, the block will execute in the last actual mode.
19	FSTATE_VAL1	Float		0		S	The preset analog value to use when failure occurs in IN_1. Ignored if the “Fault state to value 1” in the MO_OPTS parameter is false.
20	FSTATE_VAL2	Float		0		S	The preset analog value to use when failure occurs in IN_2. Ignored if the “Fault state to value 2” in the MO_OPTS parameter is false.
21	FSTATE_VAL3	Float		0		S	The preset analog value to use when failure occurs in IN_3. Ignored if the “Fault state to value 3” in the MO_OPTS parameter is false.
22	FSTATE_VAL4	Float		0		S	The preset analog value to use when failure occurs in IN_4. Ignored if the “Fault state to value 4” in the MO_OPTS parameter is false.
23	FSTATE_VAL5	Float		0		S	The preset analog value to use when failure occurs in IN_5. Ignored if the “Fault state to value 5” in the MO_OPTS parameter is false.
24	FSTATE_VAL6	Float		0		S	The preset analog value to use when failure occurs in IN_6. Ignored if the “Fault state to value 6” in the MO_OPTS parameter is false.
25	FSTATE_VAL7	Float		0		S	The preset analog value to use when failure occurs in IN_7. Ignored if the “Fault state to value 7” in the MO_OPTS parameter is false.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
26	FSTATE_VAL8	Float		0		S	The preset analog value to use when failure occurs in IN_8. Ignored if the "Fault state to value 8" in the MO_OPTS parameter is false.
27	FSTATE_STATUS	Unsigned8			None	D / RO	It shows which points are in fault state active.
28	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
29	BLOCK_ALM	DS-72			Na	D	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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":

The default value of OCCURRENCE is the number of MAO blocks instantiated for the block.

Observation

Device type	Description
FB700	Block has OCCURRENCE parameter. The UPDATE_EVT and BLOCK_ALM parameters are inverted. Block has MO_STATUS_OPTS.
DFI302, DC302 and HI302	Block has CHANNEL parameter. MO_OPTS has a different bit description MO_STATUS_OPTS is not available in profile revision 1

MDO - Multiple Discrete Output

Description
The MDO block makes available to the I/O subsystem its eight input parameters IN_D1 through IN_D8.

This function block has the same fault state characteristics as the DO block. It includes option to hold the last value or go to a preset value when fault state active, individual preset values for each point, besides a delay time to go into the fault state.

The actual mode will be LO only due to the resource block, otherwise bad status in input parameter and configuration of MO_STATUS_OPTS will not affect the mode calculation. However the functionality of fault state will be done only for that input parameter.

The parameter FSTATE_STATE shows which points are in fault state active.

BLOCK_ERR
The BLOCK_ERR of the MDO block will reflect the following causes:

- Other – the number of MDI, MDO, MAI and MAO blocks or the device tag in FB700 is different from LC700;
- Block Configuration Error – the configuration error occurs when the OCCURRENCE / CHANNEL has an invalid value (FB700);
- Output failure – the CPU of LC700 stopped working (FB700);
- Power up – there is no CPU of LC700 in the rack or the hardware configuration of LC700 has an error (FB700);
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S, LO and AUTO.

Schematic

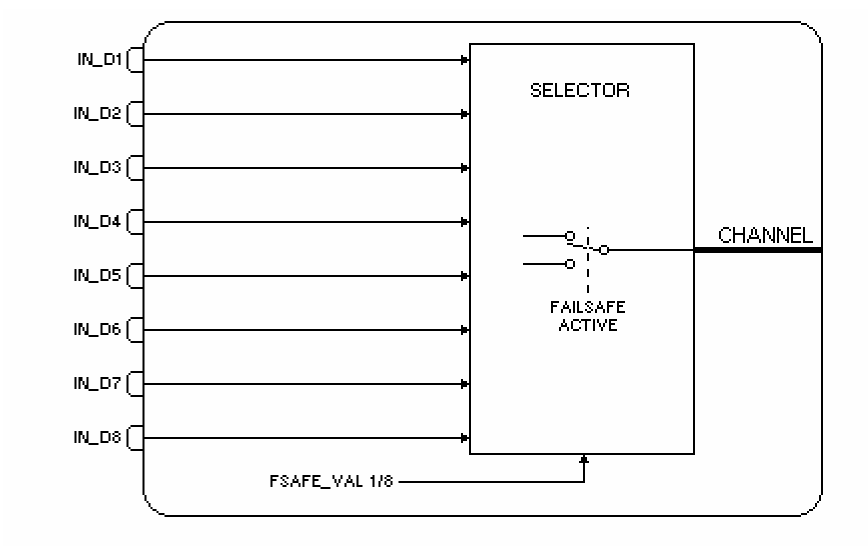


Figure 2.58 - Multiple Discrete Output Schematic

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D/RO**	
7	**OCCURRENCE / CHANNEL**	**Unsigned16**		**0**	**None**	**S / O/S**	**For more details about the configuration of this parameter, see Chapter 1 “CHANNEL Configuration”. It defines the transducer to be used going to or from the physical world. It addresses a group of eight points.**
8	**IN_D1**	**DS-66**				**D**	**Numbered discrete input 1.**
9	**IN_D2**	**DS-66**				**D**	**Numbered discrete input 2.**
10	**IN_D3**	**DS-66**				**D**	**Numbered discrete input 3.**
11	**IN_D4**	**DS-66**				**D**	**Numbered discrete input 4.**
12	**IN_D5**	**DS-66**				**D**	**Numbered discrete input 5.**
13	**IN_D6**	**DS-66**				**D**	**Numbered discrete input 6.**
14	**IN_D7**	**DS-66**				**D**	**Numbered discrete input 7.**
15	**IN_D8**	**DS-66**				**D**	**Numbered discrete input 8.**
16	MO_OPTS (different bit description in profile revision 1)	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
17	MO_STATUS_OPTS (not available in profile revision 1)	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
18	FSTATE_TIME	Float	Positive	0	Sec	S	The time in seconds to ignore the existence of a new fault state condition. If the fault state condition does not persist for FSTATE_TIME seconds and while this time does not elapse, the block will execute in the last actual mode.
19	FSTATE_VAL_D1	Unsigned8		0		S	The preset discrete value to use when failure occurs in IN_D1. Ignored if the “Fault state to value 1” in the MO_OPTS parameter is false.
20	FSTATE_VAL_D2	Unsigned8		0		S	The preset discrete value to use when failure occurs in IN_D2. Ignored if the “Fault state to value 2” in the MO_OPTS parameter is false.
21	FSTATE_VAL_D3	Unsigned8		0		S	The preset discrete value to use when failure occurs in IN_D3. Ignored if the “Fault state to value 3” in the MO_OPTS parameter is false.
22	FSTATE_VAL_D4	Unsigned8		0		S	The preset discrete value to use when failure occurs in IN_D4. Ignored if the “Fault state to value 4” in the MO_OPTS parameter is false.
23	FSTATE_VAL_D5	Unsigned8		0		S	The preset discrete value to use when failure occurs in IN_D5. Ignored if the “Fault state to value 5” in the MO_OPTS parameter is false.
24	FSTATE_VAL_D6	Unsigned8		0		S	The preset discrete value to use when failure occurs in IN_D6. Ignored if the “Fault state to value 6” in the MO_OPTS parameter is false.
25	FSTATE_VAL_D7	Unsigned8		0		S	The preset discrete value to use when failure occurs in IN_D7. Ignored if the “Fault state to value 7” in the MO_OPTS parameter is false.
26	FSTATE_VAL_D8	Unsigned8		0		S	The preset discrete value to use when failure occurs in IN_D8. Ignored if the “Fault state to value 8” in the MO_OPTS parameter is false.
27	FSTATE_STATUS	Unsigned8			None	D / RO	It shows which points are in fault state active.
28	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
29	BLOCK_ALM	DS-72			Na	D	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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

If DIAG.BEHAVIOR parameter is "Adapted":

The default value of OCCURRENCE is the number of MDO blocks instantiated in the profile revision 0.

Observation

Device type	Description
FB700	Block has OCCURRENCE parameter. The UPDATE_EVT and BLOCK_ALM parameters are inverted. Block has MO_STATUS_OPTS.
DFI302, DC302 and HI302	Block has CHANNEL parameter. MO_OPTS has a different bit description MO_STATUS_OPTS is not available in profile revision 1

STEP – Step Output Pid

Overview
A Step Control Output block is used most commonly, when the final control element has an actuator driven by an electric motor. The final control element is positioned by rotating the motor clockwise or anticlockwise, which is accomplished by activating a discrete signal for each direction. A control valve, for example, needs a signal to open and another to close. If none of the signals is present, the valve stem would stay at the same position.

Fieldbus actuators and switchgears are the transducer blocks of this block.

Schematic

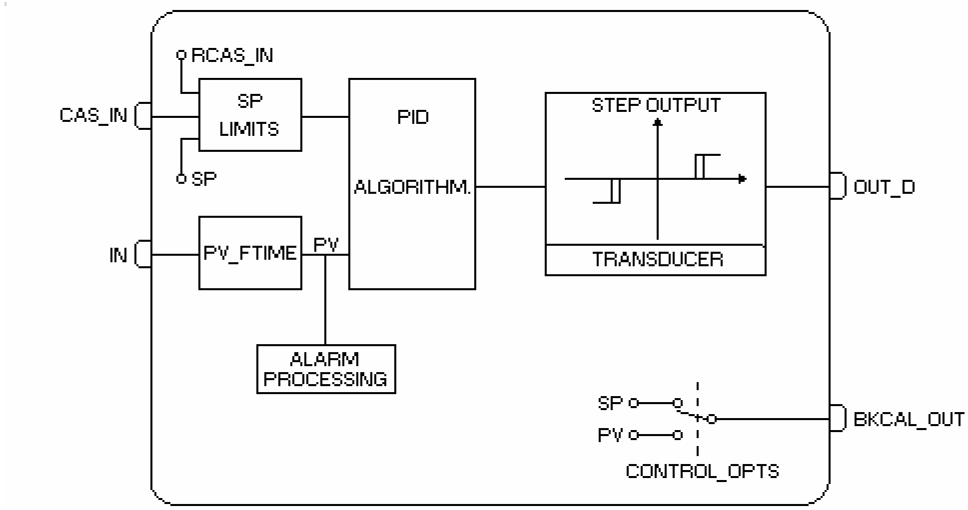


Figure 2.59 - Step Output Pid Schematic

Description
As shown on Figure 2.59, electric actuators require a switchgear module to power the electric motor and reverse it as demanded by the control loop. Most of the electric actuators require an interlock circuit to prevent the motor to overheat, or even burn, when the actuator reaches one of the travel limits or something blocks the movement in any direction, increasing the torque beyond an established limit. These actuators are normally equipped with torque switches and limit switches to provide this kind of protection.

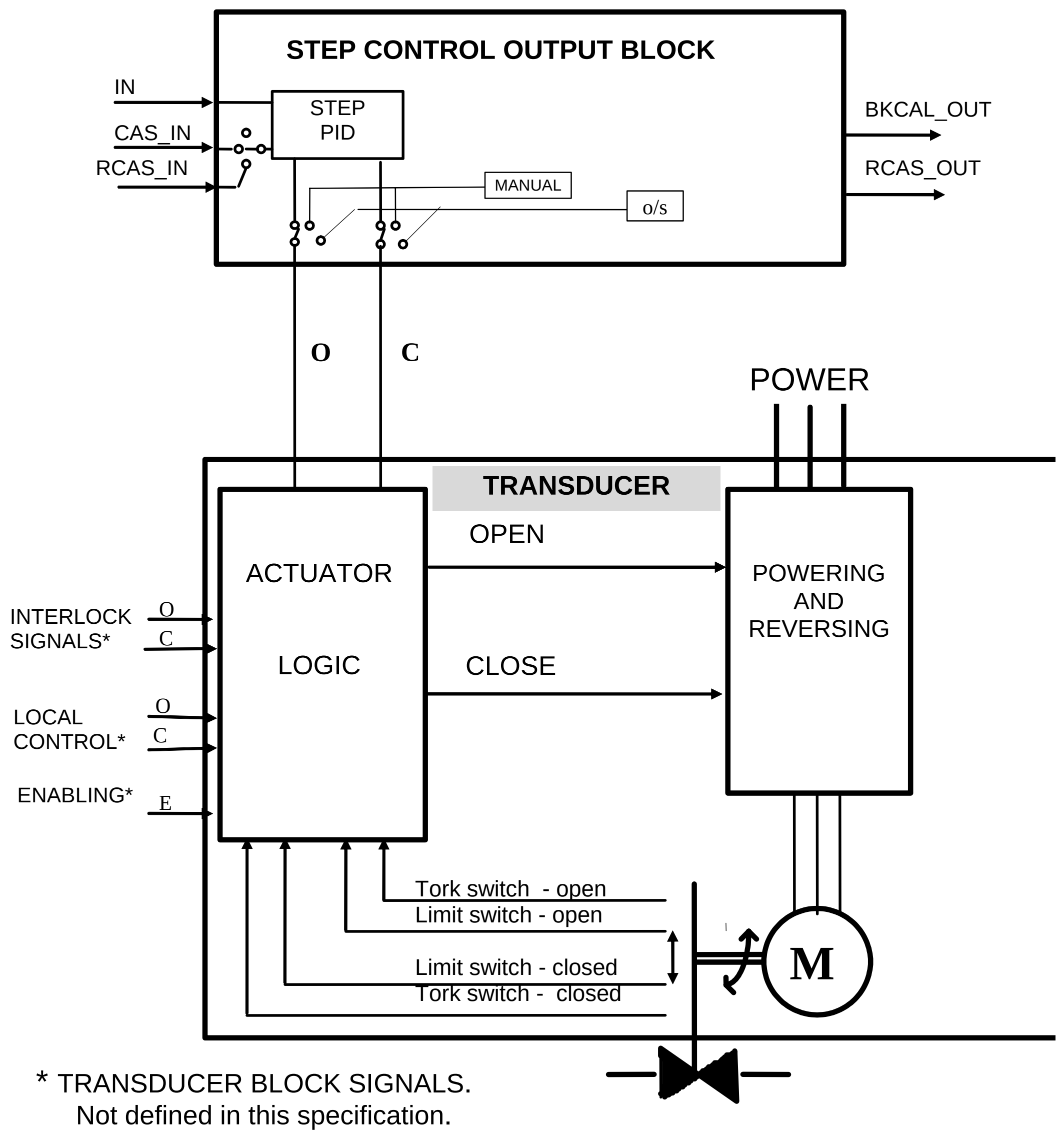


Figure 2.60 - Step Output Pid

Using a standard PID controller in cascade with a PI Step Controller.

The slave process variable is the position of the final control element, as shown in Figure 2.60. Controlling the process variable regardless of the valve position measurement.

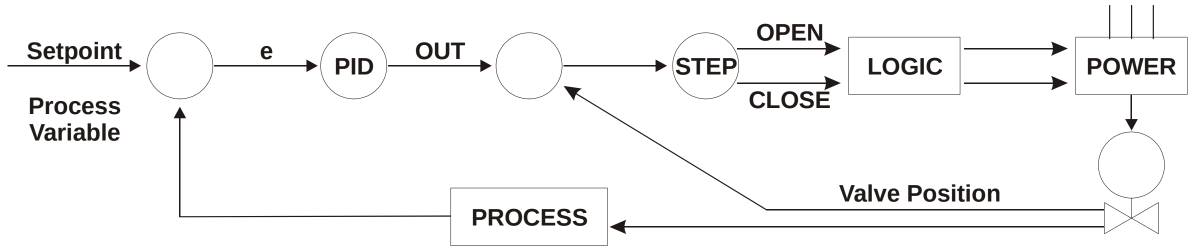


Figure 2.61 - Step controller Working as a Positioner.

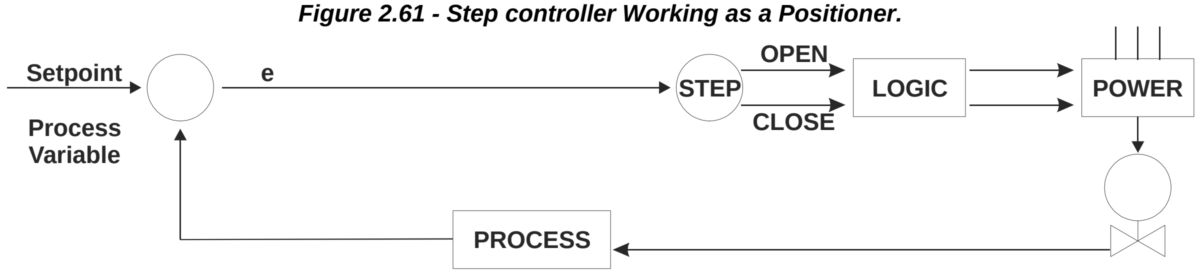


Figure 2.62 - Step Controller

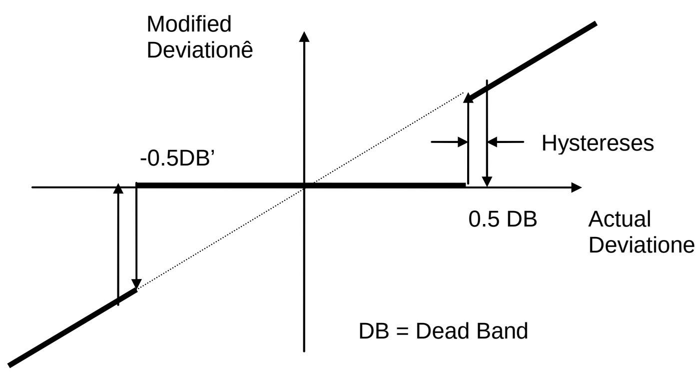


Figure 2.63 - Modified Deviation or Gap Deviation

The actuator has a Travel Time, that is the time it takes to drive the final control element from one end limit to another. For a control valve, for example, it is the time required to drive it from closed to completely open.
The proportional action will actuate the final control element in the required direction during a time proportional to:

t_P = [GAIN]* (ê /100)* [TRAVEL_TIME].....(s)

If the proportional action is not enough to turn ê = 0, the Integral Action will move the final control element at a speed of:

V = [GAIN] * ê / [RESET]......(% / s)

where the reset is the Integral time constant in seconds.
As most of the actuators work with constant and fixed speed, they can not give a speed larger than:

Maximum speed = 100% / [TRAVEL TIME].......(% / s)

while the smaller speeds required by the Integral action are obtained by giving pulses of a specified duration [PULSE_DUR]. Each pulse will move the final control element a Δx % in the required direction.

Δx % =[PULSE_DUR] * 100% / [TRAVEL_TIME]..........(%)
The pulse frequency is given by:

f = V / Δx %..........(pulses / s)

The Derivative or Rate action is given by:

t_D = [GAIN] * (dê/dt) * [RATE]

Where Rate is the derivative time constant in seconds and dê/dt can be calculated in several ways, including derivative gain, filtering, etc.

The PID Step Controller activates the OPEN or CLOSE signals according to the modified deviation, ê, the PID parameters and the other parameters in the following way:
The signal is activated during a time equivalent to:
= $t_P + t_D$

If the modified deviation is still different of zero, the Integral or Reset action will give pulses with a duration defined by [PULSE_DUR], with a frequency calculated by "f." t and f are dynamically modified by ê.
In order to avoid the Reset wind-up, the actuation time in one direction must be integrated and limited.

If the actuation time in one direction is larger than the [TRAVEL_TIME], there is no use in making the respective output signal to pulse, therefore it is recommendable to maintain it continuously activated.

The block provides a full PV and Deviation alarm support.

The meaning of possible values for OUT_D are :
OUT_D.value = 0 → Stop
OUT_D.value = 1 → Close
OUT_D.value = 2 → Open

As the STEP block requires two discrete outputs, when setting the CHANNEL parameter, indeed two outputs are allocated. The value of CHANNEL points to the CLOSE output, and the next channel points to the OPEN output.

Supported Modes
Out-of-service, Manual, *Auto, CAS and RCAS* are supported.
In *Out-of-service* mode, the status of the output will be Out-of -service.
In *Manual* mode, the OUT_D can be set by the operator. The block stops output calculation.
In *Auto* mode the block operates normally.
In *CAS* (cascade), the Setpoint is supplied by another function block through the CAS_IN parameter.
In RCAS the block setpoint is set by a control application running on a computer, DCS or PLC.

Status Handling
The status of OUT_Di shall reflect the worst quality of the status of any connected input.

Initial Value Handling
The initial value of OUT_Di should be zero, that is, no action in both directions and the Integral action value should also go to zero.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**See Mode Parameter**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7	**PV**	**DS-65**			**PV**	**D / RO**	**Process analog value. This is the IN value after pass over the PV filter.**
8	**SP**	**DS-65**	**PV_SCALE +/- 10%**		**PV**	**N / Auto**	**The analog set point. Can be set manually, automatically through the interface device or another field device.**
9	**OUT_D**	**DS-66**				**N / Man**	**The output value result of the Step Output PID calculation.**
10	PV_SCALE	DS-68		0-100%	PV	S / Man	The high and low scale values to the PV and SP parameter.
11	XD_STATE	Unsigned16		0	XD	S	Index to the text describing the states of a discrete for the value obtained from the transducer.
12	GRANT_DENY	DS-70		0	na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
13	**CONTROL_OPTS**	**Bitstring(2)**	**See Block Options**	**0**	**na**	**S / O/S**	**See Block Options**
14	**STATUS_OPTS**	**Bitstring(2)**	**See Block Options**	**0**	**Na**	**S / O/S**	**See Block Options**
15	**IN**	**DS-65**			**PV**	**D**	**The primary input value of the block, or PV value.**
16	PV_FTIME	Float	Non-Negative	0	Sec	S	Time constant of a single exponential filter for the PV, in seconds.
17	JOG_TIME	Float	Positive	0	Sec	S	Duration of OUT_D in the active state when commanded by the operator to jog open or jog closed.
18	**CAS_IN**	**DS-65**				**D**	**This parameter is the remote setpoint value, which must come from another Fieldbus block, or a DCS block through a defined link.**
19	SP_RATE_DN	Float	Positive	+INF	PV/Sec	S	Ramp rate at which upward setpoint changes in PV units per second. It is disable if is zero or +INF. Rate limiting will apply only in AUTO mode.
20	SP_RATE_UP	Float	Positive	+INF	PV/Sec	S	Ramp rate at which downward setpoint changes in PV units per second. It is disable if is zero or +INF. Rate limiting will apply only in AUTO mode.
21	SP_HI_LIM	Float	PV_SCALE +/- 10%	100	PV	S	The setpoint high limit is the highest setpoint operator entry that can be used for the block.
22	SP_LO_LIM	Float	PV_SCALE +/- 10%	0	PV	S	The setpoint low limit is the lowest setpoint operator entry that can be used for the block.
23	**GAIN**	**Float**		**0**	**None**	**S**	**Proportional term of the PID. It is the Kp value.**
24	**RESET**	**Float**	**Positive**	**+INF**	**sec**	**S**	**Integral term of the PID. It is the Tr value.**
25	BAL_TIME	Float	Positive	0	sec	S	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds. In the PID block, it may be used to specify the time constant at which the integral term will move to obtain balance when the output is limited and the mode is Auto, Cas, or RCas.
26	**RATE**	**Float**	**Positive**	**0**	**sec**	**S**	**Derivative term of the PID. It is the Td value.**
27	IO_OPTS	Bitstring(2)	See Block Options	0	na	S / O/S	See Block Options
28	CHANNEL	Unsigned16		0	None	S / O/S	For more details about the configuration of this parameter, see Chapter 1 “CHANNEL Configuration”. In the DFI302, this parameter is selecting two discrete outputs. The first one is the CLOSE output and the next point in the same group will be the OPEN output. The CHANNEL parameter will be addressing the CLOSE output, despite of it is allocating the OPEN output too.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
29	FSTATE_TIME	Float	Positive	0	Sec	S	The time in seconds from detection of fault of the output block remote setpoint to the output action of the block output if the condition still exists.
30	FSTATE_VAL_D	Unsigned8		0		S	The preset discrete SP_D value to use when fault occurs. This value will be used if the I/O option Fault State to value is selected.
31	**BKCAL_OUT**	**DS-65**			**PV**	**D / RO**	**The value and status required by an upper block's BKCAL_IN so that the upper block may prevent reset windup and provide bumpless transfer to closed loop control.**
32	RCAS_IN	DS-65			PV	D	Target setpoint and status provided by a supervisory Host to a analog control or output block.
33	SHED_OPT	Unsigned8	1: NormalShed, NormalReturn 2: NormalShed, NoReturn 3: ShedToAuto, NormalReturn 4: ShedToAuto, NoReturn 5: ShedToMan, NormalReturn 6: ShedToMan, NoReturn 7: ShedToRetainedTarget, NormalReturn 8: ShedToRetainedTarget, NoReturn	0		S	Defines action to be taken on remote control device timeout.
34	RCAS_OUT	DS-65			PV	D / RO	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.
35	TRAVEL_TIME	Float	Positive	60	Sec	S / Man	The time required by the actuator to drive the final control element from one end position to another, in seconds.
36	PULSE_DUR	Float	Positive	1	Sec	S / Man	It is the width, in seconds, of the pulses given due to the integral action.
37	DEAD_BAND	Float	Non-negative	0	%	S / Man	It is the interval where changes in the Input will not change the output
38	HYSTERESIS	Float	Non-negative	0	%	S / Man	Difference between the switching points.
39	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
40	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.
41	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
42	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
43	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. In order to clear the alarm the amount the PV must return within the alarm limit plus hysteresis.
44	HI_HI_PRI	Unsigned8	0 to 15	0		S	Priority of the high high alarm.
45	HI_HI_LIM	Float	OUT_SCALE, +INF	+INF	PV	S	The setting for high high alarm in engineering units.
46	HI_PRI	Unsigned8	0 to 15	0		S	Priority of the high alarm.
47	HI_LIM	Float	OUT_SCALE, +INF	+INF	PV	S	The setting for high alarm in engineering units.
48	LO_PRI	Unsigned8	0 to 15	0		S	Priority of the low alarm.
49	LO_LIM	Float	OUT_SCALE, -INF	-INF	PV	S	The setting for low alarm in engineering units.
50	LO_LO_PRI	Unsigned8	0 to 15	0		S	Priority of the low low alarm.
51	LO_LO_LIM	Float	OUT_SCALE, -INF	-INF	PV	S	The setting for low low alarm in engineering units.
52	DV_HI_PRI	Unsigned8	0 to 15	0		S	Priority of the deviation high alarm.
53	DV_HI_LIM	Float	0 to PV span, +INF	+INF	PV	S	The setting for deviation high alarm in engineering units.
54	DV_LO_PRI	Unsigned8	0 to 15	0		S	Priority of the deviation low alarm.
55	DV_LO_LIM	Float	-INF, -PV span to 0	-INF	PV	S	The setting for deviation low alarm in engineering units.
56	HI_HI_ALM	DS-71			PV	D	The status for high high alarm and its associated time stamp.
57	HI_ALM	DS-71			PV	D	The status for high alarm and its associated time stamp.
58	LO_ALM	DS-71			PV	D	The status for low alarm and its associated time stamp.
59	LO_LO_ALM	DS-71			PV	D	The status for low low alarm and its associated time stamp.
60	DV_HI_ALM	DS-71			PV	D	The status for deviation high alarm and its associated time stamp.
61	DV_LO_ALM	DS-71			PV	D	The status for deviation low alarm and its associated time stamp.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

Output Transducer Blocks

FR302 – Fieldbus Relay

Description
Using the transducer block the user can see the output relay type definition.

Supported Modes
OOS and Auto

Parameters

Idx	Parameter	DataType (length)	Valid Range/Options	Defaut Value	Units	Store	Description
9	TRANSDUCER_DIRECTORY	Unsigned16		0	None	S	A directory that specifies the number and the starting indices of the transducers in the transducer block.
10	TRANSDUCER_TYPE	Unsigned16	Other (0xffff)	Other (0xffff)	None	S	Identifies the transducer that follows.
11	XD_ERROR	Unsigned8	Default Value Set (0x10) General Error (0x11) Calibration Error (0x12) Configuration Error (0x13) Electronics Failure (0x14) Mechanical Failure (0x15) I/O Failure (0x16) Data Integrity Error (0x17) Software Error (0x18) Algorithm Error (0x19)	Default Value Set (0x10)	None	D	Define an error code.
12	COLLECTION_DIRECTORY	Unsigned	0	0	None	S	A directory that specifies the number, the starting indices, and DD Item IDs of data collections in each transducers in the transducer block.
13	OUTPUT_RELAY_TYPE	Unsigned8	Not Initialized. (0x0) Both Normally Opened. (0x1) Both Normally Closed. (0x2) One Normally Opened and other Normally Closed . (0x3)	Not Initializ ed. (0x0)	None	S	The type of each output relay.
14	SERIAL_NUMBER	Unsigned32	0 to 4294967296	0	None	S	The device serial number
15	ORDERING_CODE	Visible String[50]		Spaces	None	S	Indicates informations about the sensor and control from production factory.

FY302 – Fieldbus Positioner Transducer

Description

The fieldbus positioner transducer receives the demanded valve position FINAL_VALUE from the AO block and uses it as a setpoint for a PID servo-positioning algorithm with adjustable gains SERVO_GAIN and SERVO_RESET. The transducer block also makes the corrected actual position sensor reading RETURN available to the AO block. The engineering unit and the final value range are selected from the XD_SCALE in the AO block. The units allowed are: for linear valve % and mm, for rotary valve %,°, rad.

After setting GAIN and RESET an automatic calibration should be done using SETUP to start the valve operation. The supported mode is OOS and AUTO. As the transducer block runs together with AO block, the transducer block goes to AUTO only if the AO mode block is different from OOS. The sensor module temperature may be read from the SECONDARY_VALUE parameter.

Warning messages may appear in Return status or in the Block Error in certain condition as explain below.

Supported Modes

OOS and AUTO.

BLOCK_ERR

The BLOCK_ERR of the transducer block will reflect the following causes:

- Block Configuration – When the XD_SCALE has an improper range or unit.
- Output Failure – When mechanic module is disconnected from main electronic board or no air supply (if FINAL_VALUE is different from 0 or 100%).
- Out of Service – When the block is in OOS mode.

Return Status

The RETURN status of the transducer block will reflect the following causes:
Bad::NonSpecific:NotLimited – When mechanic module is disconnected from main electronic board or no air supply (if FINAL_VALUE is different from 0 or 100%).

Parameters

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
1	ST_REV	Unsigned16	Positive	0	None	S	Indicates the level of static data.
2	TAG_DESC	VisibleString		Null	Na	S	Description of Transducer Block.
3	STRATEGY	Unsigned16		0	None	S	This parameter is not checked and processed by Transducer Block.
4	ALERT_KEY	Unsigned8	1-255	0	None	S	Number of identification in the plant.
5	**MODE_BLK**	**DS-69**		**OOS**	**Na**	**S**	**Indicates the operation mode of Transducer Block.**
6	**BLOCK_ERR**	**Bit String**		**Out of Service**	**E**	**D**	**Indicates the status associated with hardware or software in the Transducer.**
7	UPDATE_EVT	DS-73		*	Na	D	It is the alert for any static data.
8	BLOCK_ALM	DS-72		*	Na	D	It is used for configuration, hardware and others fail.
9	TRANSDUCER_DIRECTORY	Array of Unsigned16		0	None	N	It is used to select several Transducer Blocks.
10	TRANSDUCER_TYPE	Unsigned16		Positioner Valve	E	N	Indicates the type of Transducer according to its class.
11	XD_ERROR	Unsigned8		Default value set	None	D	It is used to indicate calibration status.
12	COLLECTION_DIRECTORY	Array of Unsigned 32		0	None	S	Specifies the number of transducer index into Transducer Block.
13	**FINAL_VALUE**	**DS-65**		*****	**FVR**	**D**	**It is the value and status used by channel 1.**

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
14	**FINAL_VALUE_RANGE**	**DS-68**		**100/0/%**	**FVR**	**S**	**The High and Low range limit values, the engineering unit code and the number of digits to the right of the decimal point to be used for Final Value.**
15	FINAL_VALUE_CUTTOF_HI	Float		100.0	FVR	S	If the FINAL_VALUE is more positive than this value is forced to its maximum high value (fully opened).
16	FINAL VALUE_CUTTOF_LO	Float		0.0	FVR	S	If the FINAL_VALUE is more negative than this value is forced to its maximum low value (fully closed).
17	FINAL_POSITION_VALUE	DS-65		*	FVR	D	The actual valve position and status could be used at the READBACK_VALUE in an AO block.
18	**SERVO_GAIN**	**Float**		**20**	**None**	**S**	**The servo PID gain valve.**
19	**SERVO_RESET**	**Float**		**2**	**FVR/Se**	**S**	**The servo PID reset valve.**
20	SERVO_RATE	Float		0	FVR/Sec	S	The servo PID rate valve.
21	ACT_FAIL_ACTION	Unsigned8		Undefined	None	S	Specifies the action the actuator takes in case of failure.
22	ACT_MAN_ID	Unsigned32		*	None	N	The actuator manufacturer identification number.
23	ACT_MODEL_NUM	VisibleString		NULL	None	N	The actuator model number.
24	ACT_SN	VisibleString		*	None	N	The actuator serial number.
25	VALVE_MAN_ID	Unsigned32		0	None	N	The valve manufacturer identification number.
26	VALVE_MODEL_NUM	VisibleString		NULL	None	N	The valve model number.
27	VALVE_SN	VisibleString		0	None	N	The valve serial number.
28	**VALVE_TYPE**	**Unsigned8**	**Lin/Rot**	**Liner**	**None**	**N**	**The type of the valve.**
29	XD_CAL_LOC	VisibleString		NULL	None	S	The location of the last positioned calibration. This describes
30	XD_CAL_DATE	Time of Day		Unspecified	None	S	The date of last positioner calibration.
31	XD_CAL_WHO	VisibleString		NULL	None	S	The name of the person responsible for the last positioner calibration.
32	CAL_POINT_HI	Float	-10.0-110.0%	100	%	S	The highest calibrated point.
33	CAL_POINT_LO	Float	-10.0-100.0%	0	%	S	The lowest calibrated point.
34	CAL_MIN_SPAN	Float		1	%	S	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points (high and low) are not too close together.
35	CAL_UNIT	Unsigned16		%	E	S	Engineering units code for the calibration values.
35	CAL_METHOD	Unsigned8		Factory	None	S	The method of last sensor calibration.
37	**SECONDARY_VALUE**	**DS-65**		*****	**SUV**	**D**	**The secondary value related to the sensor.**
38	**SECONDARY_VALUE_UNIT**	**Unsigned16**		**°C**	**E**	**S**	**The engineering units to be used with the secondary value**
39	BACKUP_RESTORE	Unsigned8		None		S	This parameter is used to backup or to restore configuration data.
40	POS_PER	DS-65		*		D	The percent position.
41	SERVO_PID_BYPASS	Unsigned8	True/False	Not bypass		S	Enable and disable the servo PID.
42	SERVO_PID_DEAD_BAND	Float		0	%	S	The dead band error for servo PID.
43	SERVO_PID_ERROR_PER	DS-65		*	%	D	The percent error value for the servo PID.
44	SERVO_PID_INTEGRAL_PER	DS-65		*	%	D	The percent integral value for the servo PID.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
45	SERVO_PID_MV_PER	DS-65		*	%	D	The percent measured value for the servo PID.
46	MODULE_SN	Unsigned32		*		N	The module manufacturer identification number.
47	SENSOR_PRESS _POL0	Float	± INF	31811.5	None	S	The pressure sensor polynomial coefficient 0.
48	SENSOR_PRESS _POL1	Float	± INF	27251.5	None	S	The pressure sensor polynomial coefficient 1.
49	SENSOR_PRESS _POL2	Float	± INF	0	None	S	The pressure sensor polynomial coefficient 2.
50	SENSOR_PRESS _POL3	Float	± INF	0	None	S	The pressure sensor polynomial coefficient 3.
51	SENSOR_PRESS _POL4	Float	± INF	0	None	S	The pressure sensor polynomial coefficient 4.
52	SENSOR_PRESS _POL5	Float	± INF	0	None	S	The pressure sensor polynomial coefficient 5.
53	SENSOR_PRESS _POL6	Float	± INF	0	None	S	The pressure sensor polynomial coefficient 6.
54	SENSOR_PRESS _POL7	Float	± INF	0	None	S	The pressure sensor polynomial coefficient 7.
55	SENSOR_PRESS _POL8	Float	± INF	0	None	S	The pressure sensor polynomial coefficient 8.
56	SENSOR_PRESS _POL9	Float	± INF	0	None	S	The pressure sensor polynomial coefficient 9.
57	SENSOR_PRESS _POL10	Float	± INF	0	None	S	The pressure sensor polynomial coefficient 10.
58	POLYNOMIAL_SENS_VERSION	Unsigned8		0	None	S	The pressure sensor polynomial version.
59	USER_HALL_CAL_POINT_HI	Float		*	%	S	The highest calibrated point.
60	USER_HALL_CAL_POINT_LO	Float		*	%	S	The lowest calibrated point.
61	READ_HALL_CAL_POINT_HI	Float	0.0-65535.0	*	None	S	The highest calibrated point for Hall sensor.
62	READ_HALL_CAL_POINT_LO	Float	0.0-65535.0	*	None	S	The lowest calibrated point for Hall sensor.
63	COEFF_SENS_TEMP_POL0	Float	± INF	*	None	S	The polynomial temperature coefficient 0.
64	COEFF_SENS_TEMP_POL1	Float	± INF	*	None	S	The polynomial temperature coefficient 1.
65	COEFF_SENS_TEMP_POL2	Float	± INF	*	None	S	The polynomial temperature coefficient 2.
66	COEFF_SENS_TEMP_POL3	Float	± INF	*	None	S	The polynomial temperature coefficient 3.
67	COEFF_SENS_TEMP_POL4	Float	± INF	*	None	S	The polynomial temperature coefficient 4.
68	POLYNOMIAL_SENS_TEMP_VERSION	Unsigned8		*	None	S	The polynomial temperature version.
69	CAL_TEMPERATURE	Float		*	°C(1001)	S	The temperature value used to calibrate the temperature.
70	CAL_DIGITAL_TEMPERATURE	Float		*	None	S	The cal digital temperature value.
71	CHARACTERIZATION_TYPE	Unsigned8		Linear	None	S	Select the characterization type.
72	CHARACTERIZATION _BYPASS	Unsigned8	True/False	True	None	S	Enable and disable the curve type.
73	CURVE _LENGTH	Unsigned8	2 to 8	10	None	S	The curve length of table characterization.
74	CURVE _X	Array of Float		*	%	S	Input points of characterization curve.
75	CURVE _Y	Array of Float		*	%	S	Output points of characterization curve.
76	CAL_POINT_HI_ BACKUP	Float		100.0	%	S	Indicates the backup for highest calibration point.
77	CAL_POINT_LO_ BACKUP	Float		0.0	%	S	Indicates the backup lowest calibration point.
78	CAL_POINT_HI_FACTORY	Float		100.0	%	S	Indicates the factory for highest calibration point.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
79	CAL_POINT_LO_FACTORY	Float		0.0	%	S	Indicates the factory for lowest calibration point.
80	**SETUP**	**Unsigned8**	**En/Dis**	**Disable**	**None**	**N**	**Enable self-calibration.**
81	FEEDBACK _CAL	Float		0	%	S	The position value used to correct a calibration.
82	CAL_CONTROL	Unsigned8	En/Dis	Disable	None	S	Enable and disable a calibration method.
83	**RETURN**	**DS-65**		*****	**FVR**	**D**	**The actual valve position and status, could be used at the READBACK_VALUE in an AO block.**
84	POT_KP	Unsigned8		*	None	S	The servo gain value by hardware.
85	POT_DC	Unsigned8		*	None	S	The DC constant value for the piezo sensor.
86	MAGNET_SIZE	Unsigned8		*	None	S	Features of Magnet.
87	ANALOG_LATCH	Unsigned8		*	None	S	Analog Switch used by hardware.
88	MAIN_LATCH	Unsigned8		*	None	S	Air to Open/Close.
89	DIGITAL_TEMPERATURE	DS-65		*	None	D	The digital temperature value.
90	PIEZO_ANALOG_VOLTAGE	DS-65		*	VOLTS	D	The piezo analog voltage value.
91	PIEZO_DIGITAL_VOLTAGE	DS-65		*	None	D	The piezo digital voltage value.
92	DA_OUTPUT_VALUE	DS-65		*	None	D	Digital analog output value.
93	USER_DA_CAL_POINT_HI	Float		*	None	S	Digital analog value for output in a highest calibration point.
94	USER_DA_CAL_POINT_LO	Float		*	None	S	Digital analog value for output in a lowest calibration point.
95	DIGITAL_HALL_VALUE	Unsigned16		*	None	D	Digital Hall value.
96	**SETUP_PROGRESS**	**Unsigned8**	**0/100**	*****	**None**	**D**	**Shows the setup progress status.**
97	HALL_OFFSET	float		*	None	D	The value after done self offset Hall calibration for Hall sensor value.
98	ORDERING_CODE	Array of Unsigned8		NULL	None	S	Indicates information about the sensor and control from factory production.
99	TRAVEL_ENABLE	Unsigned8	True/False	False	None	S	Enables the travel action
100	TRAVEL_DEADBAND	Float	± INF	2	None	S	It's the magnitude value of the valve movement, in percent of ranged travel (full stroke), necessary to increment the Travel
101	TRAVEL_LIMIT	Float	± INF	0	None	S	It is the value of the Travel.
102	TRAVEL	Float	± INF	*	None	D	It is the number of equivalent ranged travel (full stroke). The Travel value is incremented when the magnitude of the changing exceeds the Travel Deadband.
103	REVERSAL_ENABLE	Unsigned8	True/False	False	None	S	Enables the reversal action
104	REVERSAL_DEADBAND	Float	± INF	2	None	S	It is the magnitude value of the valve movement, in percent of ranged travel, necessary to increment the Reversal
105	REVERSAL_LIMIT	Float	± INF	0	None	S	It is the value of the Reversal, which, when exceeded, an Alert is generated. The alert is cleared by entering a new Reversal value lower than the Reversal Limit.
106	REVERSAL	Float	± INF	*	None	D	It is the number of times the valve changes direction. The Reversal is incremented when there is a changing in the direction and the movement exceeds the Reversal Deadband.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
107	DEVIATION_ENABLE	Unsigned8	True/False	False	None	S	Enables the deviation action
108	DEVIATION_DEADBAND	Float	± INF	2	None	S	It's the magnitude value of the valve deviation, in percent of ranged travel.
109	DEVIATION_TIME	Float	± INF	5	None	S	It's the time, in seconds, that the valve must exceed the Deviation Deadband before the alert is generated.
110	STROKES	Float	± INF	*	None	D	It is number of the times that the valve reached its maximum and minimum position.
111	**TIME_CLOSING**	**Float**	**± INF**	*****	**None**	**S**	**The time in seconds it took to stroke the valve from fully open to fully close.**
112	**TIME_OPENING**	**Float**	**± INF**	*****	**None**	**S**	**The time in seconds it took to stroke the valve from fully closed to fully open.**
113	HIGHEST_TEMPERATUR E	Float	± INF	*	None	S	Indicates the highest environment temperature.
114	LOWEST_TEMPERATUR E	Float	± INF	*	None	S	Indicates the lowest environment temperature.
115	DIAGNOSES_STATUS	Unsigned8		*	None	D	Show the device status (fails and warnings)
116	SENSOR_PRESS_UNIT	Unsigned16		psi	E	S	Pressure unit
117	SENSOR_CAL_SELECTE D	Unsigned8	In,out1, out2	In	None	S	Selects between the three sensor pressure
118	SENSOR_CAL_POINT_HI	Float	0 - 100 psi	100	PRESS _UNIT	S	The highest calibrated point for the sensor pressure.
119	SENSOR_CAL_POINT_L O	Float	0 - 100 psi	0	PRESS _UNIT	S	The lowest calibrated point for the sensor pressure.
120	SENSOR_PRESS_IN	DS-65	0 - 100 psi	0	PRESS _UNIT	D	The reading of input sensor pressure.
121	SENSOR_PRESS_OUT1	DS-65	0 - 100 psi	0	PRESS _UNIT	D	The reading of out1 sensor pressure.
122	SENSOR_PRESS_OUT2	DS-65	0 - 100 psi	0	PRESS _UNIT	D	The reading of out2 sensor pressure.
123	SENSOR_PRESS_LO_LI M	Float	0 - 100 psi	0	PRESS _UNIT	S	The maximum limit value for the input pressure.
124	SENSOR_PRESS_HI_LI M	Float	0 - 100 psi	100	PRESS _UNIT	S	The minimum limit value for the input pressure.
125	SENSOR_PRESS_INSTA LLED	Unsigned8	Not Installed/ Installed	*	*	N	Says if there are sensor pressure installed
126	SENSOR_PRESS_STAT US	Unsigned8		*	None	D	Show the sensor pressure status

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static CU: CAL_UNIT; FVR: FINAL_VALUE_RANGE; SR: SENSOR_RANGE; SVU: SECONDARY_VALUE_RANGE

Gray Background Line: Default Parameters of Syscon

FP302 - Fieldbus Pressure Transducer

Description

The fieldbus pressure transducer block is a basic positioner transducer, which means that it is actually only a direct output, without positioning algorithm. The transducer block receives the demanded pneumatic signal output FINAL_VALUE from the AO block and makes the corrected actual position sensor reading RETURN available to the AO block. The engineering unit and the final value range are selected from the XD_SCALE in the AO block. The units allowed are: Pa, KPa, MPa, bar, mbar, torr, atm, psi, g/cm², kg/cm², inH20 a 4°C, inH2O a 68°F, mmH20 a 68°F, mmH20 a 4°C, ftH20 a 68°F, inHg a 0°C, mmHg a 0°C. The XD_SCALE range must be inside the range in the unit selected (3-30 psi). The supported mode is OOS and AUTO. As the transducer block runs together with AO block, the transducer block goes to AUTO only if the AO mode block is different from OOS. The sensor module temperature may be read from the SECONDARY_VALUE parameter.

Warning messages may appear in Return status or in the Block Error in certain condition as explain below.

Supported Modes

OOS and AUTO.

BLOCK_ERR

The BLOCK_ERR of the transducer block will reflect the following causes:

- Block Configuration – When the XD_SCALE has an improper range or unit.
- Output Failure – When mechanic module is disconnected from main electronic board or no air supply.
- Out of Service – When the block is in OOS mode.

Return Status

The RETURN status of the transducer block will reflect the following causes:
Bad::NonSpecific:NotLimited – When mechanic module is disconnected from main electronic board or no air supply.

Parameters

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
1	ST_REV	Unsigned16	Positive	0	None	S	Indicates the level of static data.
2	TAG_DESC	VisibleString		Null	Na	S	Description of Transducer Block.
3	STRATEGY	Unsigned16		0	None	S	This parameter is not checked and processed by Transducer Block.
4	ALERT_KEY	Unsigned8	1-255	0	Na	S	Number of identification in the plant.
5	**MODE_BLK**	**DS-69**		**O/S,AUTO**	**None**	**S**	**Indicates the operation mode of Transducer Block.**
6	**BLOCK_ERR**	**Bit String**			**E**	**D**	**Indicates the status associated with hardware or software in the Transducer.**
7	UPDATE_EVT	DS-73			Na	D	It is the alert for any static data.
8	BLOCK_ALM	DS-72			Na	D	It is used for configuration, hardware and others failures.
9	TRANSDUCER_DIRECTORY	Array of Unsigned16			None	N	It is used to select several Transducer Blocks.
10	TRANSDUCER_TYPE	Unsigned16		65535	None	N	Indicates the type of Transducer according to its class.
11	XD_ERROR	Unsigned8		16	None	D	It is used to indicate calibration status.
12	COLLECTION_DIRECTORY	Array of Unsigned 32			None	S	Specifies the number of transducer index into Transducer Block.
13	**FINAL_VALUE**	**DS-65**			**FRV**	**D**	**It is the pressure value and status that comes from AO block.**

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
14	**FINAL_VALUE_RANGE**	**DS-68**			**FRV**	**S**	**The High and Low range limit values, the engineering unit code and the number of digits to the right of the decimal point to be used for Final Value.**
15	CAL_POINT_HI	Float	12.0-16.0 psi	15.0	CU	S	The highest calibrated point.
16	CAL_POINT_LO	Float	2.5-5.0 psi	3.0	CU	S	The lowest calibrated point.
17	CAL_MIN_SPAN	Float		7.0	CU	S	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points (high and low) are not too close together.
18	CAL_UNIT	Unsigned16		1141(psi)	E	S	Engineering units code for the calibration values.
19	CONV_SN	Unsigned32		0	None	S	The converter serial number.
20	CAL_METHOD	Unsigned8		Factory	None	S	The method of last sensor calibration.
21	ACT_FAIL_ACTION	Unsigned8		0	None	S	Specifies the action the actuator takes in case of failure.
22	ACT_MAN_ID	Unsigned32		0	None	N	The actuator manufacturer identification number.
23	ACT_MODEL_NUM	VisibleString		NULL	None	N	The actuator model number.
24	ACT_SN	VisibleString		0	None	N	The actuator serial number.
25	VALVE_MAN_ID	Unsigned32		0	E	N	The valve manufacturer identification number.
26	VALVE_MODEL_NUM	VisibleString		NULL	None	N	The valve model number.
27	VALVE_SN	VisibleString		0	None	N	The valve serial number.
28	VALVE_TYPE	Unsigned8			E	N	The type of the valve.
29	XD_CAL_LOC	VisibleString		NULL	None	S	The location of the last device calibration.
30	XD_CAL_DATE	Time of Day			None	S	The date of last device calibration.
31	XD_CAL_WHO	VisibleString		NULL	None	S	The name of the person responsible for the last calibration.
32	SECONDARY_VALUE	DS-65		0	SUV	D	The secondary value related to the sensor.
33	**SECONDARY_VALUE_UNIT**	**Unsigned16**		**°C(1001)**	**E**	**S**	**The engineering units to be used with the secondary value related to the sensor.**
34	**SENSOR_RANGE**	**DS-68**		**3.0-15.0 psi**	**FRV**	**S**	**The high and low range limits values, the engineering unit and the number of digits to the right of the decimal for the sensor.**
35	**BACKUP_RESTORE**	**Unsigned8**		**0**	**None**	**S**	**This parameter is used to do backup or to restore configuration data.**
35	COEFF_PRESS_POL0	Float	± INF	-7.78630E-3	None	S	The coefficient of pressure 0.
37	COEFF_PRESS_POL1	Float	± INF	0.118645	None	S	The coefficient of pressure 1.
38	COEFF_PRESS_POL2	Float	± INF	-1.2996E-4	None	S	The coefficient of pressure 2.
39	COEFF_PRESS_POL3	Float	± INF	1.2045E-6	None	S	The coefficient of pressure 3.
40	COEFF_PRESS_POL4	Float	± INF	-2.05803E-9	None	S	The coefficient of pressure 4.
41	COEFF_PRESS_POL5	Float	± INF	1.04282E-6	None	S	The coefficient of pressure 5.
42	COEFF_PRESS_POL6	Float	± INF	-1.50E-5	None	S	The coefficient of pressure 6.
43	COEFF_PRESS_POL7	Float	± INF	0.0	None	S	The coefficient of pressure 7.
44	COEFF_PRESS_POL8	Float	± INF	0.0	None	S	The coefficient of pressure 8.
45	COEFF_PRESS_POL9	Float	± INF	0.0	None	S	The coefficient of pressure 9.
46	COEFF_PRESS_POL10	Float	± INF	0.0	None	S	The coefficient of pressure 10.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
47	POLYNOMIAL_PRESS_VERSION	Unsigned8		11H	None	S	The pressure polynomial version.
48	COEFF_SENS_PRESS_POL0	Float	± INF	-8.83725E-3	None	S	The coefficient of pressure sensor 0.
49	COEFF_SENS_PRESS_POL1	Float	± INF	8.2531E-2	None	S	The coefficient of pressure sensor 1.
50	COEFF_SENS_PRESS_POL2	Float	± INF	1.06854E-4	None	S	The coefficient of pressure sensor 2.
51	COEFF_SENS_PRESS_POL3	Float	± INF	-9.99245E-7	None	S	The coefficient of pressure sensor 3.
52	COEFF_SENS_PRESS_POL4	Float	± INF	1.8581E-9	None	S	The coefficient of pressure sensor 4.
53	COEFF_SENS_PRESS_POL5	Float	± INF	-6.73231E-6	None	S	The coefficient of pressure sensor 5.
54	COEFF_SENS_PRESS_POL6	Float	± INF	0.0	None	S	The coefficient of pressure sensor 6.
55	COEFF_SENS_PRESS_POL7	Float	± INF	0.0	None	S	The coefficient of pressure sensor 7.
56	POLYNOMIAL_SENS_PRESS_VERSION	Unsigned8		10H	None	S	The polynomial version for the pressure sensor.
57	CAL_POINT_HI_SENSOR_PRES	Float		15.0	psi	S	The highest calibration point for the pressure sensor.
58	CAL_POINT_LO_SENSOR_PRES	Float		3.0	psi	S	The lowest calibration point for the pressure sensor.
59	COEFF_SENS_TEMP_POL0	Float	± INF	-7.05E1	None	S	The coefficient of temperature sensor 0.
60	COEFF_SENS_TEMP_POL1	Float	± INF	7.734E-1	None	S	The coefficient of temperature sensor 1.
61	COEFF_SENS_TEMP_POL2	Float	± INF	-1.072E-4	None	S	The coefficient of temperature sensor 2.
62	COEFF_SENS_TEMP_POL3	Float	± INF	0.0	None	S	The coefficient of temperature sensor 3.
63	COEFF_SENS_TEMP_POL4	Float	± INF	0.0	None	S	The coefficient of temperature sensor 4.
64	POLYNOMIAL_SENS_TEMP_VERSION	Unsigned8		10H	None	S	The polynomial version for the temperature sensor.
65	RETURN	DS-65		0	FRV	D	The actual pressure value and status that goes too Readback_Value in an AO Block.
66	CHARACTERIZATION_TYPE	Unsigned8		255	None	S	Indicates the type of characterization curve.
67	CURVE_BYPASS	Unsigned8	True/False	True	None	S	Enable and disable the characterization curve.
68	CURVE_LENGTH	Unsigned8	2 to 8	8	None	S	Indicates the length of characterization curve.
69	CURVE_X	Array of Float		%	%	S	Input points of characterization curve.
70	CURVE_Y	Array of Float		%	%	S	Output points of characterization curve.
71	FEEDBACK _CAL	Float			FRV	S	The measured pressure value used by the calibration method.
72	CAL_CONTROL	Unsigned8	En/Dis	Disable	None	D	After enter in a calibration method CAL_CONTROL is used to return to the normal operation before the calibration.
73	CAL_POINT_HI_BACKUP	Float		15	CU	S	Indicates the backup for highest calibration point.
74	CAL_POINT_LO_ BACKUP	Float		3	CU	S	Indicates the backup for lowest calibration point.

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
75	CAL_POINT_HI_FACTORY	Float		15	CU	S	Indicates the factory for highest calibration point.
76	CAL_POINT_LO_FACTORY	Float		3	CU	S	Indicates the factory for lowest calibration point.
77	PWM_CAL_POINT_HI	Float		12450	None	S	The pwm value for the highest calibration point.
78	PWM_CAL_POINT_LO	Float		2490	None	S	The pwm value for the lowest calibration point.
79	OUT_POLYN_CAL_POINT_HI _PRES	Float		1.90	None	S	The polynomial output value for the highest calibration point.
80	OUT_POLYN _CAL_POINT_LO_PRES	Float		0.38	None	S	The polynomial output value for the lowest calibration point.
81	OUT_POLYNOMIAL_PRESS	DS-65		0	psi	D	The polynomial output value when in normal operation.
82	SENSOR_PRESSURE	DS-65		0	psi	D	The value and status for the pressure sensor.
83	DIGITAL_PRESSURE	DS-65		0	None	D	The digital value and status for the pressure sensor.
84	OUT_POLYNOMIAL_SENS _PRESS	DS-65		0	psi	D	The polynomial output value for the pressure sensor when in normal operation.
85	DIGITAL_VOLTAGE	DS-65		0	None	D	The digital value and status for the piezo.
86	VOLTAGE	DS-65		0	VOLTS	D	The value and status for the piezo.
87	PWM_VALUE	Unsigned16		0	None	D	The value pwm to actual pressure in the process.
88	SENSOR_TEMPERATURE	DS-65		0	°C	D	The value and status for temperature sensor.
89	DIGITAL_TEMPERATURE	DS-65		0	None	D	The digital value and status for temperature sensor.
90	CAL_TEMPERATURE	Unsigned8	-40/85 °C	25 °C	°C	S	The calibration point for the temperature sensor.
91	CAL_DIGITAL_TEMPERATURE	Float		125.606	None	S	The digital calibration point for the temperature sensor.
92	ORDERING_CODE	VisibleString		NULL	None	S	Indicates information about the sensor and control from factory production.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static CU: CAL_UNIT; FVR: FINAL_VALUE_RANGE; SR: SENSOR_RANGE; SVU: SECONDARY_VALUE_RANGE

Gray Background Line: Default Parameters of Syscon

FI302 – Fieldbus Current Transducer

Description

The fieldbus current transducer block is a basic converter transducer, which means that it is actually only a direct output, without positioning algorithm. The transducer block receives the demanded current signal output FINAL_VALUE from the AO block and it makes the actual position/status reading RETURN available to AO block. The engineering unit and the final value range are selected from the XD_SCALE in the AO block. The only unit allowed in this case is mA. The XD_SCALE range must be inside the current range (4-20). The selection of the output terminal for this transducer is done in TERMINAL_NUMBER (1-3). The AO block connected to this transducer has the CHANNEL the same selection as TERMINAL_NUMBER. The supported mode is OOS and AUTO. As the transducer block runs together with AO block, the transducer block goes to AUTO only if the AO mode block is different from OOS.

Warning messages may appear in Return status or in the Block Error in certain condition as explain below.

Supported Modes

OOS and AUTO.

BLOCK_ERR

The BLOCK_ERR of the transducer block will reflect the following causes:

- Block Configuration – When the XD_SCALE has an improper range or unit.
- Output Failure – When the current loop is broken.
- Out of Service – When the block is in OOS mode.

Return Status

The RETURN status of the transducer block will reflect the following causes:
Bad::NonSpecific:NotLimited – When the current loop is broken.

Parameters

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
1	ST_REV	Unsigned16	Positive	0	None	S	Indicates the level of static data.
2	TAG_DESC	VisibleString		Null	Na	S	Description of Transducer Block.
3	STRATEGY	Unsigned16		0	None	S	This parameter is not checked and processed by Transducer Block.
4	ALERT_KEY	Unsigned8	1-255	0	Na	S	Number of identification in the plant.
5	**MODE_BLK**	**DS-69**		**O/S,AUTO**	**None**	**S**	**Indicates the operation mode of Transducer Block.**
6	**BLOCK_ERR**	**Bit String**			**E**	**D**	**Indicates the status associated with hardware or software in the Transducer.**
7	UPDATE_EVT	DS-73			Na	D	It is the alert for any static data.
8	BLOCK_ALM	DS-72			Na	D	It is used for configuration, hardware and other failures.
9	TRANSDUCER_DIRECTORY	Array of Unsigned16		0	None	N	It is used to select several Transducer Blocks.
10	TRANSDUCER_TYPE	Unsigned16		65535	None	N	Indicates the type of Transducer according to its class.
11	XD_ERROR	Unsigned8		16	None	D	It is used to indicate calibration status.
12	COLLECTION_DIRECTORY	Array of Unsigned 32			None	S	Specifies the number of transducer index into Transducer Block.
13	**FINAL_VALUE**	**DS-65**		**0**	**FVR**	**D**	**It is the current value and status that comes from AO block.**
14	**FINAL_VALUE_RANGE**	**DS-68**		**4.0-20.0mA**	**FVR**	**S**	**The High and Low range limit values, the engineering units code and the number of digits to the right of the decimal point to be used for Final Value.**

Idx	Parameter	Data Type	Valid Range	Initial/ Default Value	Units	Store	Description
15	CAL_POINT_HI	Float	12.5-20.5mA	20.0	mA	S	The highest calibrated value.
16	CAL_POINT_LO	Float	3.99-11.5mA	4.0	mA	S	The lowest calibrated value.
17	CAL_MIN_SPAN	Float		1.0	mA	S	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points (high and low) are not too close together.
18	CAL_UNIT	Unsigned16		mA	mA	S	The Device Description engineering units code index for the calibration values.
19	ACT_SN	Unsigned32	0 to 2^{32}	0	None	S	Indicates the actuator serial number.
20	CAL_METHOD	Unsigned8		Factory	None	S	The method of last sensor calibration. ISO defines several standard methods of calibration. This parameter is intended to record that method, or if some other method was used.
21	CAL_LOC	Visible String		NULL	None	S	The location of last sensor calibration. This describes the physical location at which the
22	CAL_DATE	Time of Day			None	S	The date of the last sensor calibration.
23	SENSOR_CAL_WHO	VisibleString		NULL	None	S	The name of person who is in charge of last calibration.
24	**RETURN**	**DS-65**		0	**mA**	**D**	**This is the current value that goes to the AO Block.**
25	**TERMINAL_NUMBER**	**Unsigned8**	1,2,3	0	**None**	**S**	**Indicates the input terminal number (1, 2 and 3).**
26	BACKUP_RESTORE	Unsigned8		0	None	S	This parameter is used to do backup or to restore configuration data.
27	CHARACTERIZATION_TYPE	Unsigned8		255	None	S	Indicates the type of characterization curve.
28	CURVE _BYPASS	Unsigned8	True/False	False	None	S	Enable and disable the characterization curve.
29	CURVE_LENGTH	Unsigned8	2 to 8	8	None	S	Indicates the length of characterization curve.
30	CURVE_X	Array of Float		%	%	S	Input points of characterization curve.
31	CURVE_Y	Array of Float		%	%	S	Output points of characterization curve.
32	FEEDBACK_CAL	Float		0	mA	D	The measured current value used by the calibration method.
33	CAL_CONTROL	Unsigned8	En/Dis	Disable	None	D	Enable and disable for calibration process.
34	CAL_POINT_HI_BACKUP	Float		20.0	mA	S	Indicates the backup for high calibration point.
35	CAL_POINT_LO_ BACKUP	Float		4.0	mA	S	Indicates the last high calibration point.
36	CAL_POINT_HI_FACTORY	Float		20.0	mA	S	Indicates the last low calibration point.
37	CAL_POINT_LO_FACTORY	Float		4.0	mA	S	Indicates the low factory calibration point.
38	ORDERING_CODE	VisibleString			None	S	Indicates information about factory production.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static
CU: CAL_UNIT; FVR: FINAL_VALUE_RANGE; SR: SENSOR_RANGE; SVU: SECONDARY_VALUE_RANGE

Gray Background Line: Default Parameters of Syscon

Flexible Function Block

Description

The FFB block can receive up to 8 discrete input variables from the FF network through the parameters IN_D1 to IN_D8 parameters and also make available to the FF network 8 discrete output variables through the parameters OUT_D1 to OUT_D8 parameters. It can receive up to 16 discrete input variables from its hardware inputs (HW_IN) and also make available 8 discrete outputs through its hardware(HW_OUT).

Status indication for the inputs depends on the I/O subsystem. Status indication for the outputs depends on the block calculation

The FFB block provides logic such as AND, OR, XOR and NOT and functions such as Timer On-Delay, Timer Off-Delay, Timer Pulse, Pulse Counter Down (CTD), Pulse Counter Up(CTU), RS Flip-Flop and SR Flip-Flop. The logic is done using the eight discrete variables available for the FF network (OUT_Dx), the eight input parameters from the FF network (IN_Dx), the sixteen input discrete variables from DC302 hardware(HIN), the eight output discrete variables from DC302 hardware(HOUT), failsafe(FSx) values and auxiliary bit variables(AUX's).

BLOCK_ERR

The BLOCK_ERR of the FFB block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when there is error in the logic line indicates by ERROLINE parameter and ERROCODE parameter.
- Input failure – When occurs failure in the input power supply.
- Output failure – When occurs failure in the output power supply.
- Out of Service – When the block is in O/S mode.

Status Handling

The status of OUT_Dx will be the following if the BLOCK_ERR indicates:

- Other – Bad : Configuration Error
- Input failure – Bad : Device Failure
- Power up – Bad : Device Failure

In the logic, a status higher and equal to 0x80 is considered true and a status lower than 0x80 is considered false.

Supported Modes

O/S, MAN and AUTO.
Changes on the Logic Lines and its configuration parameters depend on the CHANGE_OPTION selection.

Schematic

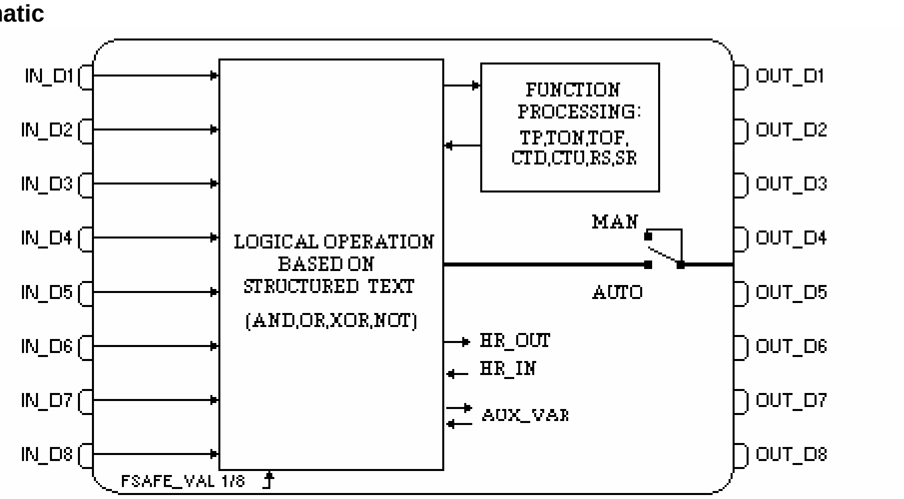


Figure 2.64 - FFB Schematic

Parameters

Idx	Parameter	Data Type/ (Length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	The revision level of static data associated with the function block.
2	TAG_DESC	OctString(32)		Spaces	Na	S	The user description of intended application of the block.
3	STRATEGY	Unsigned16		0	None	S	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
5	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**The actual, target, permitted and normal modes of the block.**
6	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	**This parameter reflects the error status associated with the hardware and software components associated with the block. It is a bit string, so multiple errors may be shown.**
7	PI_POINTER	Unsigned32		0	None	S	Index of the PI associated to the function block or resource. An index of 0 indicates that there is no PI associated to the function block or resource.
8	CONTENTS_REV	Unsigned32		0	None	S	This attribute indicates the revision level of the FFB algorithm. The low order 16 bits contain the minor revision level and the upper 16 bits contain the major revision level.
9	**IN_D1**	**DS-66**				**D**	**Discrete Input 1 for the calculation block.**
10	**IN_D2**	**DS-66**				**D**	**Discrete Input 2 for the calculation block.**
11	**IN_D3**	**DS-66**				**D**	**Discrete Input 3 for the calculation block.**
12	**IN_D4**	**DS-66**				**D**	**Discrete Input 4 for the calculation block.**
13	**IN_D5**	**DS-66**				**D**	**Discrete Input 5 for the calculation block.**
14	**IN_D6**	**DS-66**				**D**	**Discrete Input 6 for the calculation block.**
15	**IN_D7**	**DS-66**				**D**	**Discrete Input 7 for the calculation block.**
16	**IN_D8**	**DS-66**				**D**	**Discrete Input 8 for the calculation block.**
17	FSTATE_VAL_D1	Unsigned8		0		S	The preset discrete value to use in failure for hardware output 1.
18	FSTATE_VAL_D2	Unsigned8		0		S	The preset discrete value to use in failure for hardware output 2.
19	FSTATE_VAL_D3	Unsigned8		0		S	The preset discrete value to use in failure for hardware output 3.
20	FSTATE_VAL_D4	Unsigned8		0		S	The preset discrete value to use in failure for hardware output 4.
21	FSTATE_VAL_D5	Unsigned8		0		S	The preset discrete value to use in failure for hardware output 5.
22	FSTATE_VAL_D6	Unsigned8		0		S	The preset discrete value to use in failure for hardware output 6
23	FSTATE_VAL_D7	Unsigned8		0		S	The preset discrete value to use in failure for hardware output 7.
24	FSTATE_VAL_D8	Unsigned8		0		S	The preset discrete value to use in failure for hardware output 8.
25	**OUT_D1**	**DS-66**				**D / Man**	**The calculated discrete output variable 1 of the block in AUTO mode or specified by the user when in MAN mode.**
26	**OUT_D2**	**DS-66**				**D / Man**	**The calculated discrete output variable 2 of the block in AUTO mode or specified by the user when in MAN mode.**

Idx	Parameter	Data Type/ (Length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
27	**OUT_D3**	**DS-66**				**D / Man**	**The calculated discrete output variable 3 of the block in AUTO mode or specified by the user when in MAN mode.**
28	OUT_D4	DS-66				D / Man	The calculated discrete output variable 4 of the block in AUTO mode or specified by the user when in MAN mode.
29	OUT_D5	DS-66				D / Man	The calculated discrete output variable 5 of the block in AUTO mode or specified by the user when in MAN mode.
30	OUT_D6	DS-66				D / Man	The calculated discrete output variable 6 of the block in AUTO mode or specified by the user when in MAN mode.
31	OUT_D7	DS-66				D / Man	The calculated discrete output variable 7 of the block in AUTO mode or specified by the user when in MAN mode.
32	OUT_D8	DS-66				D / Man	The calculated discrete output variable 8 of the block in AUTO mode or specified by the user when in MAN mode.
33	**HW_IN**	**DS-160**				**D / Man**	**Data Structure: 16 unsigned8 values and 1 unsigned8 status for Hardware Discrete Inputs.**
34	**HW_OUT**	**DS-159**				**D / Man**	**Data Structure: 8 unsigned8 values and 1 unsigned8 status for Hardware Discrete Outputs.**
35	AUX_01_16	Bitstring(2)				D/ OS	Auxiliary bit enumerated variable 01_16.
36	AUX_17_32	Bitstring(2)				D/ OS	Auxiliary bit enumerated variable 17_32.
37	AUX_33_48	Bitstring(2)				D/ OS	Auxiliary bit enumerated variable 33_48.
38	AUX_49_64	Bitstring(2)				D/ OS	Auxiliary bit enumerated variable 49_64.
39	AUX_65_80	Bitstring(2)				D/ OS	Auxiliary bit enumerated variable 65_80.
40	AUX_81_96	Bitstring(2)				D/ OS	Auxiliary bit enumerated variable 81_96.
41	TON_PST	16 Floats	Positive	0	sec	S/ OS	Array of 16 float elements where the user can set the PST timer duration in seconds for each Timer ON Delay.
42	TON_CTA	16 Floats		0	sec	D	Array of 16 float elements where the user can read the lapsed time until the PST timer duration in seconds for each Timer ON Delay.
43	TON_OUT	Bitstring(2)				D	A bit enumerated that indicates the timer output states.
44	TOFF_PST	16 Floats	Positive	0	sec	S/ OS	Array of 16 float elements where the user can set the PST timer duration in seconds for each Timer OFF Delay.
45	TOFF_CTA	16 Floats		0	sec	D	Array of 16 float elements where the user can read the lapsed time until the PST timer duration in seconds for each Timer OFF Delay.
46	TOFF_OUT	Bitstring(2)				D	A bit enumerated that indicates the timer output states.
47	TP_PST	16 Floats	Positive	0	sec	S/ OS	Array of 16 float elements where the user can set the PST timer duration in seconds for each Timer Pulse.
48	TP_CTA	16 Floats		0	sec	D	Array of 16 float elements where the user can read the lapsed time until the PST timer duration in seconds for each Timer Pulse.
49	TP_OUT	Bitstring(2)				D	A bit enumerated that indicates the timer output states.
50	CTU_PST	16 Unsigned32	Positive	0	None	S/ OS	Array of 16 unsigned integer32 elements where the user can set the PST value of each pulse counter. The counter will increment from zero to PST value.

Idx	Parameter	Data Type/ (Length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
51	CTU_CTA	16 Unsigned32		0	None	D	Array of 16 unsigned integer32 elements where the user can read the incremented value of each pulse counter.
52	CTU_OUT	Bitstring(2)				D	A bit enumerated that indicates the counter output states.
53	CTD_PST	16 Unsigned32	Positive	0	None	S/ OS	Array of 16 unsigned integer32 elements where the user can set the PST value of each pulse counter. PST is a preset value since the counter will decrement until zero.
54	CTD_CTA	16 Unsigned32		0	None	D	Array of 16 unsigned integer32 elements where the user can read the decremented value of each pulse counter.
55	CTD_OUT	Bitstring(2)				D	A bit enumerated that indicates the counter output states.
56	RS_OUT	Bitstring(2)				D	A bit enumerated that indicates the RS Flip-Flop output states.
57	SR_OUT	Bitstring(2)				D	A bit enumerated that indicates the SR Flip-Flop output states.
58	**LOGIC_01**	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 1.
59	**LOGIC_02**	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 2.
60	**LOGIC_03**	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 3.
61	LOGIC_04	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 4.
62	LOGIC_05	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 5.
63	LOGIC_06	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 6.
64	LOGIC_07	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 7.
65	LOGIC_08	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 8.
66	LOGIC_09	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 9.
67	LOGIC_10	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 10.
68	LOGIC_11	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 11.
69	LOGIC_12	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 12.
70	LOGIC_13	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 13.
71	LOGIC_14	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 14.
72	LOGIC_15	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 15.
73	LOGIC_16	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 16.
74	LOGIC_17	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 17.
75	LOGIC_18	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 18.
76	LOGIC_19	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 19.
77	LOGIC_20	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 20.
78	LOGIC_21	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 21.
79	LOGIC_22	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 22.
80	LOGIC_23	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 23.
81	LOGIC_24	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 24.
82	LOGIC_25	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 25.
83	LOGIC_26	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 26.
84	LOGIC_27	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 27.
85	LOGIC_28	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 28.
86	LOGIC_29	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 29.
87	LOGIC_30	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 30.
88	LOGIC_31	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 31.
89	LOGIC_32	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 32.

Idx	Parameter	Data Type/ (Length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
90	LOGIC_33	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 33.
91	LOGIC_34	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 34.
92	LOGIC_35	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 35.
93	LOGIC_36	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 36.
94	LOGIC_37	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 37.
95	LOGIC_38	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 38.
96	LOGIC_39	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 39.
97	LOGIC_40	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 40.
98	LOGIC_41	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 41.
99	LOGIC_42	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 42.
100	LOGIC_43	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 43.
101	LOGIC_44	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 44.
102	LOGIC_45	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 45.
103	LOGIC_46	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 46.
104	LOGIC_47	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 47.
105	LOGIC_48	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 48.
106	LOGIC_49	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 49.
107	LOGIC_50	VisibleString(24)		Spaces	Na	S/ OS	Logical Line Command 50.
108	**LOGIC_CHECk**	**Unsigned8**	**0 - Enable.,** **1 – Checked.** **2- Changed but not checked yet.**	**1 - Checked.**	**Na**	**D/OS**	**Allows the check for logic line.**
109	**ERROR_LINE**	**Unsigned8**	**0-50**	**1**	**Na**	**S**	**Indicates the logic line where there is an error.**
110	ERROR_CODE	Unsigned8	0 - Logic Ok. 1 - Exceed String Length or string not valid. 2 - Non valid operand. 3 - No implemented logic or missing ';' 4 - Missing parentheses or argument not valid. 5 - Non valid resource. 6 - Argument not valid. 7 - Function not valid 8 - Non available resource. 9 - Non valid attribution. 10 - First Argument not valid. 11- Second Argument not valid.	3 - No implemented logic or missing ';'	Na	S	Indicated the code for the error in the logic line.

Idx	Parameter	Data Type/ (Length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
111	CHANGE_OPTION	Unsigned8	0 - Logic parameter changes are only allowed in Out of Service. 1 - Always accept Logic parameter changes.	0 - Logic parameter changes are only allowed in Out of Service.	Na	S	Enable logic parameter changes independent of Mode Block parameter
112	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
113	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

The following table describes the Logic Operation and Command line and the correspondent Symbols used in the logic line:

<table>
<tr><th>Logic Operation and Command line</th><th>Symbol - description</th></tr>
<tr><td>AND</td><td>&</td></tr>
<tr><td>OR</td><td>|</td></tr>
<tr><td>XOR</td><td>^</td></tr>
<tr><td>NOT</td><td>!</td></tr>
<tr><td>EQUAL</td><td>=</td></tr>
<tr><td>(arg1,arg2)</td><td>To define function arguments</td></tr>
<tr><td>;</td><td>End of logic line</td></tr>
</table>

The logic NOT (!) works only with simple variables. Example: OUT1=!IN1;
Note That is not allowed to have, for example, OUT1=!TP01(IN1);. To use this way, we should have: A01= TP01(IN1);. -> OUT1=!A01;

The logic is always executed line by line and from left to right in the logic line. Spaces are not allowed between the characters. **It is not allowed empty lines between logic lines and the implemantation of logic lines must be in sequence.**

After writing the logic into the LOGIC_XX (XX:01 -> XX:50) parameters, the user needs to select the option "Enable" in the parameter LOGIC_CHECK to verify the errors. **When the logic is configured using the download process, it is necessary to configure firstly the LOGIC_XX (XX:01 -> XX:50) parameters and then the LOGIC_CKECK parameter. This sequence is fundamental to performing the check.**

The following table shows the mnemonic for each block parameter used in the logic lines. The mnemonic must be in capital letters:

Parameter	Mnemonic
HW_IN.Value1	I01
HW_IN.Value2	I02
HW_IN.Value3	I03
HW_IN.Value4	I04
HW_IN.Value5	I05
HW_IN.Value6	I06
HW_IN.Value7	I07
HW_IN.Value8	I08
HW_IN.Value9	I09
HW_IN.Value10	I10
HW_IN.Value11	I11
HW_IN.Value12	I12
HW_IN.Value13	I13
HW_IN.Value14	I14
HW_IN.Value15	I15
HW_IN.Value16	I16
HW_IN.Status	SI
HW_OUT.Status	SO
HW_OUT.Value1	O1
HW_OUT.Value2	O2
HW_OUT.Value3	O3
HW_OUT.Value4	O4
HW_OUT.Value5	O5
HW_OUT.Value6	O6
HW_OUT.Value7	O7
HW_OUT.Value8	O8
IN_D1.Status	IN1S
IN_D2.Status	IN2S
IN_D3.Status	IN3S
IN_D4.Status	IN4S
IN_D5.Status	IN5S
IN_D6.Status	IN6S
IN_D7.Status	IN7S
IN_D8.Status	IN8S
IN_D1.Value	IN1
IN_D2.Value	IN2
IN_D3.Value	IN3
IN_D4.Value	IN4
IN_D5.Value	IN5
IN_D6.Value	IN6
IN_D7.Value	IN7
IN_D8.Value	IN8
OUT_D1.Status	SOUT1
OUT_D2.Status	SOUT2
OUT_D3.Status	SOUT3
OUT_D4.Status	SOUT4
OUT_D5.Status	SOUT5
OUT_D6.Status	SOUT6

Parameter	Mnemonic
OUT_D7.Status	SOUT7
OUT_D8.Status	SOUT8
OUT_D1.Value	OUT1
OUT_D2.Value	OUT2
OUT_D3.Value	OUT3
OUT_D4.Value	OUT4
OUT_D5.Value	OUT5
OUT_D6.Value	OUT6
OUT_D7.Value	OUT7
OUT_D8.Value	OUT8
FSTATE_VAL_D1	FS1
FSTATE_VAL_D2	FS2
FSTATE_VAL_D3	FS3
FSTATE_VAL_D4	FS4
FSTATE_VAL_D5	FS5
FSTATE_VAL_D6	FS6
FSTATE_VAL_D7	FS7
FSTATE_VAL_D8	FS8
AUX_01_16	A01-A16
AUX_17_32	A17-A32
AUX_33_48	A33-A48
AUX_49_64	A49-A64
AUX_65_80	A65-A80
AUX_81_96	A81-A96
TON	TON01-TON16
TOFF	TOF01-TOF16
TP	TP01-TP16
CTU	CTU01-CTU16
CTD	CTD01-CTD16
RS	RS01-RS16
SR	SR01-SR16

Functions

For each type of function there are 16 available resources and the user can user only once each resource. To use the function results, the user can make attribution for auxiliary bits.

TP TIMER PULSE

This function generates a fixed time pulse in the output timer for every rising (false to true transition) on the input timer. The pulse width is determined by TP_PST parameter in seconds. Transitions in the input timer will be ignored while the pulse is active. The current time is available in the TP_CTA parameter.

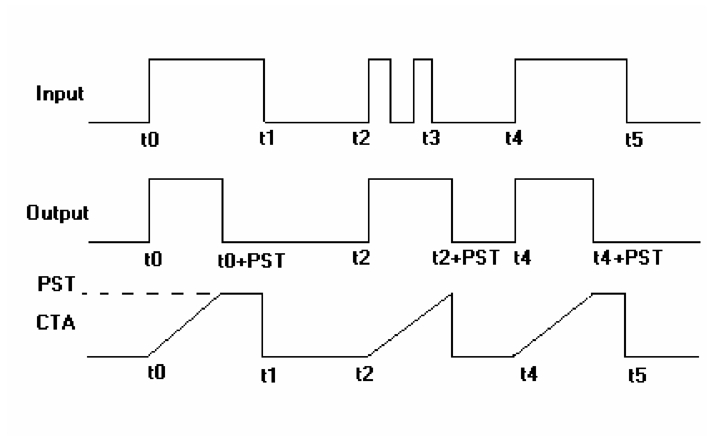


Figure 2.65 - Timer Pulse Function – Timing Diagrams

The Syntax for Timer Pulse is: TPxx(arg)

Where, xx is the used resource from 01 to 16 and arg is the function argument and it must be a simple variable. Examples:

O1=TP01(IN1);
OUT1= TP01(A05);
OUT3=TP08(FS1);

For example, the following examples are not allowed in the logic line:
O1=TP01(IN1&IN2);: note that the argument is a result of an operation, it is not allowed.
O1=TP10(!IN1);: note that the argument is a result of NOT function, it is not allowed.
O1=TP10(CTD01(IN1,IN2));: note that the argument is a result of a function, it is not allowed.

TON TIMER ON-DELAY

This function delays the timer output of going to true for a period of time after the input has moved to true. This period is configured by TON_PST parameter in seconds. If the input goes to false before the PST time, the output timer will remain in false. The CTA parameter will show the remainder time until PST value.

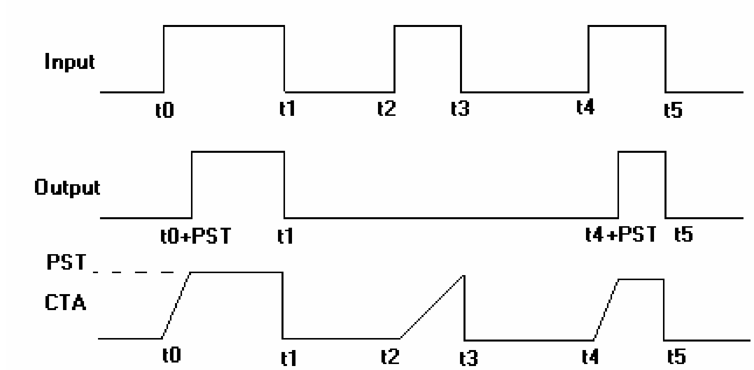


Figure 2.66 - Timer On-Delay Function – Timing Diagrams

The syntax for Timer On-Delay is: TONxx(arg)

Where, xx is the used resource from 01 to 16 and arg is the function argument and it must be a simple variable . Examples:

O1=TON01(IN1)&SI;
OUT1= TON01(A05);
OUT3=TON08(FS1);

For example, the following examples are not allowed in the logic line:
O1=TON01(IN1&IN2);: note that the argument is a result of an operation, it is not allowed.
O1=TON10(!IN1);: note that the argument is a result of NOT function, it is not allowed.
O1=TON10(CTD01(IN1,IN2));: note that the argument is a result of a function, it is not allowed.

TOF TIMER OFF-DELAY

This function extends the true state of timer input for a determined period of time for the output timer. This period is configured by TOF_PST parameter in seconds. If the input goes to true before the out goes to false, the out will stay on true and the time period will begin to count again at the moment when the input goes to false. The CTA parameter will show the remainder time until PST value.

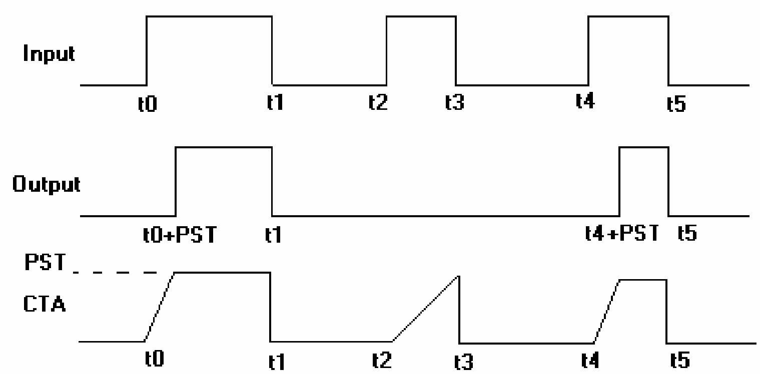


Figure 2.67 - Timer OFF-Delay Function – Timing Diagrams

The syntax for Timer Off-Delay is: TOFxx(arg)

Where, xx is the used resource from 01 to 16 and arg is the function argument and it must be a simple variable .Examples:

O1=TOF01(IN1)&SI;
OUT1= TOF01(A05);
OUT3=TOF08(FS1);

For example, the following examples are not allowed in the logic line:
O1=TOF01(IN1&IN2);: note that the argument is a result of an operation, it is not allowed.
O1=TOF10(!IN1);: note that the argument is a result of NOT function, it is not allowed.
O1=TOF10(CTD01(IN1,IN2));: note that the argument is a result of a function, it is not allowed.

CTD PULSE COUNTER DOWN

This function is used to count rising transitions (from false to true) in the counter input(arg1). Every time it is seeing a rising transition the internal counter accumulator (CTA) decrements of one. When the CTA reaches zero the counter output will go to true. The counter value will be preset for PST.A transition from false to true in the second argument(arg2) presets the counter.

The syntax for CTD is: CTDxx(arg1,arg2)

Where, xx is the used resource from 01 to 16 and arg1 and arg2 are the function arguments and they must be simple variables. Examples:

O3=CTD10(IN1,IN2);
OUT1=CTD03(A11,A14)&SI;

For example, the following examples are not allowed in the logic line:
O1=CTD01(IN1&IN2,IN3);: note that the argument is a result of an operation, it is not allowed.
O1=CTD10(!IN1,IN3);: note that the argument is a result of NOT function, it is not allowed.
O1=CTD10(TP01(IN1),IN2);: note that the argument is a result of a function, it is not allowed.

CTU PULSE COUNTER UP

This function is used to count rising transitions (from false to true) in the counter input(arg1). Every time it is seeing a rising transition the internal counter accumulator (CTA) increments of one. When the CTA reaches the preset value PST, the counter output will go to true. A transition from false to true in the second argument(arg2) resets the counter.

The syntax for CTU is: CTUxx(arg1,arg2)

Where, xx is the used resource from 01 to 16 and arg1 and arg2 are the function arguments and they must be simple variables. Examples:

O3=CTU10(IN1,IN2);
OUT1=CTU03(A11,A14)&SI;

For example, the following examples are not allowed in the logic line:
O1=CTU01(IN1&IN2,IN3);: note that the argument is a result of an operation, it is not allowed.
O1=CTU10(!IN1,IN3);: note that the argument is a result of NOT function, it is not allowed.
O1=CTU10(TP01(IN1),IN2);: note that the argument is a result of a function, it is not allowed.

RS FLIP-FLOP

This function has the following operation table:

R(arg1)	S(arg2)	OUT
0	0	Last state
0	1	1
1	0	0
1	1	0

The syntax for RS Flip-Flop is: RSxx(arg1,arg2)

Where, xx is the used resource from 01 to 16 and arg1 and arg2 are the function arguments and they must be simple variables. Examples:

O3=RS10(IN1,IN2);
OUT1=RS03(A11,A14)&SI;

For example, the following examples are not allowed in the logic line:
O1=RS01(IN1&IN2,IN3);: note that the argument is a result of an operation, it is not allowed.
O1=RS10(!IN1,IN3);: note that the argument is a result of NOT function, it is not allowed.
O1=RS10(TP01(IN1),IN2);: note that the argument is a result of a function, it is not allowed.

SR FLIP-FLOP

This function has the following operation table:

S(arg1)	R(arg2)	OUT
0	0	Last state
0	1	0
1	0	1
1	1	1

The syntax for SR Flip-Flop is: SRxx(arg1,arg2)

Where, xx is the used resource from 01 to 16 and arg1 and arg2 are the function arguments and they must be simple variables. Examples:

O3=SR10(IN1,IN2);
OUT1=SR03(A11,A14)&SI;

For example, the following examples are not allowed in the logic line:
O1=SR01(IN1&IN2,IN3);: note that the argument is a result of an operation, it is not allowed.
O1=SR10(!IN1,IN3);: note that the argument is a result of NOT function, it is not allowed.
O1=SR10(TP01(IN1),IN2);: note that the argument is a result of a function, it is not allowed.

Error Code

Some examples of error conditions:

Error Code: "Exceed String Length or string not valid."

a) OUT1=IN1&IN2&IN2|IN4^IN5|IN6;

Note that they are 29 characters on the string and the maximum allowed is 24.

b) OUT1=IN1&in2;

Note that the logic is case sensitive. All characters must be in capital letters.

Error Code: "Non valid operand."

OUT1=IN1%IN2;

Note that the % is not allowed. See the table that describes the Logic Operation and Command line.

Error Code: "No implemented logic or missing ';' ."

OUT1=IN1

Note that is missing the "; "at the final of logic line.

Error Code: "Missing parentheses or argument not valid."

OUT1=TP10(IN1;

Note that is missing parentheses in the timer pulse function.

Error Code: "Non valid resource."

OUT1=TP18(IN1);

Note there are 16 resources for each function

Error Code: "Argument not valid."

OUT1=TP10(IN10);

Note there are only 8 inputs. IN10 is not valid argument.

Error Code: "Function not valid."

OUT1=TR10(IN1);

Note that TR is not valid function.

Error Code: "Non available resource."

OUT1=TP10(IN1);

A03=TP10(IN7);

Note there are 16 resources for each function and the resource 10 for the timer was already in using than the user needs to select other resource for the logic line:
A03=TP10(IN7);

Error Code: "Non valid attribution."

IN1=IN2^TP03(IN4);

Note that is not allowed attribution to inputs.

Error Code: "First Argument not valid."

OUT1=CTD01(!IN1,IN2);

Note that the arguments are necessarily simple variables and not functions.

OUT1=RS11(IN15,IN2);

Note that the first argument is not allowed.

Error Code: "Second Argument not valid."
a) OUT1=CTD01(IN1,!IN2);

Note that the arguments are necessarily simple variables and not functions.

OUT1=RS11(IN1,IN20);

Note that the second argument is not allowed.

Example of applications:

1) According to the Figure 2.68, we have an industrial application where the aim is to fill up the bottles with a chemical fluid. The conveyor moves the bottles up to the filling direction and then the bottle is detected by a sensor .The conveyor must stop and open the valve of filling and the level is detected by another sensor. After detecting the level, the system must wait for 10 seconds and then moves the conveyor again until the next bottle.

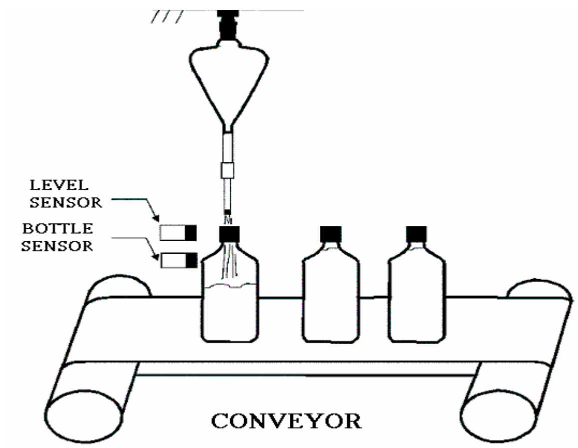


Figure 2.68 – Application Example of Bottles filling up

Using the Flexible Function Block we have the following definitions:

- The conveyor will be turned on using the hardware output 01 (O1);
- The fluid valve will be turned on using the hardware output 02 (O2);
- The bottle sensor will be connected to the hardware input 01 (I01);
- The level sensor will be connected to the hardware input 02 (I02);
- The power system will be connected to the hardware input 03 (I03);

We have the following configuration:

TON_PST resource [01] = 10.0s.
LOGIC_01 A01=TON01(I02);
LOGIC_02 O1=I03&!I01|A01;
LOGIC_03 O2=I01&!I02;

Making an analogy to ladder programming, we have:

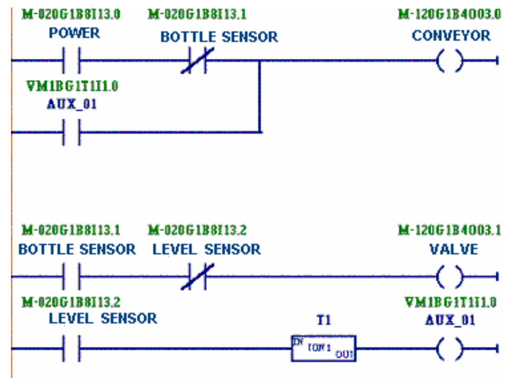


Figure 2.69 –Example of Ladder Programming

2) The following application we have the control of steps to operate an electro-mechanical balance, that weights phosphatic stone.
The weight process is done by boat-load, the system executes one full weight cycle each interval time of 20 seconds. See the following figure:

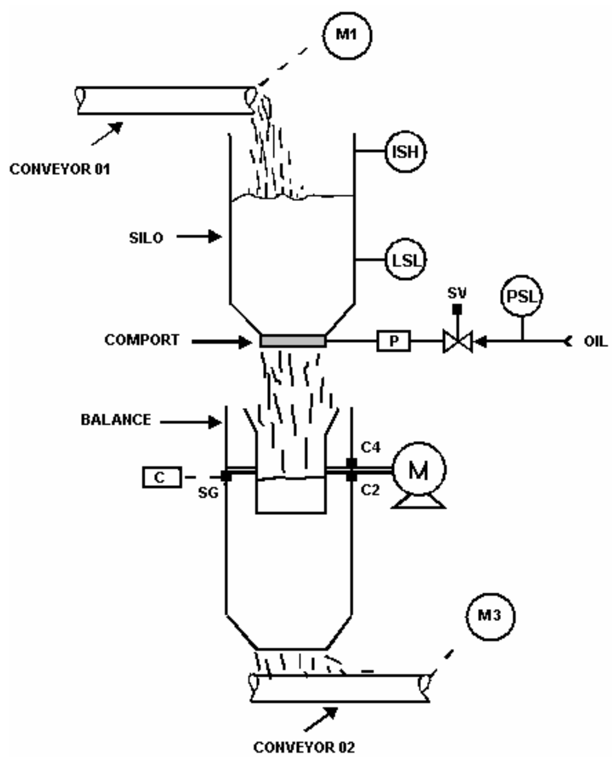


Figure 2.70 – Example of electro-mechanical Balance

M1 e M3 - Motors for the conveyors
C2 e C4 - Limit Switches
LSH - High Level Sensor
LSL - Low Level Sensor
SG - Load Cell
SV - Solenoid Valve
M - Bucket Motor
P - Comport Piston
C - Weight Circuit
Process:
The system requires the following conditions to startup:

- The phosphatic stone level (LSL non activated);
- Oil Pressure (PSL on);
- Conveyor 02 active (M3 on);
- Bucket in initial position (C4 on);

After the initial conditions, we note:

- Activating the power switch, the comport opens, and then this begins the loading bucket
- After reaches the desired weight, the comport closes. After 5 seconds, the bucket rotates 180^o and unload the product into the conveyor 02.

Observation:
This new detected position will be detected by C2 and after 5 seconds, the bucket will have to return to initial position and this will be detected by C4.

- After the bucket return to the initial position, we have a new weight cycle.

Comment:
- The operation sequence must be stopped if any requiring is not satisfied.
- The silo comport is activated by a hydraulic piston.

Using the Flexible Function Block we have the following definitions:

- LSL will be connected to the hardware input 01 (I01);
- LSH will be connected to the hardware input 02 (I02);
- PSL will be connected to the hardware input 03 (I03);
- C2 will be connected to the hardware input 04 (I04);
- C4 will be connected to the hardware input 05 (I05);
- Power will be connected to the hardware input 06 (I06);
- M3 will be connected to the hardware input 07 (I07);
- M will be activated by hardware output 01 (O1);
- The Comport will be activated by hardware output 02 (O2);
- M1 will be activated by hardware output 03 (O3);

We have the following configuration:

TON_PST resource [01] = 5.0s.
LOGIC_01 A01=!I01&I03&I07&I05;
LOGIC_02 A02=I06&RS01(I02,I01);
LOGIC_03 O3=A02&I03;
LOGIC_04 A03=I03&I07;
LOGIC_05 O2=I06&A03&!I04;
LOGIC_06 O1=TON01(I04)&!I05&A03;

3) Using Fault-State values:

Lets suppose we have the following condition:
- A01: it receives the logic between the status for discrete inputs like this: A01=IN1S&IN2S; when the status is bad for one of these inputs then A01=false(0), otherwise, A01=true (1);
- FS1: it is the fault-state value for O1;
- A02: it is the bit containing the logic for O1;

We have the following table between the FS1, A01 and A02:

FS1	A01	A02	O1
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

Then,

A03=!FS1&A01&A02;
A04=FS1&!A01&!A02;
A05=FS1&!A01&A02;
A06=FS1&A01&A02;
O1=A03|A04|A05|A06;

HART Function Blocks

Instructions on HI302 Configuration

The minimum configuration to be applied in the Syscon consists of:

- 1 RESOURCE block;
- 1 HCFG block;
- 1HIRT block for each HART device;
- 1 AI block for current reading.

The maximum block limit and its quantity in the factory configuration are shown below:

BLOCK	MAXIMUM	FCT INIT[2]	FCT INIT[3]
RS2	1	1	1
DIAG	1	1	1
MAO/MAI[1]	1	1	0
AO/AI[1]	8	8	8
HCFG	1	1	1
HIRT	8	8	0
HUT	8	0	8
HVT	8	0	0
HCD	1	0	0
HWPC	1	0	0
HBC	1	0	0

1 – In HI302-N model consider 0.
2 – Normal version of factory.
3 – Special version for Hosts FF that not support blocks dynamic instantiation, by inquiry.

Limits for applications:
Maximum number of blocks: 24
Maximum number of Subscriber links: 12
Maximum number of Publisher links: 19

IMPORTANT
Whenever a download is performed, wait for the yellow SAVING LED to turn off. Only then turn off or reset the equipment. If the equipment is turned off or reset during the data saving process, the configuration must be redone. See the chapter "HI302 Configuration Example" for more details.

HCFG Block

Configuring the HCFG block

The HCFG block (HART Configuration) has a series of parameters which can be divided into two categories: operation parameters and diagnostic parameters.

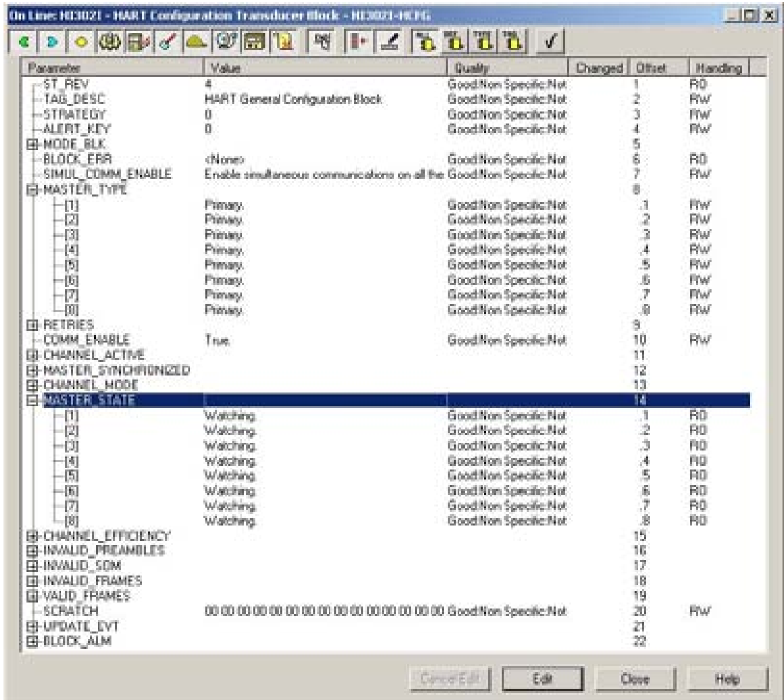


Figure 2.71 – Configuring the HCFG Block

HART communication Operation Parameters

FIRMWARE_VERSION: A parameter indispensable to solve problems. If something is not working properly, confirm the equipment version before contacting the technical support.

COMM_BEHAVIOR: Defines the HI302 behavior. It can operate in two ways: if the parameter is **Autonomous**, the HI302 communicates with the HART devices by using the previous configuration, i.e., in an independent way. The second way uses bypass parameters to send and receive HART messages. To do so, this parameter should be configured as **Bypass**.

COMM_ENABLE: This parameter has two important functions:

- To disable the whole HART communication for maintenance and configuration changes;
- To validate the configuration loaded in the equipment and then begin the communication (afterwards). Its first value is **DISABLED**. Before making any change in the block configuration, (a must) set it on **ENABLED**, stopping the HART communication. After the configuration download, this parameter should be re-set to **ENABLED**.

ATTENTION
When changing the channel in the HIRT block or downloading new configurations, this parameter is automatically set on **DISABLED**, stopping, then, the HART communication in all channels. When the download finishes **ENABLED** must be set manually. If this procedure is not performed, the HI302 will not work properly.

CHANNEL_ACTIVE: This indicates how many HIRT blocks are instantiated for each HART channel. If no HIRT block is instantiated for the channel, the corresponding element of this parameter will display **NO** and the channel will be deactivated. As a result, there will be no device communication or scanning. The LED channel will blink at approximately ¼ Hz. This parameter is useful to check the configuration. The HVT block is also counted in this parameter.

MASTER_TYPE: This parameter allows for adjusting the channel as a **Primary** master or as a **Secondary** master. Remember that each channel is an independent master. In normal conditions, the channel should be a primary master in order to permit the use of a portable configurator.

RETRIES: This parameter adjusts the number of times the HI302 will try to communicate with a device, before detecting that the device doesn't respond. The standard value is 3 retries.

HART Communication Diagnostic Parameters

MASTER_SYNCHRONIZED: Indicates if every Master channel has synchronized the communication layer and if each is ready to transmit the HART messages in normal operation or in Bypass mode.

CHANNEL_MODE: Indicates if the channel is operating normally or there is any device in BURST_MODE.

MASTER_STATE: Shows the status of the HART channel at every moment:.

- **WATCHING**, indicates that the channel is only reading data that passes through the line and are crucial to keep the synchronism if there is another Master or any device in Burst mode.
- **ENABLED**, the channel is free to send a HART message.
- **USING,** indicates that a message was sent and a corresponding response is expected. The response has to be sent within the maximum number of retries configured in the RETRIES parameter.

COMM_ERRORS: shows the percentage of detected errors in the communication of each HART channel. If the error percentage is lower than 0,5%, communication is in high quality.

REQUEST_COUNTER: Totals the number of messages sent by each channel, including the retries.

RETRIES_COUNTER: Totals the number of repetitions for each channel. A high value in this parameter (>0,5%) may indicate any installation problem or any command not supported by the device.

INVALID_SOM: Totals the number of invalid SOM (Start of Message) detected in the channel. A high value in this parameter may indicate installation problems or any device with a problem.

INVALID_RX_FRAMES: Totals the number of HART messages received but not considered because of any inconsistency in the message, for example, checksum error.

VALID_RX_FRAMES: Totals the number of valid messages received and processed by the HI302, even if they are not addressed to it, for example, OACK, OBACK, STX etc

WARNING
The counter parameters, used for diagnostic purposes, are always reset when the **COMM_ENABLE** parameter goes to **ENABLED**.

HIRT Block

Configuring the HIRT block

This block has a set of parameters that map all of the HART variables that can be accessed by the universal commands and by the some of the most usable “common practice” commands. Remember that there is a HIRT block for each HART device installed and that the configuration may vary according to the application mode and type. For more details about the supported commands, check Appendix A of the HI302 Manual.

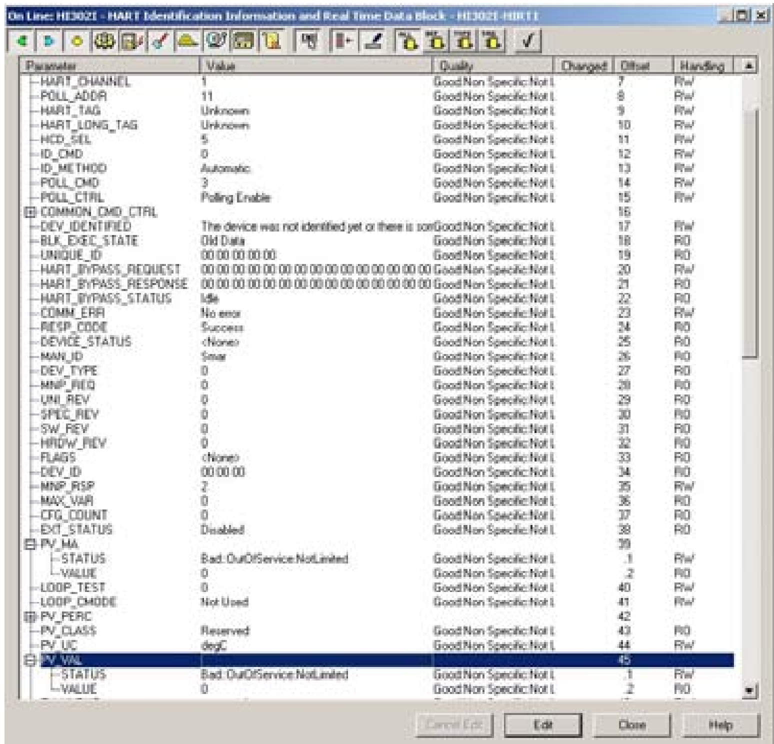


Figure 2.72 – Configuring the HIRT Block

A minimum set of parameters needs a configuration to allow the HI302 to work properly. Most of the parameters have standard values that are suitable for many operation cases. Thus, it is not necessary to download them. However, a comprehensive analysis must be done in order to determine the best profile for each device configuration. The HI302 offers several resources that must be understood. The parameters that require configuration to work are the following:

MODE_BLK: Should be set on **AUTO**. If it is in OS (Out of Service), the communication with the respective device is interrupted. When the block is set on OS, it returns to the initial Identification state. When it is set on AUTO, all the update and identification processes are repeated.

HART_CHANNEL: Indicates the channel on which the device is installed, from 1 to 8. In normal operation, any change in this parameter will stop the HART communication. See the HCFG.COMM_ENABLE parameter.

POLL_ADDR: Indicates the polling address that has been configured in the device, from 0 to 15. This address is used to recognize the device if the command 0 has been selected in the ID_CMD parameter.

IMPORTANT
If the HART communication is enabled and this parameter has been written, the HI302 will accept the writing in the HART device and will generate a writing transaction. To change this value, without doing it in the device, write *DISABLED* in the HCFG.COMM_ENABLE parameter or set the block on OS.

HART_TAG: the HART device's tag that can be configured by the HI302 module or by a portable configurator. It supports 8 characters and is used by the command 11 to identify the device. The same POLL_ADDR writing observation mentioned above, applies here.

ID_CMD: This parameter indicates to the module which universal command identification (0, or 11) will be used to identify the device. The standard value is 0:

- The command 0 uses the "polling address" (POLL_ADDR) and is the most used command.
- The command 11 uses an 8-character tag and can be used provided the device has a tag configured in the block through the HART_TAG parameter. This option is indicated when there are equipments in multidrop.

IMPORTANT
The identification using TAG is very useful when the device is operating in the multidrop mode and the analog signal is enabled, ranging from 4 mA to 20 mA. In this case, the polling address for all devices in the channel should be 0 making the identification impossible through the command 0.

POLL_CTRL: Indicates if the HI302 will keep polling the device

IMPORTANT
The HI302 will poll the device only if the block has performed the initial procedure successfully and reached the UPDATE status. See the BLK_EXEC_STATE parameter.

COMMON_CMD_FILTER: This parameter is a set of filters that prevents a HART command configured and not supported by the device, to be sent. Their elements should be filled in the HCD block with the definition index of the HART command. See the HI302 manual for more details.

VIEW_SELECTION: Allows the user to choose the group of variables to be updated cyclically in the polling, according to the following table:

Dynamic Variables Polling Map																														
View number	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
Needs Configuration?	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Polling cycle [s]	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**4**	**6**	**1**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**3**	**5**	**3**	**3**	**3**	**3**	**4**	**4**	**4**	**1**	**1**	**1**
Parameter name	**Updated Parameters**																													
COMM_ERR	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DEVICE_STATUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ADDITIONAL_STATUS	X	X	X	X	X	X	X	X	X	X																		X		
LOOP_CURRENT	X	X								X	X	X								X	X	X	X	X	X	X	X		X	
PV_PERC	X	X								X	X	X								X	X	X	X	X	X	X	X			
PV_UC		X								X		X								X	X	X	X	X	X	X	X		X	
PV_VAL		X								X		X								X	X	X	X	X	X	X	X		X	
SV_UC		X								X		X								X	X	X	X	X	X	X	X		X	
SV_VAL		X								X		X								X	X	X	X	X	X	X	X		X	
TV_UC		X								X		X								X	X	X	X	X	X	X	X		X	
TV_VAL		X								X		X								X	X	X	X	X	X	X	X		X	
QV_UC		X								X		X								X	X	X	X	X	X	X	X		X	
QV_VAL		X								X		X								X	X	X	X	X	X	X	X		X	
A1_UC			X			X		X	X	X			X			X		X	X	X	X				X					X
A1_VAL			X			X		X	X	X			X			X		X	X	X	X				X					X
A2_UC			X			X		X	X	X			X			X		X	X	X	X				X					X
A2_VAL			X			X		X	X	X			X			X		X	X	X	X				X					X
A3_UC			X			X		X	X	X			X			X		X	X	X	X				X					X
A3_VAL			X			X		X	X	X			X			X		X	X	X	X				X					X
A4_UC			X			X		X	X	X			X			X		X	X	X	X				X					X
A4_VAL			X			X		X	X	X			X			X		X	X	X	X				X					X
B1_UC				X		X	X		X	X				X		X	X		X	X		X			X	X				
B1_VAL				X		X	X		X	X				X		X	X		X	X		X			X	X				
B2_UC				X		X	X		X	X				X		X	X		X	X		X			X	X				
B2_VAL				X		X	X		X	X				X		X	X		X	X		X			X	X				
B3_UC				X		X	X		X	X				X		X	X		X	X		X			X	X				
B3_VAL				X		X	X		X	X				X		X	X		X	X		X			X	X				
B4_UC				X		X	X		X	X				X		X	X		X	X		X			X	X				
B4_VAL				X		X	X		X	X				X		X	X		X	X		X			X	X				
C1_UC					X		X	X	X	X					X		X	X	X	X			X			X	X			
C1_VAL					X		X	X	X	X					X		X	X	X	X			X			X	X			
C2_UC					X		X	X	X	X					X		X	X	X	X			X			X	X			
C2_VAL					X		X	X	X	X					X		X	X	X	X			X			X	X			
C3_UC					X		X	X	X	X					X		X	X	X	X			X			X	X			
C3_VAL					X		X	X	X	X					X		X	X	X	X			X			X	X			
C4_UC					X		X	X	X	X					X		X	X	X	X			X			X	X			
C4_VAL					X		X	X	X	X					X		X	X	X	X			X			X	X			
D1_UC					X		X	X	X	X					X		X	X	X	X				X			X			
D1_VAL					X		X	X	X	X					X		X	X	X	X				X			X			
D2_UC					X		X	X	X	X					X		X	X	X	X				X			X			
D2_VAL					X		X	X	X	X					X		X	X	X	X				X			X			
D3_UC					X		X	X	X	X					X		X	X	X	X				X			X			
D3_VAL					X		X	X	X	X					X		X	X	X	X				X			X			
D4_UC					X		X	X	X	X					X		X	X	X	X				X			X			
D4_VAL					X		X	X	X	X					X		X	X	X	X				X			X			

Configuration needed: **N** means that no additional configuration must be done in order to read/write the VIEW-related parameters. Otherwise, if **Y**, the corresponding parameters **XX_CODE** must be set to a proper value in order to tell to HI302 which HART variables are associated with the parameters. This is necessary because the HART 33 command and the HI302 use the stored values at XX_CODE parameters to assembly the HART 33 command. Check the device's specific documentation to find out the variable codes associated with command 33.

Poling cycle ~ [s]: represents the approximate time that each polling cycle will take for that particular VIEW. This time is evaluated as 1 second per each HART transaction (issued command).

HVT Block

Configuring the HVT Block
The HVT block lists the variables relative to the specific commands of the HART equipment. For its correct operation is necessary that before the specific commands have been configured in the HI302 memory or through HCD/HWPC blocks. Consult the Smar about this options.

The HVT block can be seen as a complement for the HIRT block. It includes all non-mapped variables in the HIRT block. Therefore, it is not necessary to have all of the parameters configured, except the following:

MODE_BLK: Should be set on **AUTO**. If it is set on OS, the block operation will stop. When the block is set on OS, it returns to the initial Identification state. When the block is set on AUTO, the block identification and the update process is repeated if there is a valid TAG in the DEV_TAG_SEL parameter.

DEV_TAG_SEL: This parameter doesn't need to be configured for the download. It connects the HIRT block to the HVT block temporarily, allowing the HVT block to communicate with the HART device. This connection is made through the HART_TAG parameter. If the supervisory software has to read the HVT parameters for any device, it should fill the device's HART_TAG. The HVT block then searches in every HIRT block for a written HART_TAG in order to make an association with it automatically. Then, it identifies the HART device and the specific command configuration to be used, as long as this configuration is stored in the Flash memory of the HI302 or in any HCD block. See HI302 manual, chapter about Functioning Theory for more details.

HI302-I - Configuring the MAI or AI block

All HI302-I inputs have an input circuit for the 4-20 mA acquisition. So, it is possible to instantiate until 8 AI blocks or 1 multiple analog input block, MAI.. These blocks are standardized and they are registered on Fieldbus FOUNDATION.

- AI: to associate the AI block to one of the inputs just configure the CHANNEL parameter with the number of the desired physical input, from 1 to 8.
- MAI: has 8 output parameters that provide the percentage value of the analog input. This block needs no configuration to operate, just set up it on AUTO.

HI302-O - Configuring the MAO or AO block

The HI302-O has 8 HART channels in parallel to circuits that control the loop current and the actuators connected to them. The analog outputs can be used through the AO standard blocks (until 8) or through 1 MAO block. These blocks are standardized and they are registered on Fieldbus FOUNDATION.

- AO: to associate the AO block to one of the outputs just configure the CHANNEL parameter with the number of the desired output, from 1 to 8.
- MAO: the channel is configured automatically. The input parameter value always has to be written in percentage. Just set up the block on AUTO.

There are other configuration options, for example, the output value in case of failure.

Starting the HI302 Operation

After configuring the block, download it. Upon the download completion, set the HCFG.COMM_ENABLE parameter on ENABLED to enable the configuration and start the HART communication over all channels.

IMPORTANT
After the download is completed, the configuration should be saved in the non-volatile memory. Saving is automatic and starts with the download. It will take approximately 20 minutes, according to the configuration size. While the SAVING LED is lit, the HI302 cannot be turned off or reset, otherwise, the configuration will be lost..

If the user has devices whose configuration is already in the HI302 memory, e.g. Smar devices, go to the chapter about operation and functioning theory. In case the user has to set a specific configuration, see on the HI302 manual the chapter about advanced configuration, first. For more details on how to configure the HI302, visit our site www.smar.com.

Calibrating the analog HI302circuits

In order to achieve the most accurate operation of the HI302-I or HI302-O, it is important to calibrate the analog boards. During the factory tests, a preliminary calibration is done, being sufficient for most applications. However, it may be necessary to perform a new calibration in the field. To do so, follow the steps described in the Help of the HCFG.ANALOG_INPUT_TRIM or HCFG.ANALOG_OUTPUT_CAL parameters. See a summary below.

Important
When the calibration is done, it is valid for the pair GLL1193+(GLL1205 or GLL1194). If the analog board has been changed for any reason, a new calibration should be done because the calibration data is stored in the base board for that particular analog board (GLL1193).

Calibration of the HI302-I (GLL1205)

To calibrate a GLL1205, the user should use an accurate current source and follow the steps below:

1. Apply a 12 mA current (50% of the 16mA span) to each input. The calibration can be done in only one channel or in all of the 8 channels at once.
2. After stabilizing the current (2 seconds), write the number of the desired channel on the HCFG.ANALOG_INPUT_TRIM parameter or write All Channels to calibrate all of them at once.
3. Check, in the AI/MAI block, if the value of the current is 50% (12mA). If the reading, in any channel, is incorrect, re-do the procedures.
4. If the reading in the 8 channels is 50% (12mA), write on the HCFG.ANALOG_INPUT_TRIM parameter the Trimmed and Checked value in order to save the calibration data.
5. Wait until the SAVING Led turns off and then, turn off the device.

Calibration of the HI302-O (GLL1194)

The user should use an accurate multimeter to calibrate the GLL1194. Follow the steps below:

1. Write 50% on all of the input parameters of the AO/MAO block.
2. Measure the current in each loop using the multimeter. Write each read value on the corresponding element of the HCFG.ANALOG_OUTPUT_CAL[channel] parameter. Write all of the numbers displayed on the multimeter to maximum accuracy.
3. Measure the current again and check if its value has changed, that is, approximately 12 mA.
4. In case the current has changed, write on the HCFG.ANALOG_INPUT_TRIM parameter the Trimmed and Checked value to save the calibration data.

HIRT - HART IDENTIFICATION INFORMATION AND REAL TIME DATA

Parameters

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description	HART Read	HART Write
0	BLOCK_STRUCTURE	DS-64			NA	S			
1	ST_REV	Unsigned16		0	None	S / RO			
2	TAG_DESC	OctString(32)		Spaces	NA	S			
3	STRATEGY	Unsigned16		0	None	S			
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S			
5	**MODE_BLK**	**DS-69**		**O/S**	**NA**	**S**	**See Mode Parameter**		
6	**BLK_ERR**	**Bitstring(2)**			**None**	**D / RO**			
7	**HART_CHANNEL**	**Unsigned8**	**1 to 8**	**1**	**None**	**S**	**HART channel where the device is attached to.**		
8	**ID_CMD**	**Enumerated**	**0: 0 - Polling Address** **11: 11 - HART Tag**	**0 - Polling Address**	**None**	**S**	**Selects the HART Universal Command used to identify the device associated with this block.**		
9	LAST_HART_WRITE_STATUS	Enumerated	**0x00: No Command-Specific Errors** **0x05: Too Few Data Bytes Received** **0x07: In Write Protection Mode** **0x08: Warning: Update Failure** **0x20: Busy** **0x40: Command Not Implemented** **0x81: Undefined Comm Error** **0x82: Buffer Overflow** **0x84: Reserved Comm Error** **0x88: Longitudinal Parity Error** **0x90: Framing Error** **0xA0: Overrun Error** **0xC0: Vertical Parity Error**	0x00: No Command-Specific Errors	None	D / RO	This parameter always reflects the first byte of the Response Code (Command Response Summary) of THE LAST WRITE HART COMMAND ISSUED and must be checked to ensure the write operation has been succeeded.		
10	**POLL_ADDR**	**Unsigned8**	**0 to 15**	**0**	**None**	**S**	**Device's Polling (short) Address).**	**7**	**6**
11	**HART_TAG**	**VisibleString (8)**		**Spaces**	**NA**	**S**	**Device's TAG.**	**13**	**18**
12	POLL_CTRL	Boolean	**0x01:** Polling Enabled **0x00:** Polling Disabled	Polling Enabled	NA	S	Real Time Data Polling Control.		

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description	HART Read	HART Write
13	**VIEW_SELECTION**	**Enumerated**	**0x00: VIEW_00, 0x01: VIEW_01** **0x02: VIEW_02, 0x03: VIEW_03** **0x04: VIEW_04, 0x05: VIEW_05** **0x06: VIEW_06, 0x07: VIEW_07** **0x08: VIEW_08, 0x09: VIEW_09** **0x0A: VIEW_10, 0x0B: VIEW_11** **0x0C: VIEW_12, 0x0D: VIEW_13** **0x0E: VIEW_14, 0x0F: VIEW_15** **0x10: VIEW_16, 0x11: VIEW_17** **0x12: VIEW_18, 0x13: VIEW_19** **0x14: VIEW_20, 0x15: VIEW_21** **0x16: VIEW_22, 0x17: VIEW_23** **0x18: VIEW_24, 0x19: VIEW_25** **0x1A: VIEW_26, 0x1B: VIEW_27** **0x1C: VIEW_28, 0x1D: VIEW_29**	**VIEW_00**	**None**	**S**	**Selects the set of parameters to be updated at each polling cycle. See HI302's user manual for further information about each VIEW.**		
14	COMMON_CMD_FILTER	Unsigned8[5]		0	None	S	This parameter has 5 positions to ignore commands present in configuration but not supported by the device. See HI302´s User Manual for a complete list of that commands.		
15	**BLK_EXEC_STATE**	**Enumerated**	**0x00: Identification** **0x01: Old Data** **0x02: Updating** **0x03: Updated** **0x04: Partially Updated** **0x05: Not Responding** **0x06: Bypass** **0x07: Device Not Found** **0x08: HCD Error** **0x09: TAG Not Found** **0x0A: Writing**	**Identification**	**None**	**D / RO**	**Status of parameter update information and HART communication. Normal condition is UPDATED.**		

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description	HART Read	HART Write
16	COMM_ERR	BitString(8)	**0x00:** No Command-Specific Errors **0x05:** Too Few Data Bytes Received **0x07:** In Write Protection Mode **0x08:** Warning: Update Failure **0x20:** Busy **0x40:** Command Not Implemented **0x81**: Undefined Comm Error **0x82:** Buffer Overflow **0x84:** Reserved Comm Error **0x88:** Longitudinal Parity Error **0x90:** Framing Error **0xA0:** Overrun Error **0xC0:** Vertical Parity Error	0x00: No Command-Specific Errors	None	D / RO	First byte of the last transaction's Response Code if communication error has occurred (Bit7 = 1).	**All**	**All**
17	**DEVICE_STATUS**	**BitString(8)**	**0x01:** Primary Variable Out of Limits **0x02:** Non-Primary Variable Out of Limits **0x04:** Loop Current Saturated **0x08:** Loop Current Fixed **0x10:** More Status Available **0x20:** Cold Start **0x40:** Configuration Changed **0x80:** Device Malfunction	**0**	**NA**	**D / RO**	**Second byte of the last transaction´s Response Code. See HI302's User Manual or HART specification for further details.**	**All**	**All**
18	**ADDITIONAL_STATUS**	**OctString(6)**		**0**	**NA**	**D / RO**	**Cyclic read depends on chosen VIEW. Device specific Additional Status. See device´s specific documentation for details.**	**48**	
19	MAN_ID	Enumerated	HC TABLE 8	0	None	D / RO	Manufacturer ID Code. Used to select specific configuration for HVT block.	**(0, 11)**	
20	DEV_TYPE	Unsigned8		0	None	D / RO	Manufacturer Device Type Code. Used to select specific configuration for HVT block.	**(0, 11)**	
21	UNI_REV	Unsigned8		0	None	D / RO	Revision Level of the HART Universal Commands. Used to select specific configuration for HVT block.	**(0, 11)**	
22	SPEC_REV	Unsigned8		0	None	D / RO	Revision Level of the Device Specific. Used to select specific configuration for HVT block.	**(0, 11)**	
23	SW_REV	Unsigned8		0	None	D / RO	Software Revision Level. Used to select specific configuration for HVT block.	**(0, 11)**	
24	HRDW_REV	Unsigned8		0	None	D / RO	Hardware Revision Level.	**(0, 11)**	
25	FLAGS	BitString(8)	HC TABLE 11	0	NA	D / RO	Flags (manufacturer specific).	**(0, 11)**	
26	DEV_ID	OctString(3)		0	NA	D / RO	Device ID Number.	**(0, 11)**	

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description	HART Read	HART Write
27	**LOOP_CURRENT**	**DS-65**		**0**	**mA**	**D**	**Cyclic read depends on chosen VIEW. Loop Current Value (mA). LOOP_CURRENT.VALUE: loop mA last value, LOOP_CURRENT.STATUS: HART Response Code converted to FOUNDATION Fieldbus status. See HI302´s User Manual for further details.**	**2**	
28	**LOOP_TEST**	**Float**		**0**	**mA**	**D**	**Write the desired current value in mA to enter fixed current mode. Write 0 to exit fixed current mode.**		**40**
29	LOOP_CMODE	Enumerated	HC TABLE 16	0	None	D	Loop Current Mode. See device´s specific documentation.	**7**	**6**
30	MESSAGE	VisibleString(32)		Spaces	NA	D	Message for general purpose.	**12**	**17**
31	DESCRIPTOR	VisibleString(16)		Spaces	NA	D	Descriptor, text for general purpose.	**13**	**18**
32	DATE_INFO	Date		1/1/2001 00:00:00:0000	NA	D	Date (Only Day/Month/Year are considered).	**13**	**18**
33	WRITE_PCODE	Enumerated	HC TABLE 7	0	None	D / RO	Write Protect Code. See device´s specific documentation.	**15**	
34	PLDC	Enumerated	HC TABLE 8	0	None	D / RO	Private Label Distribuitor Code.	**15**	
35	PV_ACF	Enumerated	HC TABLE 26	0	None	D / RO	PV Analog Channel Flags. See device´s specific documentation.	**15**	
36	FAN	OctString(3)		0	NA	D	Final Assembly Number.	**16**	**19**
37	DEV_TEST	Enumerated	**0x00:** Invoke Self Test	0	None	D	Write to perform a device self test.		**41**
38	DEV_RESET	Unsigned8	**0x00:** Reset Device	0	None	D	Write to perfom a device Master RESET.		**42**
39	BURST_MODE	Enumerated	HC TABLE 9	0	None	D	It allows to control device's Burst Mode		**109**
40	PV_ULRUC	Enumerated	HC TABLE 2	0	None	D	PV Upper & Lower Range Value Units Code	**15**	**35**
41	PV_RANGE	DS-68		{0, 0, 0, 0}	XD_SCALE	D	**PV_RANGE.EU_100**: HART PV Upper Range Value, **PV_RANGE.EU_0**: HART PV Lower Range Value, **PV_RANGE_UNITS_INDEX**: HART PV Range (Upper & Lower) Value Units Code translated to Fieldbus table, **PV_RANGE.DECIMAL**: no meam.	**15**	**35, 44**
42	PV_CAL_POINT_L	Enumerated	**0x00:** Set PV Zero	0	None	D	Write to this parameter to set PV Zero (invoke HART Command 43).		**43**
43	PV_SENSOR_SN	OctString(3)		0	NA	D	PV Sensor Serial Number.	**14**	**49**
44	PV_SENSOR_LMSUC	Enumerated	HC_TABLE 2	0	None	D / O	PV Sensor Limits and Minimun Span Units Code.	**14**	
45	PV_SENSOR_MSPAN	Float		0	49	D / RO	PV Minimun Span.	**14**	

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description	HART Read	HART Write
46	PV_SENSOR_RANGE	DS-68		{0, 0, 0, 0}	XD_SCALE	D / RO	**PV_SENSOR_RANGE.EU_100**: PV Upper Sensor Limit, **PV_SENSOR_RANGE.EU_0**: PV Lower Sensor Limit. **PV_SENSOR_RANGE.UNITS_INDEX**: PV Sensor limits and Minimun Span Units Code translated to Fieldbus table. **PV_SENSOR_RANGE.DECIMAL:** no mean.	**14**	
47	PV_ASC	Enumerated	HC TABLE 6	0	None	D / RO	PV Alarm Select code.	**15**	
48	PV_TFC	Enumerated	HC TABLE 3	0	None	D	PV Transfer Function Code.	**15**	**47**
49	PV_DV	Float		0	s	D	PV Damping Value.	**15**	**34**
50	**PV_PERC**	**DS-65**		**0**	**%**	**D / RO**	**Cyclic read depends on chosen VIEW. PV Percent of Range. PV_PERC.VALUE: the percentual Pv value, PV_PERC.Status: HART Response Code converted to FF status.**	**2**	
51	PV_UC	Enumerated	HC TABLE 2	0	None	D	PV Units Code.	**15**	**44**
52	**PV_VAL**	**DS-65**		**0**	**PV_UC**	**D / RO**	**Cyclic read depends on chosen VIEW. PV_VAL.Value : actual PV value in engineering units, PV_VAL.Status: HART Response Code converted to FF status.**	**3**	
53	SV_UC	Enumerated	HC TABLE 2	0	None	D / RO	SV Units Code.	**3**	
54	SV_VAL	DS-65		0	SV_UC	D / RO	**Cyclic read depends on chosen VIEW. SV_VAL.Value**: SV actual value, **SV_VAL.Status**:HART Response Code converted to FF status.	**3**	
55	TV_UC	Enumerated	HC TABLE 2	0	None	D / RO	TV Units Code.	**3**	
56	**TV_VAL**	**DS-65**		**0**	**TV_UC**	**D / RO**	**Cyclic read depends on chosen VIEW. TV_VAL.Value: TV actual value, TV_VAL.Status: HART Response Code converted to FOUNDATION Fieldbus status.**	**3**	
57	QV_UC	Enumerated	HC TABLE 2	0	None	D / RO	QV Units Code.	**3**	
58	QV_VAL	DS-65		0	QV_UC	D / RO	**Cyclic read depends on chosen VIEW. QV_VAL.Value**: TV actual value, **QV_VAL.Status**: HART Response Code converted to FOUNDATION Fieldbus status.	**3**	
59	**A1_CODE**	**Unsigned8**		**0**	**None**	**S**	**Selects variable to appear on A1_VAL**	**33**	
60	A1_UC	Enumerated	HC TABLE 2	0	None	D / RO	A1 variable Units Code.	**33**	
61	A1_VAL	DS-65		0	S0_UC	D / RO	**OUTPUT PARAMETER. Cyclic read depends on chosen VIEW and A1_CODE.**	**33**	
62	**A2_CODE**	**Unsigned8**		**0**	**None**	**S**	**Selects variable to appear on A2_VAL**	**33**	
63	A2_UC	Enumerated	HC TABLE 2	0	None	D / RO	A2 variable Units Code.	**33**	
64	A2_VAL	DS-65		0	S1_UC	D / RO	**Cyclic read depends on chosen VIEW and A2_CODE.**	**33**	
65	**A3_CODE**	**Unsigned8**		**0**	**None**	**S**	**Selects variable to appear on A3_VAL**	**33**	
66	A3_UC	Enumerated	HC TABLE 2	0	None	D / RO	A3 variable Units Code.	**33**	
67	A3_VAL	DS-65		0	S2_UC	D / RO	**Cyclic read depends on chosen VIEW and A3_CODE.**	**33**	
68	**A4_CODE**	**Unsigned8**		**0**	**None**	**S**	**Selects variable to appear on A4_VAL**	**33**	

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description	HART Read	HART Write
69	A4_UC	Enumerated	HC TABLE 2	0	None	D / RO	A4 variable Units Code.	**33**	
70	A4_VAL	DS-65		0	S3_UC	D / RO	**Cyclic read depends on chosen VIEW and A4_CODE.**	**33**	
71	B1_CODE	Unsigned8		0	None	S	Selects variable to appear on B1_VAL	**33**	
72	B1_UC	Enumerated	HC TABLE 2	0	None	D / RO	B1 variable Units Code.	**33**	
73	B1_VAL	DS-65		0	S0_UC	D / RO	**Cyclic read depends on chosen VIEW and B1_CODE.**	**33**	
74	B2_CODE	Unsigned8		0	None	S	Selects variable to appear on B2_VAL	**33**	
75	B2_UC	Enumerated	HC TABLE 2	0	None	D / RO	B2 variable Units Code.	**33**	
76	B2_VAL	DS-65		0	S1_UC	D / RO	**Cyclic read depends on chosen VIEW and B2_CODE.**	**33**	
77	B3_CODE	Unsigned8		0	None	S	Selects variable to appear on B3_VAL	**33**	
78	B3_UC	Enumerated	HC TABLE 2	0	None	D	B3 variable Units Code.	**33**	
79	B3_VAL	DS-65		0	S2_UC	D / RO	**Cyclic read depends on chosen VIEW and B3_CODE.**	**33**	
80	B4_CODE	Unsigned8		0	None	S	Selects variable to appear on B4_VAL	**33**	
81	B4_UC	Enumerated	HC TABLE 2	0	None	D / RO	B4 variable Units Code.	**33**	
82	B4_VAL	DS-65		0	S3_UC	D / RO	**Cyclic read depends on chosen VIEW and B4_CODE.**	**33**	
83	C1_CODE	Unsigned8		0	None	S	Selects variable to appear on C1_VAL	**33**	
84	C1_UC	Enumerated	HC TABLE 2	0	None	D / RO	C1 variable Units Code.	**33**	
85	C1_VAL	DS-65		0	S0_UC	D / RO	**Cyclic read depends on chosen VIEW and C1_CODE.**	**33**	
86	C2_CODE	Unsigned8		0	None	S	Selects variable to appear on C2_VAL	**33**	
87	C2_UC	Enumerated	HC TABLE 2	0	None	D / RO	C2 variable Units Code.	**33**	
88	C2_VAL	DS-65		0	S1_UC	D / RO	**Cyclic read depends on chosen VIEW and C2_CODE.**	**33**	
89	C3_CODE	Unsigned8		0	None	S	Selects variable to appear on C3_VAL	**33**	
90	C3_UC	Enumerated	HC TABLE 2	0	None	D / RO	C3 variable Units Code.	**33**	
91	C3_VAL	DS-65		0	S2_UC	D / RO	**Cyclic read depends on chosen VIEW and C3_CODE.**	**33**	
92	C4_CODE	Unsigned8		0	None	S	Selects variable to appear on C4_VAL	**33**	
93	C4_UC	Enumerated	HC TABLE 2	0	None	D / RO	C4 variable Units Code.	**33**	
94	C4_VAL	DS-65		0	S3_UC	D / RO	**Cyclic read depends on chosen VIEW and C4_CODE.**	**33**	
95	D1_CODE	Unsigned8		0	None	S	Selects variable to appear on D1_VAL	**33**	
96	D1_UC	Enumerated	HC TABLE 2	0	None	D / RO	D1 variable Units Code.	**33**	
97	D1_VAL	DS-65		0	S0_UC	D / RO	**Cyclic read depends on chosen VIEW and D1_CODE.**	**33**	
98	D2_CODE	Unsigned8		0	None	S	Selects variable to appear on D2_VAL	**33**	
99	D2_UC	Enumerated	HC TABLE 2	0	None	D / RO	D2 variable Units Code.	**33**	
100	D2_VAL	DS-65		0	S1_UC	D / RO	**Cyclic read depends on chosen VIEW and D2_CODE.**	**33**	
101	D3_CODE	Unsigned8		0	None	S	Selects variable to appear on D3_VAL	**33**	
102	D3_UC	Enumerated	HC TABLE 2	0	None	D / RO	D3 variable Units Code.	**33**	
103	D3_VAL	DS-65		0	S2_UC	D / RO	**Cyclic read depends on chosen VIEW and D3_CODE.**	**33**	
104	D4_CODE	Unsigned8		0	None	S	Selects variable to appear on D4_VAL	**33**	
105	D4_UC	Enumerated	HC TABLE 2	0	None	D / RO	D4 variable Units Code.	**33**	
106	D4_VAL	DS-65		0	S3_UC	D / RO	**Cyclic read depends on chosen VIEW and D4_CODE.**	**33**	
107	UPDATE_EVT	DS-73			NA	D	This alert is generated by any change to the static data.		

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description	HART Read	HART Write
108	BLK_ALM	DS-72			NA	D	The block alarm is used for all configuration, hardware, 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.		

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

IMPORTANT
The HIRT and HUT blocks are apparentely equals, but they have some important differences: • The HIRT block is a function block, that is, can be used in control strategies in systems which support “manufacturer specific” function blocks. The HUT block is a transducer block to be used in systems which does not work with the HIRT block. In this case, the HART variables can be used only for supervision. • The HIRT block lasts macrocycle’s time to be executed. If you need decrease the application macrocycle check the possibility to use the HUT block instead of HIRT block. • The both blocks’ parameters are absolutely the same, except the following: PV_VAL, SV_VAL, TV_VAL, QV_VAL, A1_VAL, A2_VAL, A3_VA and A4_VAL. In the HIRT block, these parameters can be linked in the strategy while with the HUT block it is not possible.

HCFG - HART Configuration Transducer Block

Parameters

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
0	BLOCK_STRUCTURE	DS-64			NA	S	
1	ST_REV	Unsigned16		0	None	S / RO	
2	TAG_DESC	OctString(32)		Spaces	NA	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	MODE_BLK	DS-69		O/S	NA	S	See Mode Parameter
6	BLK_ERR	Bitstring(2)			None	D / RO	
7	FIRMWARE_VERSION	VisibleString(32)		0	NA	D / RO	Useful for information and diagnostic purposes.
8	COMM_BEHAVIOR	Enumerated	**0x00:** Autonomous **0x01:** Bypass	Autonomous	NA	S	Autonomous means the normal behavior where the database is built automatically. If set to Bypass the device depends on external applications to send HART commands and the block HBC must be used.
9	COMM_ENABLE	Enumerated	**0x01** Enabled **0x00:** Disabled	Disabled	NA	S	After a download or if a channel has been changed in a HIRT block, this parameter will be set to Disabled automatically. Set it to Enabled to start HART communication. **Caution: this parameter must not be saved OFF LINE and downloaded. It must always be written in ON LINE mode only!**
10	CHANNEL_ACTIVE	Enumerated[8]	**0x00:** No **0x01:** 1 **0x02:** 2 **0x0F:** 15	No	NA	D / RO	This parameter shows how many HIRT blocks have been configured to use the corresponding channel. If no block is using the channel, it will remain deactivated.
11	COMM_ERRORS	Float[8]		0	%	D / RO	Shows the percentual of communication errors. Up to 0.5% is acceptable for more than 10.000 requests.
12	MASTER_TYPE	Enumerated[8]	**0x01**: Primary **0x00**: Secondary	Primary	NA	S	HART Master Type, normally Primary.
13	RETRIES	Unsigned8[8]	3 to 10	3	None	S	Number of retries if slave does not respond before slave timeout or if any error is received. Increase the number to make the communication more reliable in noisy environments.
14	MASTER_SYNCHRONIZED	Boolean[8]	**0x01:** Synchronized **0x00:** Not synchronized	Not synchronized	NA	D / RO	**FACTORY USE** - Synchronized means normal operation.
15	CHANNEL_MODE	Enumerated[8]	**0x00:** Normal **0x01:** Burst Mode	Normal	None	D / RO	**FACTORY USE -** This parameter shows if any burst mode device was detected on the respective channel.
16	MASTER_STATE	Enumerated[8]	**0x00:** Watching **0x01:** Enabled **0x02:** Using	Watching	None	D / RO	**FACTORY USE -** It's the Master State Machine behavior at each moment.
17	REQUEST_COUNTER	Unsigned32[8]		0	None	D / RO	**FACTORY USE -** Counts the number of requests made to all devices on that channel.
18	RETRIES_COUNTER	Unsigned32[8]		0	None	D / RO	**FACTORY USE -** Counts the number of retries to all devices on each channel.
19	INVALID_SOM	Unsigned32[8]		0	None	D / RO	**FACTORY USE -** Counts the number of invalid Start Of Messages captured in that channel.
20	INVALID_RX_FRAMES	Unsigned32[8]		0	None	D / RO	**FACTORY USE -** It totalizes the number of INVALID frames received by each channel, whichever the error.
21	VALID_RX_FRAMES	Unsigned32[8]		0	None	D / RO	**FACTORY USE -** It totalizes the number of VALID frames received by each channel.

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
22	ANALOG_INPUT_TRIM	Enumerated	**0x00:** Channel 1, **0x01:** Channel 2, **0x02:** Channel 3, **0x03:** Channel 4, **0x04:** Channel 5, **0x05:** Channel 6, **0x06:** Channel 7, **0x07:** Channel 8, **0x08:** All Channels, **0x09:** Not Trimmed, **0x0A:** Trimmed and Checked	Not Trimmed	NA	S	**FACTORY USE** - Used to calibrate the analog inputs when applicable. Apply a stable signal of 12 mA (+/- 0.005 mA) to the channel (or to all channels at once) and write to this parameter accordingly to the channel you want to calibrate (or All Channels if you want to calibrate all at once). **After calibrate and test write this parameter to Trimmed and Checked to save the data.**
23	ANALOG_OUTPUT_CAL	Float[8]		1.00	mA	S	**FACTORY USE** - This array is used to calibrate the analog outputs when applicable. Using a precision miliampmeter (+/- 1uA) put all outputs in 50% by actuating in MAO block. Using the value the meter is reading, write it in the correspondig element of this array, always with at least 2 decimal, in mA (should be ~ 12 mA). After written the value look at the meter again and confirm the reading now is 12.0 mA. **After calibrate and test write ANALOG INPUT TRIM parameter to Trimmed and Checked to save the calibration data.**
24	UPDATE_EVT	DS-73			NA	D	This alert is generated by any change to the static data.
25	BLK_ALM	DS-72			NA	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

HVT - HART VARIABLE TEMPLATE

Parameters

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
0	BLOCK_STRUCTURE	DS-64			NA	S	
1	ST_REV	Unsigned16		0	None	S / RO	
2	TAG_DESC	OctString(32)		Spaces	NA	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	MODE_BLK	DS-69		O/S	NA	S	See Mode Parameter
6	BLK_ERR	Bitstring(2)			None	D / RO	
7	DEV_TAG_SEL	VisibleString(8)		Spaces	NA	S	Write here a valid HIRT.HART_TAG from an installed device to start HVT on demand reading.
8	HCD_SELECTED	OctString(5)		0	None	D / RO	This code is used to identify the specific configuration associated with the chosen device. This code is read from HIRT block and is a combination of MAN_ID, DEV_TYPE, UNI_REV, SPEC_REV, SW_REV.
9	HCD_DEVICE_INFO	VisibleString(32)		Spaces	NA	D / RO	This parameter shows comment related to selected specific configuration.
10	BLK_EXEC_STATE	Unsigned8	**0x00:** Identification **0x01:** Old Data **0x02:** Updating **0x03:** Updated **0x04:** Partially Updated **0x05:** Not Responding **0x06:** Bypass **0x07:** Device Not Found **0x08:** HCD Error **0x09**: TAG Not Found **0x0A:** Writing	0	None	D / RO	Reflects the execution progress or error conditions. See also BLK_ERR.
11	U8B_ARRAY_1	Unsigned8[20]		0	None	D	First array used for 8-bit variables
12	U8B_ARRAY_2	Unsigned8[20]		0	None	D	Second array used for 8-bit variables
13	U8B_ARRAY_3	Unsigned8[20]		0	None	D	Third array used for 8-bit variables
14	U8B_ARRAY_4	Unsigned8[20]		0	None	D	Fourth array used for 8-bit variables
15	U8B_ARRAY_5	Unsigned8[20]		0	None	D	Fifth array used for 8-bit variables
16	FLOAT_ARRAY_1	FloatingPoint[20]		0	None	D	First array used for Floating Point variables
17	FLOAT_ARRAY_2	FloatingPoint[20]		0	None	D	Second array used for Floating Point variables
18	FLOAT_ARRAY_3	FloatingPoint[20]		0	None	D	Third array used for Floating Point variables
19	FLOAT_ARRAY_4	FloatingPoint[20]		0	None	D	Fourth array used for Floating Point variables
20	FLOAT_ARRAY_5	FloatingPoint[20]		0	None	D	Fifth array used for Floating Point variables
21	U16B_ARRAY_1	Unsigned16[20]		0	None	D	First array of 16-bit (2-byte) values
22	U32B_ARRAY_1	Unsigned32[10]		0	None	D	First array of 32-bit variables
23	U32B_ARRAY_2	Unsigned32[10]		0	None	D	Second array of 32-bit variables
24	String_01	VisibleString(8)		Spaces	NA	D	First general string (8 characters)
25	String_02	VisibleString(8)		Spaces	NA	D	8 characters general use string
26	String_03	VisibleString(8)		Spaces	NA	D	8 characters general use string
27	String_04	VisibleString(8)		Spaces	NA	D	8 characters general use string
28	String_05	VisibleString(8)		Spaces	NA	D	8 characters general use string
29	String_06	VIsibleString(16)		Spaces	NA	D	16 characters general use string
30	String_07	VisibleString(16)		Spaces	NA	D	16 characters general use string
31	String_08	VIsibleString(16)		Spaces	NA	D	16 characters general use string
32	String_09	VisibleString(16)		Spaces	NA	D	16 characters general use string
33	String_10	VIsibleString(16)		Spaces	NA	D	16 characters general use string
34	String_11	VisibleString(32)		Spaces	NA	D	32 characters general use string
35	String_12	VisibleString(32)		Spaces	NA	D	32 characters general use string

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
36	String_13	VisibleString(32)		Spaces	NA	D	32 characters general use string
37	String_14	VisibleString(32)		Spaces	NA	D	32 characters general use string
38	String_15	VisibleString(32)		Spaces	NA	D	32 characters general use string
39	String_16	VisibleString(32)		Spaces	NA	D	32 characters general use string
40	String_17	VisibleString(32)		Spaces	NA	D	32 charactres general use string
41	String_18	VisibleString(32)		Spaces	NA	D	32 characters general use string
42	String_19	VisibleString(32)		Spaces	NA	D	32 characters general use string
43	String_20	VisibleString(32)		Spaces	NA	D	32 characters general use string
44	UPDATE_EVT	DS-73			NA	D	This alert is generated by any change to the static data.
45	BLK_ALM	DS-72			NA	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

HCD - HART Commands Definition

Parameters

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
0	BLOCK_STRUCTURE	DS-64			NA	S	
1	ST_REV	Unsigned16		0	None	S / RO	
2	TAG_DESC	OctString(32)		Spaces	NA	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	MODE_BLK	DS-69		O/S	NA	S	See Mode Parameter
6	BLK_ERR	Bitstring(2)			None	D / RO	
7	HCD_CODE	OctString(5)		0	None	S	This code identifies uniquely this configuration and must be formed by combining MAN_ID, DEV_TYPE, UNI_REV, SPEC_REV and SW_REV of the targeted device.
8	DEVICE_INFO	VisibleString(32)		Spaces	NA	S	This parameter stores the device name or any other comment related to this set of command definitions.
9	CMD_00	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
10	CMD_01	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
11	CMD_02	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
12	CMD_03	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
13	CMD_04	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
14	CMD_05	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
15	CMD_06	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
16	CMD_07	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
17	CMD_08	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
18	CMD_09	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
19	CMD_10	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
20	CMD_11	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
21	CMD_12	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
22	CMD_13	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
23	CMD_14	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
24	CMD_15	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
25	CMD_16	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
26	CMD_17	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
27	CMD_18	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
28	CMD_19	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
29	CMD_20	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
30	CMD_21	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
31	CMD_22	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
32	CMD_23	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
33	CMD_24	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
34	CMD_25	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
35	CMD_26	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
36	CMD_27	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
37	CMD_28	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
38	CMD_29	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
39	CMD_30	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
40	CMD_31	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
41	CMD_32	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
42	CMD_33	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
43	CMD_34	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
44	CMD_35	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
45	CMD_36	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
46	CMD_37	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
47	CMD_38	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
48	CMD_39	OctString(44)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
49	CMD_40	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
50	CMD_41	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
51	CMD_42	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
52	CMD_43	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
53	CMD_44	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
54	CMD_45	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
55	CMD_46	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
56	CMD_47	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
57	CMD_48	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
58	CMD_49	OctString(104)	Request and Response parameters	0	NA	S	See HART Command configuration parameters.
59	UPDATE_EVT	DS-73			NA	D	This alert is generated by any change to the static data.

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
60	BLK_ALM	DS-72			NA	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

HWPC - HART WRITEABLE-PARAMETER TO COMMAND CORRELATION

Parameters

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
0	BLOCK_STRUCTURE	DS-64			NA	S	
1	ST_REV	Unsigned16		0	None	S / RO	
2	TAG_DESC	OctString(32)		Spaces	NA	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	MODE_BLK	DS-69		O/S	NA	S	See Mode Parameter
6	BLK_ERR	Bitstring(2)			None	D / RO	
7	HWPC_CODE	OctString(5)		0	None	S	Must be equal to the associated HCD.
8	WPC_00	Unsigned8[20]		0	None	S	See parameter to command correlation description.
9	WPC_01	Unsigned8[20]		0	None	S	See parameter to command correlation description.
10	WPC_02	Unsigned8[20]		0	None	S	See parameter to command correlation description.
11	WPC_03	Unsigned8[20]		0	None	S	See parameter to command correlation description.
12	WPC_04	Unsigned8[20]		0	None	S	See parameter to command correlation description.
13	WPC_05	Unsigned8[20]		0	None	S	See parameter to command correlation description.
14	WPC_06	Unsigned8[20]		0	None	S	See parameter to command correlation description.
15	WPC_07	Unsigned8[20]		0	None	S	See parameter to command correlation description.
16	WPC_08	Unsigned8[20]		0	None	S	See parameter to command correlation description.
17	WPC_09	Unsigned8[20]		0	None	S	See parameter to command correlation description.
18	WPC_10	Unsigned8[20]		0	None	S	See parameter to command correlation description.
19	WPC_11	Unsigned8[20]		0	None	S	See parameter to command correlation description.
20	WPC_12	Unsigned8[20]		0	None	S	See parameter to command correlation description.
21	WPC_13	Unsigned8[20]		0	None	S	See parameter to command correlation description.
22	WPC_14	Unsigned8[20]		0	None	S	See parameter to command correlation description.
23	WPC_15	Unsigned8[20]		0	None	S	See parameter to command correlation description.
24	WPC_16	Unsigned8[20]		0	None	S	See parameter to command correlation description.
25	WPC_17	Unsigned8[20]		0	None	S	See parameter to command correlation description.
26	WPC_18	Unsigned8[20]		0	None	S	See parameter to command correlation description.
27	WPC_19	Unsigned8[20]		0	None	S	See parameter to command correlation description.
28	WPC_20	Unsigned8[20]		0	None	S	See parameter to command correlation description.
29	WPC_21	Unsigned8[20]		0	None	S	See parameter to command correlation description.
30	WPC_22	Unsigned8[20]		0	None	S	See parameter to command correlation description.
31	WPC_23	Unsigned8[20]		0	None	S	See parameter to command correlation description.

Idx	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
32	WPC_24	Unsigned8[20]		0	None	S	See parameter to command correlation description.
33	UPDATE_EVT	DS-73			NA	D	This alert is generated by any change to the static data.
34	BLK_ALM	DS-72			NA	D	The block alarm is used for all configuration, hardware, 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

HBC – HART Bypass Communication

Bypass mode using HBC block was created to allow HART messages to be sent to any device by writing a block parameter. The written content in the parameter is whole sent to the channel, when it is available. Thus, the application should include in the message the preambles, the delimiter and so on, until the HART frame check byte. For operation in the BYPASS mode, only the RESOURCE, HCFG and HBC blocks are needed. Any HIRT or HVT block, perchance instantiated, will stay in the BYPASS state (BLK_EXEC_STATE parameter) have not any function.

IMPORTANTE
Before use BYPASS the HCFG.COMM_BEHAVIOR parameter must be configured as BYPASS.

The HBC.BYPASS_STATUS parameter indicates the message situation, it can be:

- **IDLE:** the channel is ready and can send a message using the REQUEST_N parameter, or there is an available message to be read in the RESPONSE_N parameter. Even the channel was monitoring the communication of other Master or device in the Burst mode, it will be available to send a message whenever is possible.
- **BUSY:** REQUEST issued waiting reply from the device .
- **TIMEOUT:** after the programmed number of retries, it was not possible to receive a valid response.
- **RESPONSE AVAILABLE**: there is an available response to read. This response is valid while the parameter is in this state.

The HI302 does not check integrity for transmitted or received message contents, passing totally what was received by the communication channel. It is responsibility of the user to guarantee the quality of the sent messages and the response interpretation.

Sequence for Sending a HART message through a BYPASS

- Check if the HCFG.BYPASS_STATUS [N] parameter is on IDLE, TIMEOUT or RESPONSE AVAILABLE. If positive, the message can be written on the HCFG.BYPASS_REQ_N parameter. The HI302 will check if the channel is available and transmit the content of the HCFG.BYPASS_REQ_N parameter.

- While the HCFG.BYPASS_STATUS [N] parameter is on BUSY, the HI302 is waiting the response or repeating the request up to the limit programmed in the HCFG.RETRIES [N].

- The HCFG.BYPASS_STATUS [N] parameter goes to IDLE if it has received a valid message. It goes to TIMEOUT; in case it has not received a valid response yet.

IMPORTANT
As the message has to be entirely supplied by the applicative writing on the HCFG.BYPASS_REQ_N, the applicative will guarantee that the message is in the right format, with the right address, etc.

Example

Example of HART commands that were sent to the device and the received responses by the device with the address = 0 and DEV_ID = 3E 02 0C 72 29.

The number of initial FF (preambles can vary normally between 3 and 10). Remember the HART frame has the following structure: <Frame Size>, <Preambles>, <Delimiter>, <Address>, <Command>, <Data Size>, <Data>, <Checksum>.

Command #0: 0A FF FF FF FF FF 02 80 00 00 82
Response: FF FF FF FF FF 06 80 00 0E 00 02 FE 3E 02 05 05 03 24 09 00 0C 72 29 31

Command #33: 12 FF FF FF FF FF 82 BE 02 0C 72 29 21 04 01 02 03 04 48
Response: FF FF FF FF FF 86 BE 02 0C 72 29 21 1A 00 42 01 39 42 C8 05 14 02 25 42 C8 05 14 03 20 7F FF FF FF 04 39 42 C8 05 14 0E

Parameters

Index	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
0	BLOCK_STRUCTURE	DS-64			NA	S	
1	ST_REV	Unsigned16		0	None	S / RO	
2	TAG_DESC	OctString(32)		Spaces	NA	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	MODE_BLK	DS-69		O/S	NA	S	See Mode's Parameter
6	BLK_ERR	Bitstring(2)			None	D / RO	
7	BYPASS_STATUS	Enumerated[8]	**0x00:** Idle, **0x01:** Busy, **0x02:** Timeout, **0x03**: Response Available	Idle	None	D / RO	This array shows the status of HART channels.
8	REQUEST_1	OctString(100)			NA	D	Write the HART frame into this parameter to send it through the channel 1.
9	RESPONSE_1	OctString(100)			NA	D / RO	Response grabbed by the channel if the addressed device has replied.
10	REQUEST_2	OctString(100)			NA	D	Write the HART frame into this parameter to send it through the channel 2.
11	RESPONSE_2	OctString(100)			NA	D / RO	Response grabbed by the channel if the addressed device has replied.
12	REQUEST_3	OctString(100)			NA	D	Write the HART frame into this parameter to send it through the channel 3.
13	RESPONSE_3	OctString(100)			NA	D / RO	Response grabbed by the channel if the addressed device has replied.
14	REQUEST_4	OctString(100)			NA	D	Write the HART frame into this parameter to send it through the channel 4.
15	RESPONSE_4	OctString(100)			NA	D / RO	Response grabbed by the channel if the addressed device has replied.
16	REQUEST_5	OctString(100)			NA	D	Write the HART frame into this parameter to send it through the channel 5.
17	RESPONSE_5	OctString(100)			NA	D / RO	Response grabbed by the channel if the addressed device has replied.
18	REQUEST_6	OctString(100)			NA	D	Write the HART frame into this parameter to send it through the channel 6.
19	RESPONSE_6	OctString(100)			NA	D / RO	Response grabbed by the channel if the addressed device has replied.
20	REQUEST_7	OctString(100)			NA	D	Write the HART frame into this parameter to send it through the channel 7.
21	RESPONSE_7	OctString(100)			NA	D / RO	Response grabbed by the channel if the addressed device has replied.
22	REQUEST_8	OctString(100)			NA	D	Write the HART frame into this parameter to send it through the channel 8.
23	RESPONSE_8	OctString(100)			NA	D / RO	Response grabbed by the channel if the addressed device has replied.
24	UPDATE_EVT	DS-73			NA	D	This alert is generated by any change to the static data.

Index	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store / Mode	Description
25	BLK_ALM	DS-72			NA	D	The alarm block 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.

Legend: E – Enumerated parameter; Na – Dimensionless parameter; RO – Read only; D – dynamic; N – non-volatile; S – Static

Gray Background Line: Default Parameters of Syscon

Block Options

Resource Block Bit Strings

HARD_TYPES

Hardware types supported

Bit	Meaning
0	Scalar input (LSB)
1	Scalar output
2	Discrete input
3	Discrete output
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

CYCLE_TYPE and CYCLE_SEL

Types of cycle supported

Bit	Meaning
0	Scheduled (LSB)
1	Block Execution
2	Manufac Specific
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

FEATURES and FEATURE_SEL

Things that this resource supports

Bit	Meaning
0	Unicode
1	Reports
2	Fault State
3	Soft Write lock
4	Hard Write lock
5	Output readback (*)
6	Direct Write
7	Change of bypass in an automatic mode (*)
8	MVC supported (*)
9	
10	
11	
12	
13	
14	
15	

Order of Resource Block Alerts

For ALARM_SUM and ACK_OPTION

Bit	Meaning
0	Writes have been enabled
1	
2	
3	
4	
5	
6	
7	Block alarm
8	
9	
10	
11	
12	
13	
14	
15	

(*) This feature depends on the Hardware Type

FEATURES and FEATURE_SEL

Unicode strings
This feature is not supported.

Reports supported
It is necessary to set this feature in order to enable alert reporting in the resource.

Fault State supported
If this feature is selected in FEATURE_SEL, setting the SET_FSTATE parameter will force all output function blocks (AO and DO) in the resource to go to fault state.
Individual output function block will go to Fault State due to a loss of communication to CAS_IN or IFS status in CAS_IN, regardless the selection of this feature.

Soft Write lock supported
It is necessary to select this feature to set the WRITE_LOCK parameter.

Hard Write lock supported
This feature is not supported.

Output readback supported
Only the FY302 and FP302 support output readback and this feature is used regardless the selection in FEATURE_SEL.

Direct write to output hardware
This feature is not supported.

Change of BYPASS in an automatic mode
If this feature is selected in FEATURE_SEL, it is allowed to write in BYPASS in an automatic mode, otherwise only in Man or O/S modes.

MVC supported
The selection of this feature allows optimize communication performance by transferring a grouped data as a single variable list in either publisher/subscriber transactions for function block links, or report distribution to a host device.

Function Block Options

IO_OPTS

Bit	Meaning	AI	DI	AO	DO	STEP
0	Invert (LSB)		X		X	
1	SP tracks PV if Man			X	X	
2	SP tracks PV if LO			X	X	
3	SP tracks Rcas or Cas if LO or Man			X	X	
4	Increase to close			X		
5	Faultstate Type			X	X	X
6	Faultstate restart			X	X	X
7	Target to Man			X	X	X
8	PV for BKCal_Out			X	X	
9	Low cutoff	X				
10	Low cutoff					
11	Reserved					
12	Reserved					
13	Reserved					
14	Reserved					
15	Reserved					

Invert
Indicate whether the discrete input value should be logically inverted before it is stored in the process variable.

SP-PV Track in Man
Permit the setpoint to track the process variable when the target mode of the block is Man.

SP-PV Track in LO
Permit the setpoint to track the process variable when the actual mode of the block is LO. IMan is not possible in an I/O block.

SP tracks RCAS or CAS if LO or MAN
Permit the set point to track the Rcas or Cas parameter based on the retained target mode when the actual mode of the block is LO or Man.

Increase to close
Indicate whether the output value should be inverted before it is communicated to the I/O channel.

Faultstate Type
The output action to take when failure occurs. (0: freeze, 1: go to preset value)

Faultstate restart
Use the value of FSTATE_VAL if the device is restarted, otherwise use the non-volatile value. This does not act like Fault State, just 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.

Use PV for BKCAL_OUT
The BKCAL_OUT value is normally the working SP. This option changes it to the PV.

Low cutoff
The AI low cutoff algorithm is enabled.

CONTROL_OPTS

Bit	Meaning	PID	EPID	APID	CHAR	STEP
0	Bypass Enable (LSB)	X	X	X	X	
1	SP-PV Track in Man	X	X	X		X
2	SP-PV Track in Rout	X	X	X		
3	SP-PV Track in LO or Iman	X	X	X		X
4	SP Track Retained Target	X	X	X		X
5	Direct Acting	X	X	X		X
6	Balance Ramp					
7	Track Enable	X	X	X		
8	Track in Manual	X	X	X		
9	PV for BKCAL_OUT	X	X	X		X
10	Bias may be adjusted					
11	Convert IN_1 to Out_Scale					
12	Restrict SP limits if Cas or Rcas	X	X	X		X
13	No OUT limits in Manual	X	X	X		
14	Reserved					
15	Reserved					

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
Permit the setpoint to track the process variable when the target mode of the block is Man.

SP-PV Track in Rout
Permit the setpoint to track the process variable when the actual mode of the block is ROut.

SP-PV Track in LO or IMan
Permit the setpoint to track the process variable when the actual mode of the block is LO or IMan.

SP Track retained target
Permit 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. When SP-PV Track options are enable, then SP track retained target will have precedence in the selection of the value to track when the actual mode is MAN, IMAN, ROUT and LO.

Direct Acting
Define 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.

PV for BKCAL_OUT
The BKCAL _OUT and RCAS_OUT values are normally the working SP. If this options is enable, then the PV value will be used after the CASCADE is closed.

Convert IN_1 to Out_Scale
This feature is not used.

Restrict SP to 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 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 mode are Man. Trust the operator to do the right thing.

STATUS_OPTS

Bit	Meaning	AI	DI	PUL	PID	EPID	APID	SPLT	AALM	ISEL	SPG	TIME	LLAG	DENS	FFET	AO	DO	STEP
0	IFS if BAD IN (LSB)				X	X	X											
1	IFS if BAD CAS_IN				X	X	X	X										
2	Use Uncertain as Good				X	X	X	X	X	X	X	X	X	X	X			X
3	Propagate Fail Forward	X	X	X														
4	Propagate Fail Backward															X	X	X
5	Target to Manual if BAD IN				X	X	X											X
6	Uncertain if Limited	X		X														
7	BAD if Limited	X		X														
8	Uncertain if Man mode	X	X	X														
9	No select if No AUTO				X	X	X											X
10	No select if no Cas																	
11	Reserved																	
12	Reserved																	
13	Reserved																	
14	Reserved																	
15	Reserved																	

IFS if BAD IN
Set Initiate Fault State status in the OUT parameter if the status of the IN parameter is BAD.

IFS if BAD CAS_IN
Set Initiate Fault State 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.

Propagate Fail 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.

Propagate Fail 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-status in BKCAL_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 upstream for alarming.

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.

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.

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.

ALARM_SUM and ACK_OPTION

(Valid for all blocks, except for Resource Block)

Bit	Description	Meaning	AI	PUL	DI	APID	PID/EPID	AALM	SPG	DENS	STEP
	Unack Alarm1	Discrete alarm			X						
	Unack Alarm2	High High alarm	x	x		x	x	x			x
	Unack Alarm3	High alarm	x	x		x	x	x		x	x
	Unack Alarm4	Low Low alarm	x	x		x	x	x			x
	Unack Alarm5	Low alarm	x	x		x	x	x		x	x
	Unack Alarm6	Deviation High alarm				x	x		x		x
	Unack Alarm7	Deviation Low alarm				x	x		x		x
	Unack Alarm8	Block alarm	x	x	X	x	x	x	x	x	x
	Unack Alarm9	Not used									
	Unack Alarm10	Not used									
	Unack Alarm11	Not used									
	Unack Alarm12	Not used									
	Unack Alarm13	Not used									
	Unack Alarm14	Not used									
	Unack Alarm15	Not used									
15	Unack Alarm16	Not used									

APID and EPID Function Blocks Options

PID_OPTS

Bit	Meaning
0	IFS if Bad TRK_IN_D
1	IFS if Bad TRK_VAL
2	Man if Bad TRK_IN_D
3	Man if Bad TRK_VAL
4	Target to Manual if BAD TRK_IN_D
5	Target to Manual if BAD TRK_VAL
6	Target to Man if Tracking Active **(*)**
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

(*) Feature available only in transmitters with version 3.52 (DD 0601) or higher, and DF51 with version 3.8.0 (DD 04xx) or higher

Integrator Function Block Options

INTEG_OPTS

Bit	Meaning
0	Input 1 accumulate
1	Input 2 accumulate
2	Flow forward
3	Flow reverse
4	Use Uncertain
5	Use Bad
6	Carry
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

Timer Function Block Options

INVERT_OPTS

Bit	Meaning	TIMER	AALM
0	Invert IN_D1	X	
1	Invert IN_D2	X	
2	Invert IN_D3	X	
3	Invert IN_D4	X	
4	Invert OUT_D	X	X **(*)**
5	Invert OUT_ALM		X **(*)**
6	Reserved		
7	Reserved		
8	Reserved		
9	Reserved		
10	Reserved		
11	Reserved		
12	Reserved		
13	Reserved		
14	Reserved		
15	Reserved		

(*) Feature available only in transmitters with version 3.52 (DD 0601) or higher, and DF51 with version 3.8.0 (DD 04xx) or higher

Arithmetic Function Block Options

INPUT_OPTS

Bit	Meaning
0	IN Use uncertain
1	IN_LO Use uncertain
2	IN_1 Use uncertain
3	IN_1 Use bad
4	IN_2 Use uncertain
5	IN_2 Use bad
6	IN_3 Use uncertain
7	IN_3 Use bad
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

Output Signal Selector and Dynamic Limiter Function Block Options

OSDL_OPTS

Bit	Meaning
0	IFS if BAD IN
1	IFS if BAD CAS_IN
2	Use Uncertain as Good
3	IFS for only selected output
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	IFS if BAD IN_1
12	Keep last value if not select
13	IFS for only selected output
14	Use OUT for BKCAL_OUT **(*)**
15	Use OUT_1 for BKCAL_OUT **(*)**

(*) Feature available only in transmitters with version 3.52 (DD 0601) or higher, and DF51 with version 3.8.0 (DD 04xx) or higher

Multiple Output Function Block Options

MO_STATUS_OPTS

Bit	Meaning
0	IFS if BAD IN_1
1	IFS if BAD IN_2
2	IFS if BAD IN_3
3	IFS if BAD IN_4
4	IFS if BAD IN_5
5	IFS if BAD IN_6
6	IFS if BAD IN_7
7	IFS if BAD IN_8
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

MO_OPTS (Profile Rev. 0 – FB700)

Bit	Meaning
0	Fault state to value 1
1	Use fault state value on restart 1
2	Fault state to value 2
3	Use fault state value on restart 2
4	Fault state to value 3
5	Use fault state value on restart 3
6	Fault state to value 4
7	Use fault state value on restart 4
8	Fault state to value 5
9	Use fault state value on restart 5
10	Fault state to value 6
11	Use fault state value on restart 6
12	Fault state to value 7
13	Use fault state value on restart 7
14	Fault state to value 8
15	Use fault state value on restart 8

MO_OPTS (Profile Rev. 1 – DFI302)

Bit	Meaning
0	Fault state to value 1
1	Fault state to value 2
2	Fault state to value 3
3	Fault state to value 4
4	Fault state to value 5
5	Fault state to value 6
6	Fault state to value 7
7	Fault state to value 8
8	Use fault state value on restart 1
9	Use fault state value on restart 2
10	Use fault state value on restart 3
11	Use fault state value on restart 4
12	Use fault state value on restart 5
13	Use fault state value on restart 6
14	Use fault state value on restart 7
15	Use fault state value on restart 8

Hardware Configuration Block Options

MODULE_STATUS_R0_3

Bit	Meaning
0	Status of module in rack 0 slot 0
1	Status of module in rack 0 slot 1
2	Status of module in rack 0 slot 2
3	Status of module in rack 0 slot 3
4	Status of module in rack 1 slot 0
5	Status of module in rack 1 slot 1
6	Status of module in rack 1 slot 2
7	Status of module in rack 1 slot 3

Bit	Meaning
0	Status of module in rack 2 slot 0
1	Status of module in rack 2 slot 1
2	Status of module in rack 2 slot 2
3	Status of module in rack 2 slot 3
4	Status of module in rack 3 slot 0
5	Status of module in rack 3 slot 1
6	Status of module in rack 3 slot 2
7	Status of module in rack 3 slot 3

MODULE_STATUS_R4_7

Bit	Meaning
0	Status of module in rack 4 slot 0
1	Status of module in rack 4 slot 1
2	Status of module in rack 4 slot 2
3	Status of module in rack 4 slot 3
4	Status of module in rack 5 slot 0
5	Status of module in rack 5 slot 1
6	Status of module in rack 5 slot 2
7	Status of module in rack 5 slot 3

Bit	Meaning
0	Status of module in rack 6 slot 0
1	Status of module in rack 6 slot 1
2	Status of module in rack 6 slot 2
3	Status of module in rack 6 slot 3
4	Status of module in rack 7 slot 0
5	Status of module in rack 7 slot 1
6	Status of module in rack 7 slot 2
7	Status of module in rack 7 slot 3

MODULE_STATUS_R8_11

Bit	Meaning
0	Status of module in rack 8 slot 0
1	Status of module in rack 8 slot 1
2	Status of module in rack 8 slot 2
3	Status of module in rack 8 slot 3
4	Status of module in rack 9 slot 0
5	Status of module in rack 9 slot 1
6	Status of module in rack 9 slot 2
7	Status of module in rack 9 slot 3

Bit	Meaning
0	Status of module in rack 10 slot 0
1	Status of module in rack 10 slot 1
2	Status of module in rack 10 slot 2
3	Status of module in rack 10 slot 3
4	Status of module in rack 11 slot 0
5	Status of module in rack 11 slot 1
6	Status of module in rack 11 slot 2
7	Status of module in rack 11 slot 3

MODULE_STATUS_R12_14

Bit	Meaning
0	Status of module in rack 12 slot 0
1	Status of module in rack 12 slot 1
2	Status of module in rack 12 slot 2
3	Status of module in rack 12 slot 3
4	Status of module in rack 13 slot 0
5	Status of module in rack 13 slot 1
6	Status of module in rack 13 slot 2
7	Status of module in rack 13 slot 3

Bit	Meaning
0	Status of module in rack 14 slot 0
1	Status of module in rack 14 slot 1
2	Status of module in rack 14 slot 2
3	Status of module in rack 14 slot 3
4	
5	
6	
7	

EXAMPLES

Simple Control Application

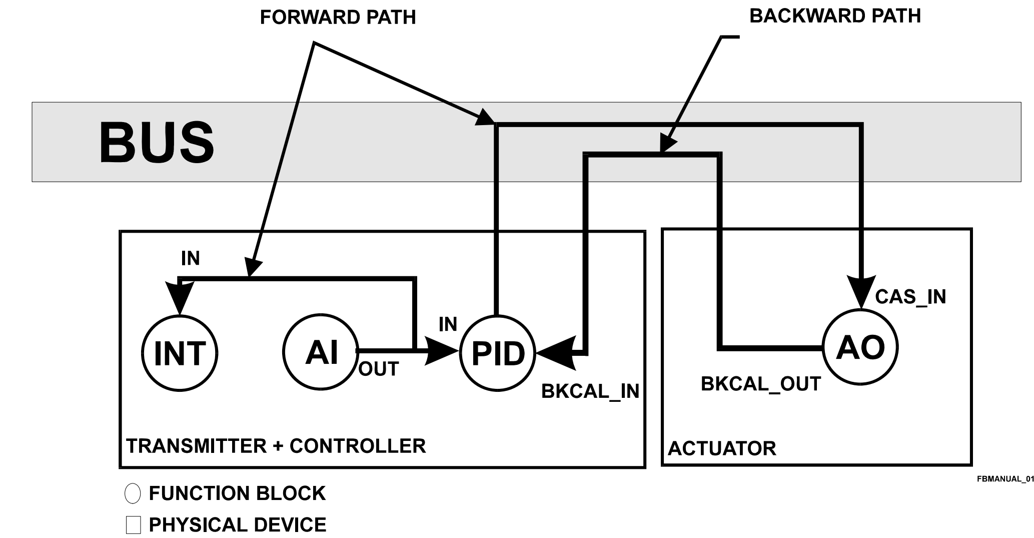


Figure 3.1 – Simple Control Application

Cascade Control

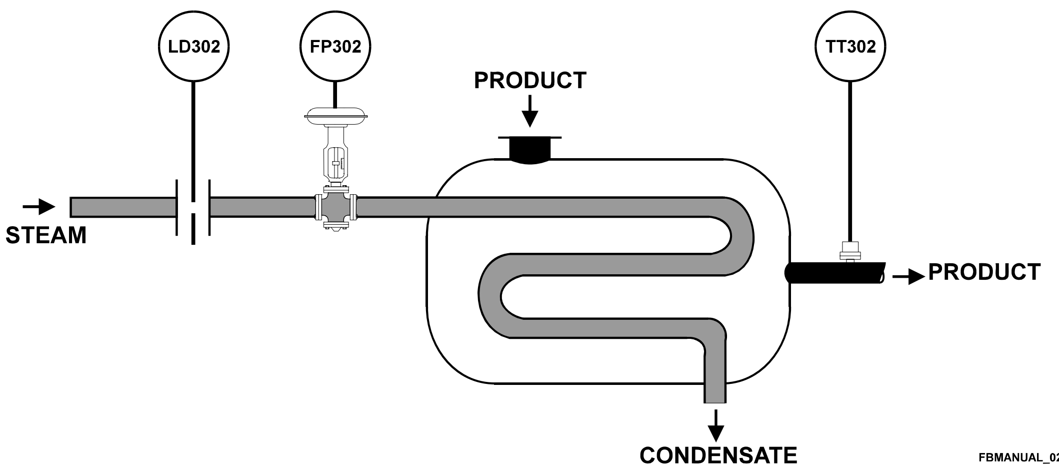


Figure 3.2 – Cascade Control

Corresponding Configuration

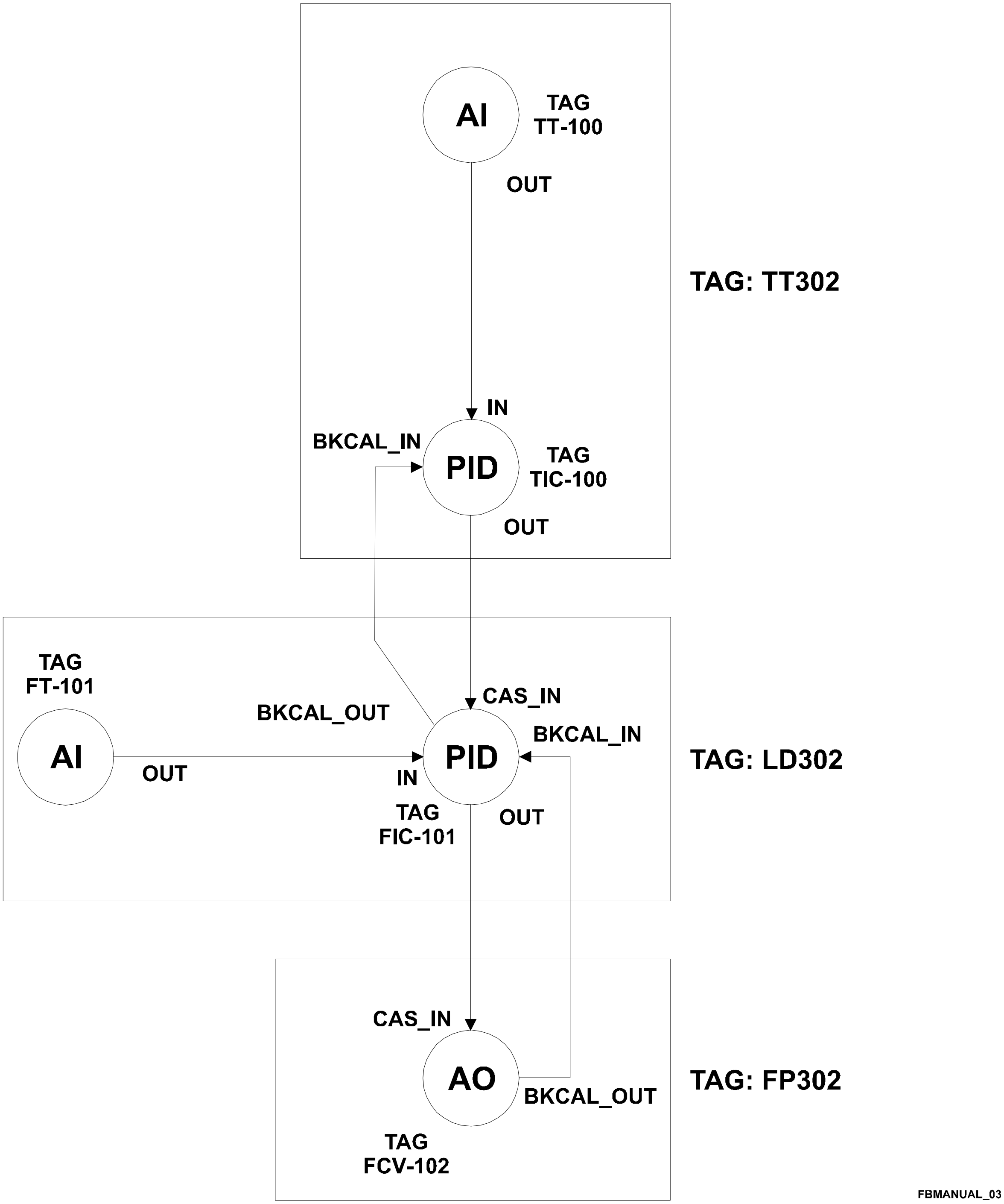


Figure 3.3 – Cascade Control Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
TT302	AI	TT-100	MODE_BLK	Target	AUTO
	PID	TIC-100	MODE_BLK	Target	AUTO
			PV_SCALE		0-600 ºC
			OUT_SCALE		0-200 kg/h
LD302	AI	FT-101	MODE_BLK	Target	AUTO
			L_TYPE		Indirect, square root
			XD_SCALE		0-200 in H2O
			OUT_SCALE		0-200 kg/h
	PID	FIC_101	MODE_BLK	Target	CAS
			PV_SCALE		0-200 kg/h
			OUT_SCALE		0-100%
FP302	AO	FCV-102	MODE_BLK	Target	CAS
			PV_SCALE		0-100%
			XD_SCALE		3-15 psi

Ratio Control

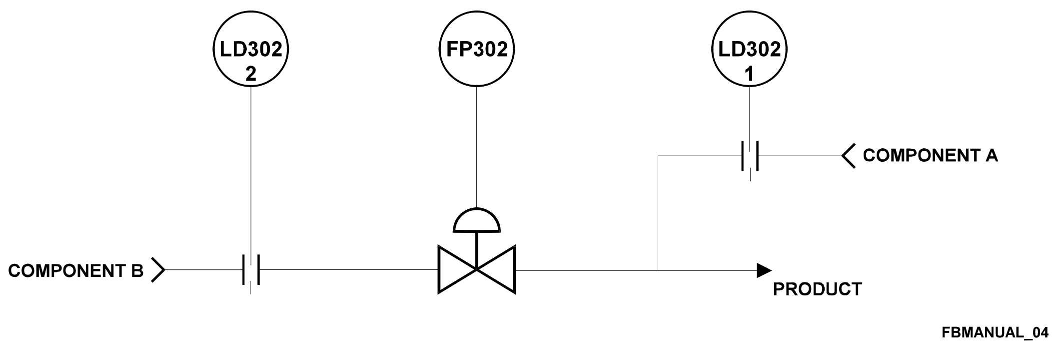


Figure 3.4 – Ratio Control

Corresponding Configuration

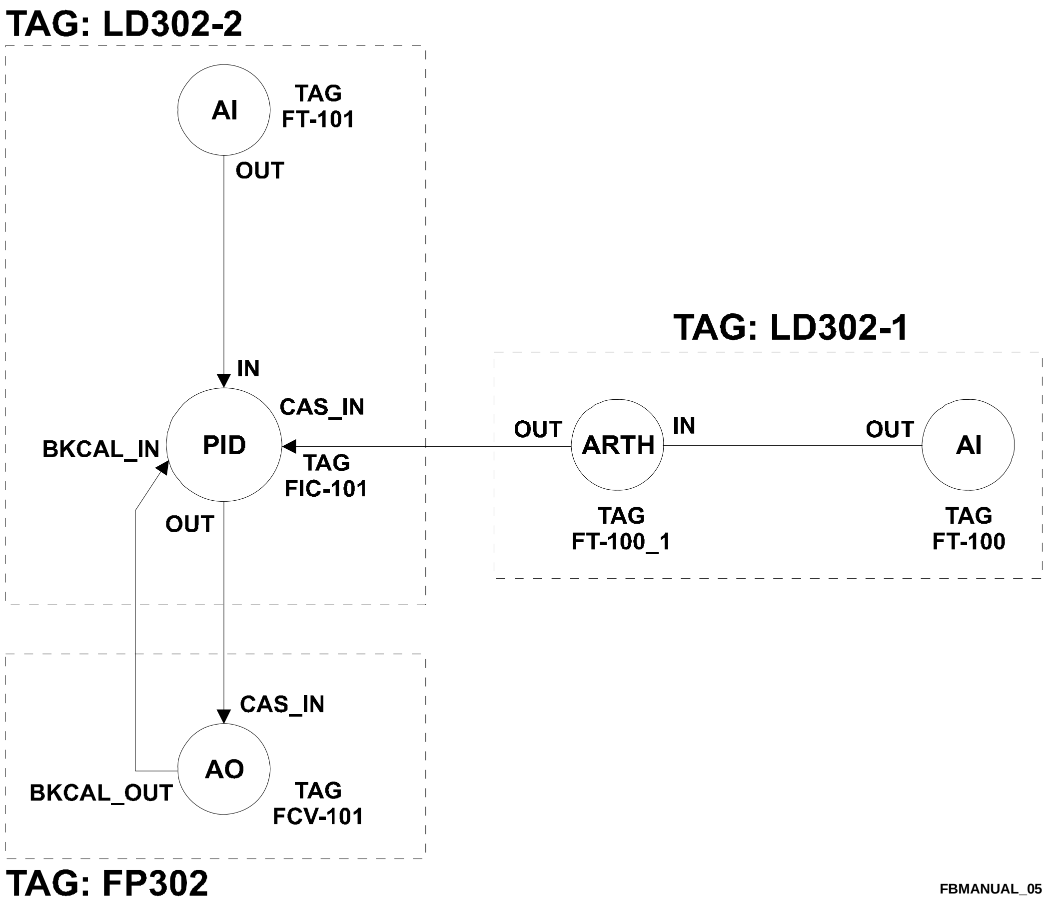


Figure 3.5 – Ratio Control Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
LD302-1	AI	FT-100	MODE_BLK	Target	AUTO
	ARTH	FY-100_1	MODE_BLK	Target	AUTO
			ARITH_TYPE		7
			GAIN		Adjusted by user to the desired rate p
			RANGE_LO		0
			RANGE_HI		-10 (for g = 1)
LD302-2	AI	FT-101	MODE_BLK	Target	AUTO
	PID	FIC-101	MODE_BLK	Target	Cas
			PV_SCALE		0-200 in H2O
			OUT_SCALE		0-100 %
FP302	AO	FCV-101	MODE_BLK	Target	Cas
			PV_SCALE		0-100 %
			XD_SCALE		3-15 psi

Feedforward Control

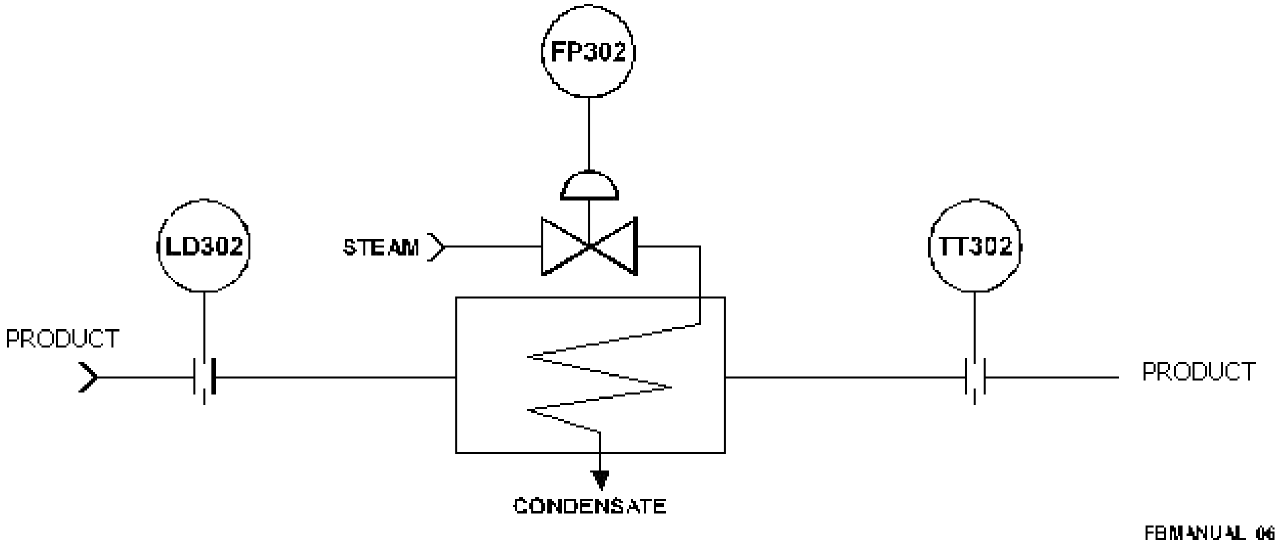


Figure 3.6 – Control Feedforward

Corresponding Configuration

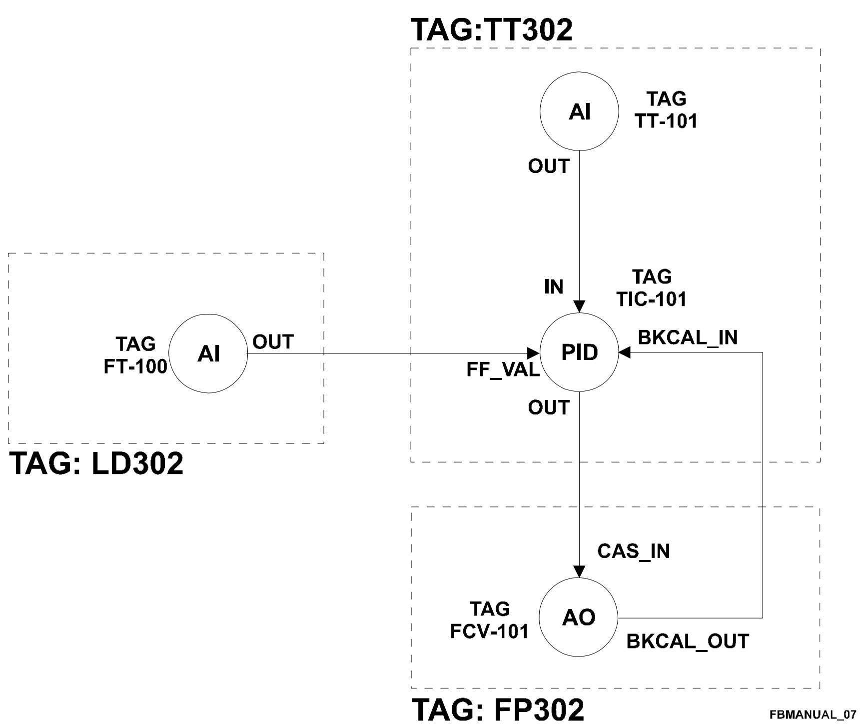


Figure 3.7 – Control Feedforward Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
TT302	AI	TT-101	MODE_BLK	Target	AUTO
	PID	TIC-101	MODE_BLK	Target	AUTO
			PV_SCALE		0-600 ºC
			FF_SCALE		0-500 GAL/min
			FF_GAIN		0.1
LD302	AI	FT-100	MODE_BLK	Target	AUTO
			L_TYPE		Indirect, square root
			XD_SCALE		0-125 in H2O
			OUT_SCALE		0-500 GAL/min
FP302	AO	FCV-101	MODE_BLK	Target	CAS
			PV_SCALE		0-100%
			XD_SCALE		3-15 psi

Split Range Control

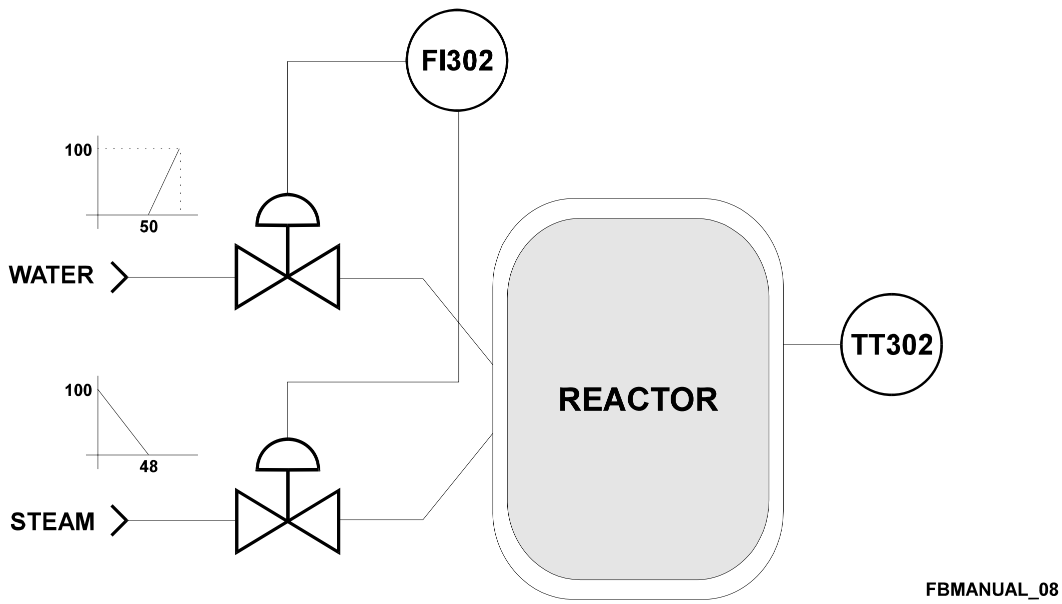


Figure 3.8 – Split Range Control

Corresponding Configuration

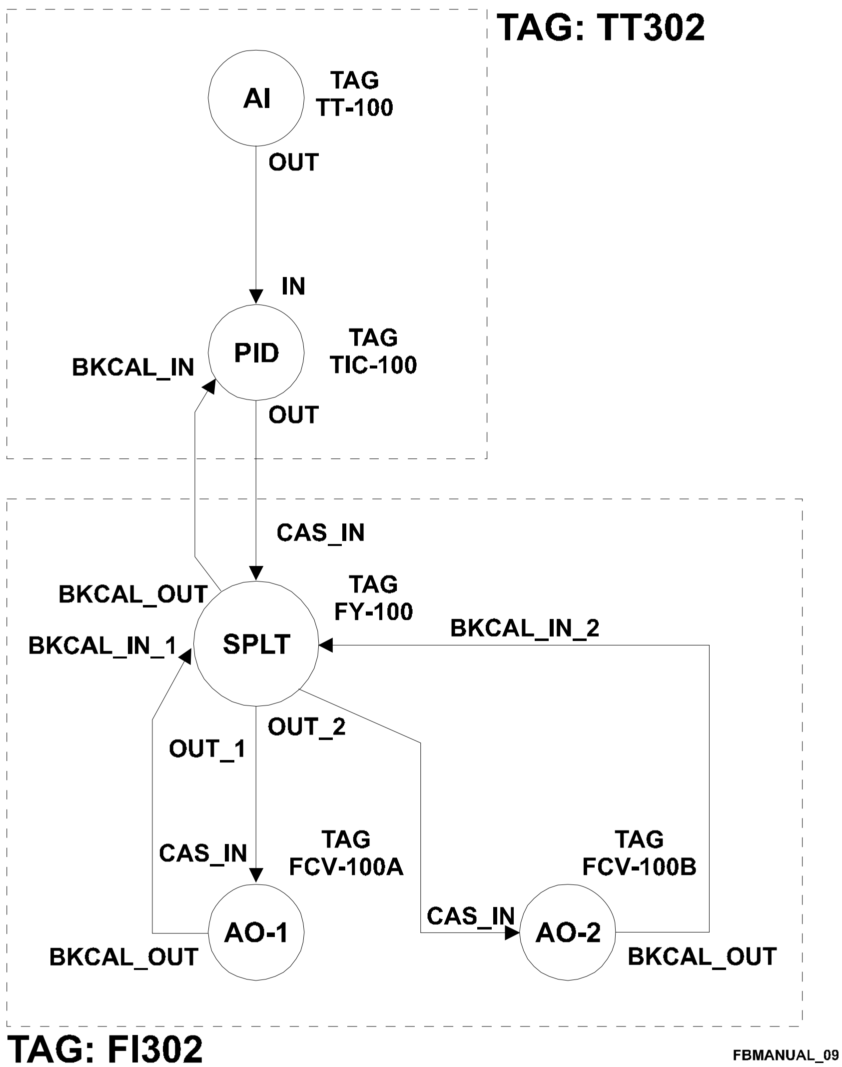


Figure 3.9 – Split Range Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
TT302	AI	TT-100	MODE_BLK	Target	AUTO
	PID	TIC-100	MODE_BLK	Target	AUTO
			PV_SCALE		0-600 ºC
			OUT_SCALE		0-100 %
	SPLT	FY-100	MODE_BLK	Target	Cas
			LOCKVAL		Yes
			IN_ARRAY		0, 48, 50, 100
			OUT_ARRAY		100, 0, 0, 100
FI302	AO	FCV-100A	MODE_BLK	Target	Cas
			PV_SCALE		0-100 %
			XD_SCALE		4-20 mA
	AO 2	FCV-100B	MODE_BLK	Target	Cas
			PV_SCALE		0-100 %
			XD_SCALE		4-20 mA

Level Control

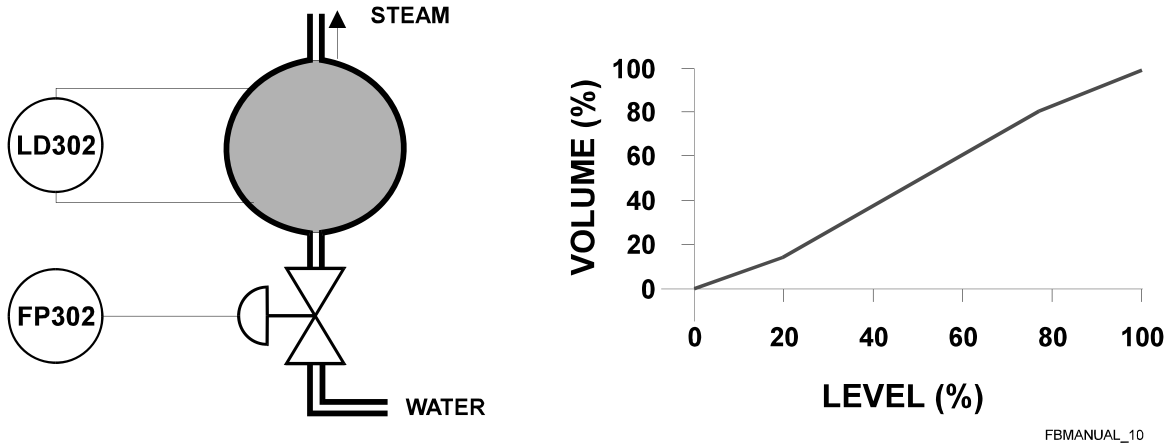


Figure 3.10 – Level Control

Corresponding Configuration

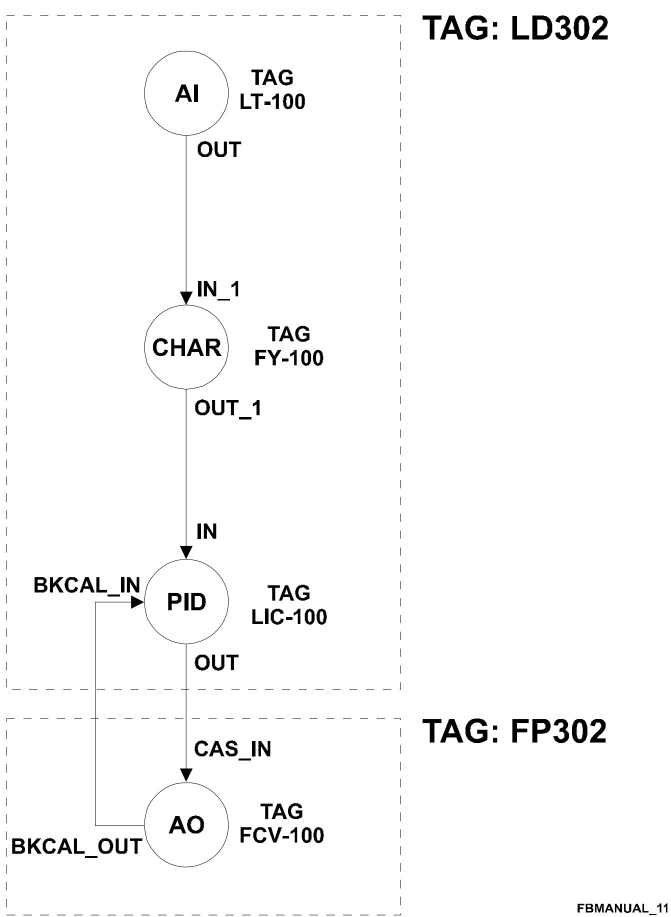


Figure 3.11 – Level Control Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
LD302	AI	LT-100	MODE_BLK	Target	AUTO
	CHAR	FY-100	MODE_BLK	Target	AUTO
			X_UNITS		inH2O
			Y_UNITS		gal
			CURV_INPUTS		0,40,80,100,120,160,200
			CURV_OUTPUTS		0, 14.23, 37.35, 50, 62.64, 85.76, 100
	PID	LIC-100	MODE_BLK	Target	AUTO
			PV_SCALE		0-100 gal
			OUT_SCALE		0-100 %
FP302	AO	FCV-100	MODE_BLK	Target	Cas
			PV_SCALE		0-100 %
			XD_SCALE		3-15 psi

Rate Control Loop with Lead - Lag

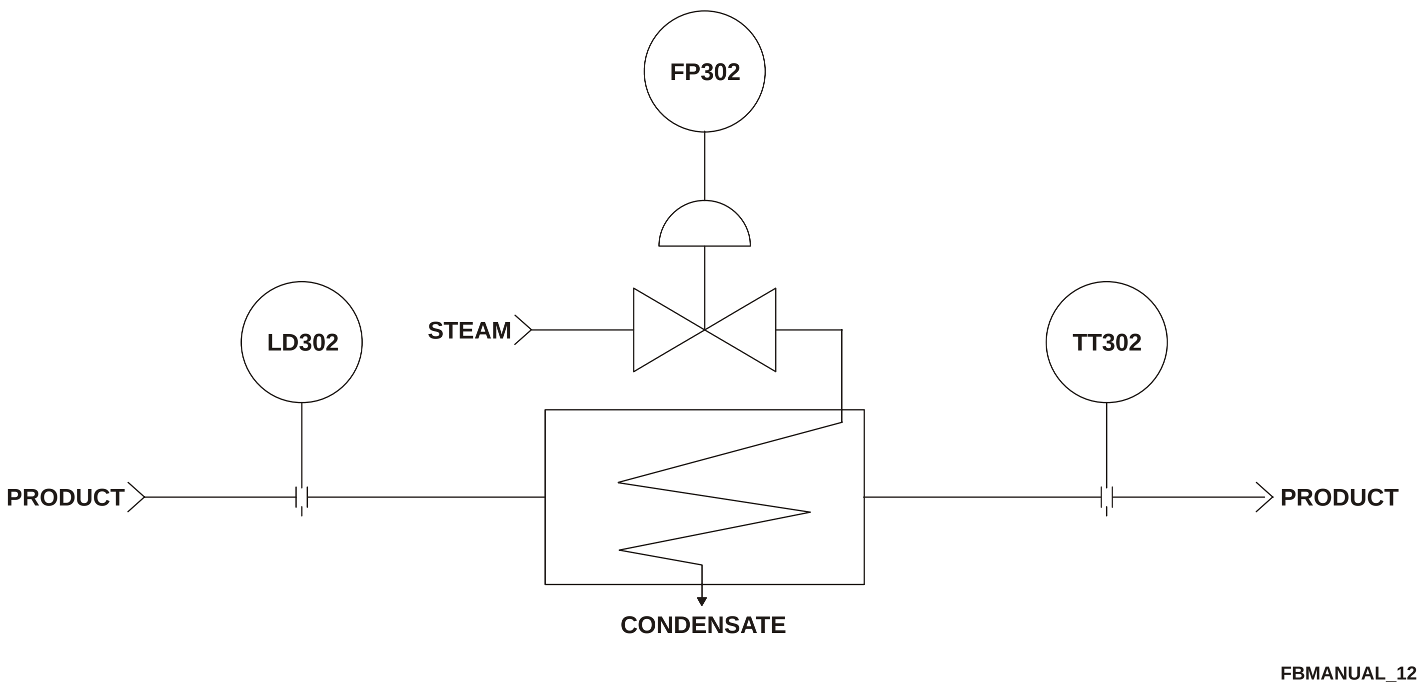


Figure 3.12 – Rate Control Loop with Lead - Lag

Corresponding Configuration

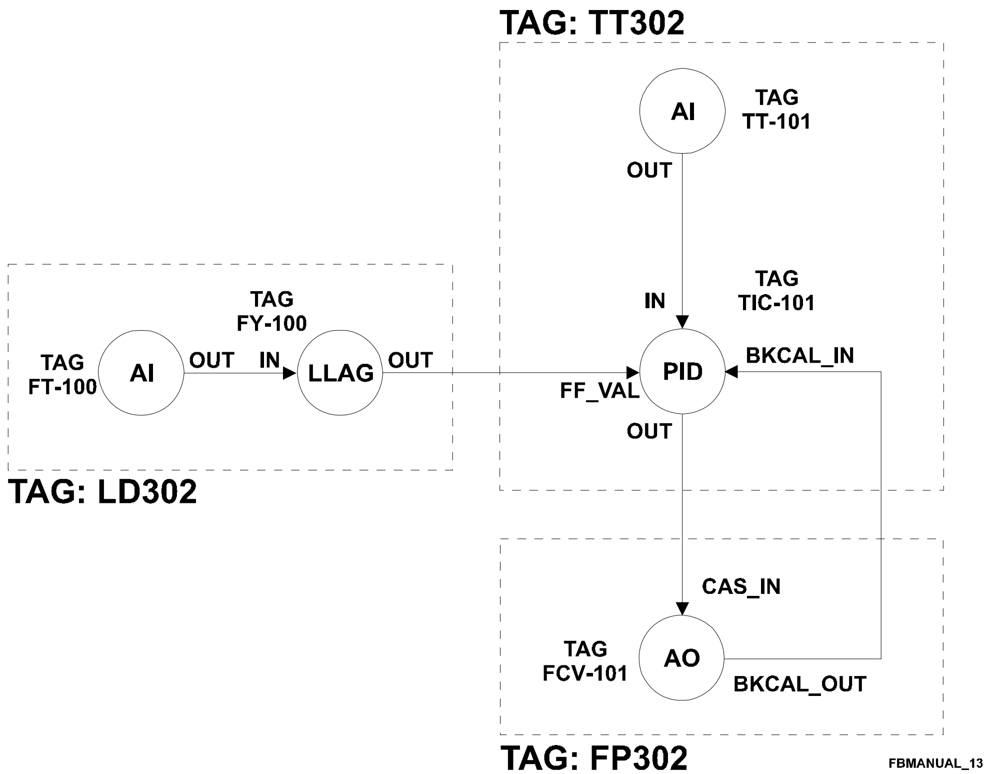


Figure 3.13 – Rate Control Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
TT302	AI	TT-101	MODE_BLK	Target	AUTO
	PID	TIC-101	MODE_BLK	Target	AUTO
			PV_SCALE		0-100 gal
			OUT_SCALE		0-100 %
			FF_SCALE		0-500 GAL/min
			FF_GAIN		0.1
LD302	AI	FT-100	MODE_BLK	Target	AUTO
			XD_SCALE		0-125 inH2O
			OUT_SCALE		0-500GAL/min
			L_TYPE		Indirect, square root
	LLAG	FY-100	MODE_BLK	Target	AUTO
			OUT_UNIT		GAL/min
			LEAD_TIME		60
			LAG_TIME		60
FP302	AO	FCV-101	MODE_BLK	Target	Cas
			PV_SCALE		0-100 %
			XD_SCALE		3-15 psi

Flow Compensation Configuration with Totalization

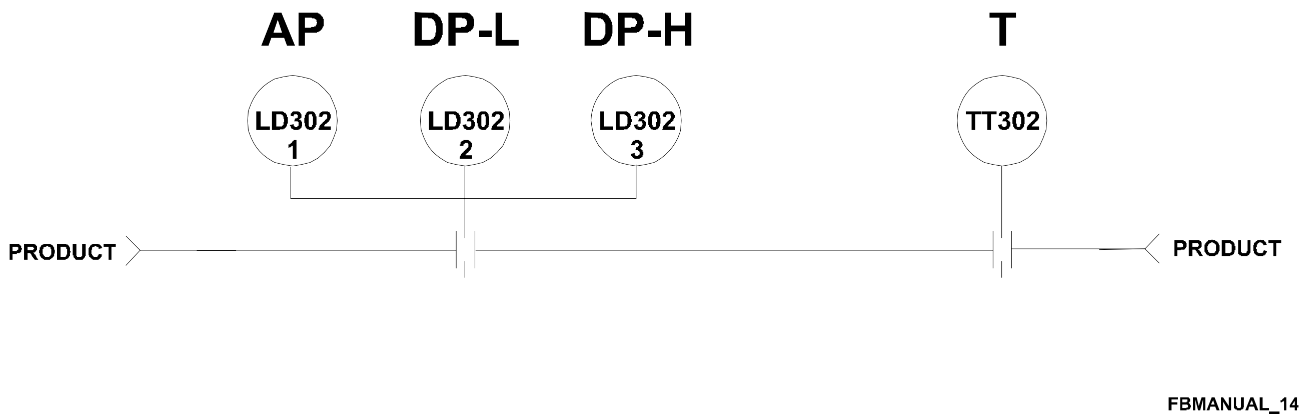


Figure 3.14 – Flow Compensation Configuration with Totalization

Corresponding Configuration

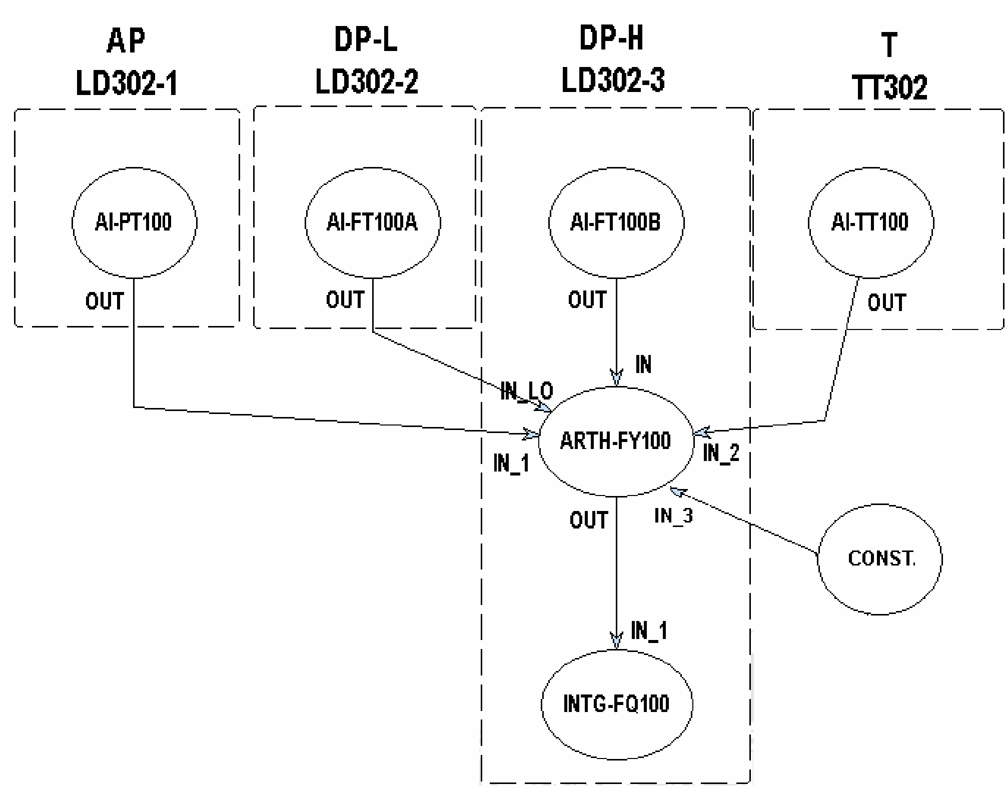


Figure 3.15 – Flow Compensation Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
LD302-1	AI	PT-100	MODE_BLK	Target	AUTO
			L_TYPE		Direct
			XD_SCALE	UNIT	Pa
LD302-2	AI	FT-100A	MODE_BLK	Target	AUTO
			XD_SCALE		0-20 H2O
			OUT_SCALE		0-156 Cutf/min

Device	Block	Block Tag	Parameter	Element	Value
			L_TYPE		SQR ROOT
LD302-3	AI	FT-100B	MODE_BLK	Target	AUTO
			XD_SCALE		0-200 in H2O
			OUT_SCALE		0-495 Cutf/min
			L_TYPE		SQR ROOT
	ARTH	FY-100	MODE_BLK	Target	AUTO
			PV_UNIT		GAL/min
			OUT_UNIT		GAL/min
			ARITH_TYPE		2 (flow comp. square root – AGA3)
			GAIN_IN_1		1
			GAIN		1
			RANGE_LO		400
			RANGE_HI		600
			COMP_HI_LIM		+ INF
			COMP_LO_LIM		- INF
	INT	FQ-100	MODE_BLK	Target	AUTO
			OUT_UNITS		GAL
TT302	AI	TT-100	MODE_BLK	Target	AUTO
			XD_SCALE	UNIT	K

Hydrostatic Tank Gauging

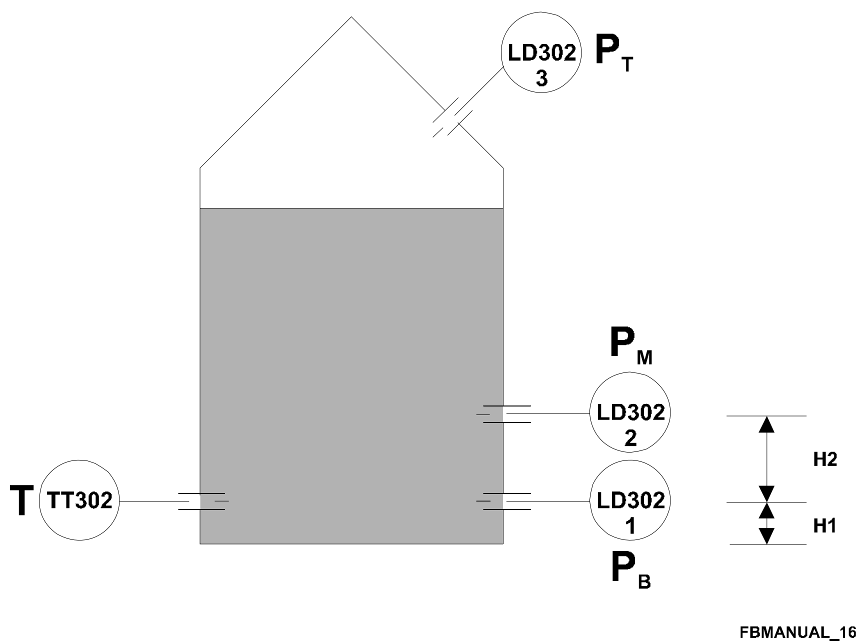


Figure 3.16 – Hydrostatic Tank Gauging

Corresponding Configuration

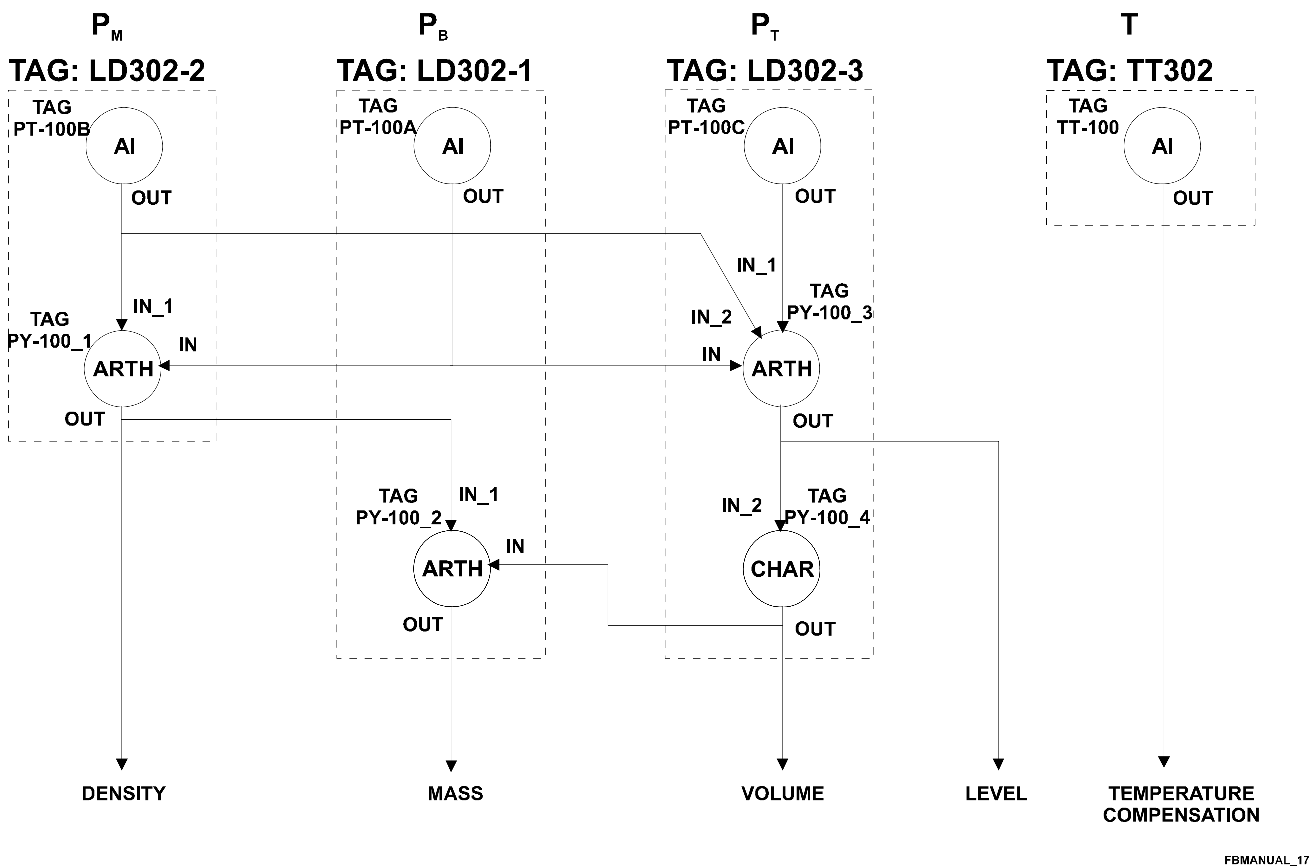


Figure 3.17 – Hydrostatic Tank Gauging Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
LD302-2	AI	PT-100B	MODE_BLK	Target	AUTO
			XD_SCALE	UNIT	Pa
			OUT_SCALE		0-156 Cutf/min
			L_TYPE		SQR ROOT
	ARTH	PY-100_1	MODE_BLK	Target	AUTO
			OUT_UNIT		Kg/m^3
			ARITH_TYPE		7 (traditional summer)
			GAIN_IN_1		1
			GAIN		1/ (H2*g)
			RANGE_LO	Target	20
			RANGE_HI		-10
LD302-1	AI	PT-100A	MODE_BLK	Target	AUTO
			XD_SCALE	UNIT	Pa
	ARTH	PY-100_2	MODE_BLK	Target	AUTO
			PV_UNIT		m^3
			OUT_UNIT		Ton
			ARITH_TYPE		5 (traditional mult. div.)
			GAIN_IN_2		1
			GAIN		1
			COMP_HI_LIM		+ INF

Device	Block	Block Tag	Parameter	Element	Value
			COMP_LO_LIM		- INF
LD302-3	AI	PT-100C	MODE_BLK	Target	AUTO
			XD_SCALE	UNIT	Pa
	ARTH	PY-100_3	MODE_BLK	Target	AUTO
			PV_UNIT		mH2O
			OUT_UNIT		m
			ARITH_TYPE		9 (HTG comp. level)
			GAIN		H2
			BIAS		H1
			RANGE_LO		20
			RANGE_HI		-10
	CHAR	PY-100_4	MODE_BLK	Target	AUTO
			X_UNITS		m
			Y_UNIS		M^3
			CURVE_X		0 ,20,40,50,70,80,100
			CURVE_Y		0,20,40,50,70,80,100
TT302	AI	TT-100	MODE_BLK	Target	AUTO

Combustion Control with Double Cross Limits

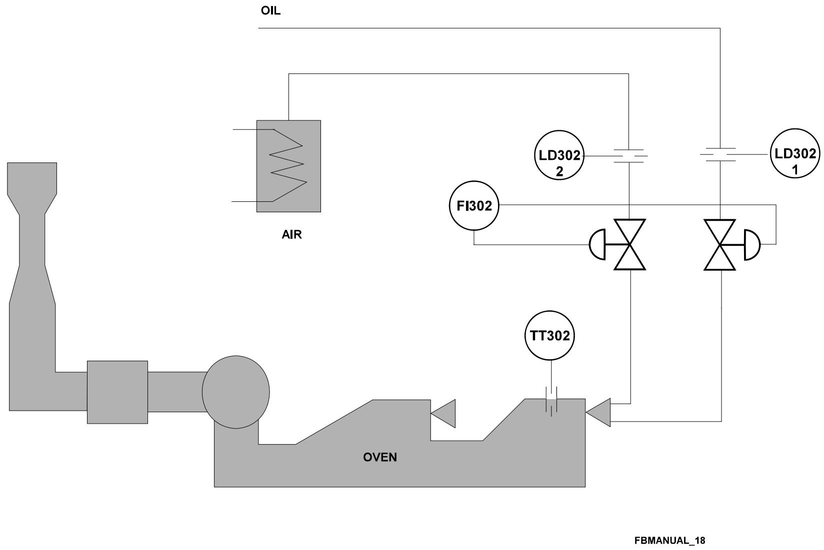


Figure 3.18 – Combustion Control with Double Cross Limits

This type of control tries to keep the air-fuel ratio strictly within the limits. A sudden change on the load would require a corresponding air and fuel variation.

The master controller supplies Setpoint values to air and fuel flow controllers while it is stabilized.

During the transitions, the air flow determines the maximum upper and lower limits that the fuel flow cannot exceed. The same occurs for the air flow, whose limits are fixed by those of the fuel flow.

In this way, even when there is a large shift in the master signal the air/fuel ratio is maintained very close to the desired value.

The “double cross limits” prevents that the fastest variable unbalance the desired ratio. This strategy is implemented using the OSDL Block, that generates the setpoint for the air and fuel controllers based on the output of the master controller, air flow (Qa –> IN parameter) and fuel flow (Qc –> IN_1 parameter).

This configuration allows the air flow setpoint to vary just between (Qc-LO_BIAS) and (Qc+HI_BIAS) and the fuel flow setpoint to vary just between (Qa-LO_BIAS_1) and (Qa+HI_BIAS_1).

When the double crossed limit is interfered with, then an unexpected change in the consumption upsets the desired ratio and in the same way when there is a transient in the master signal of the air/fuel flow it is able to be maintained very close to the desired ratio.

Corresponding Configuration

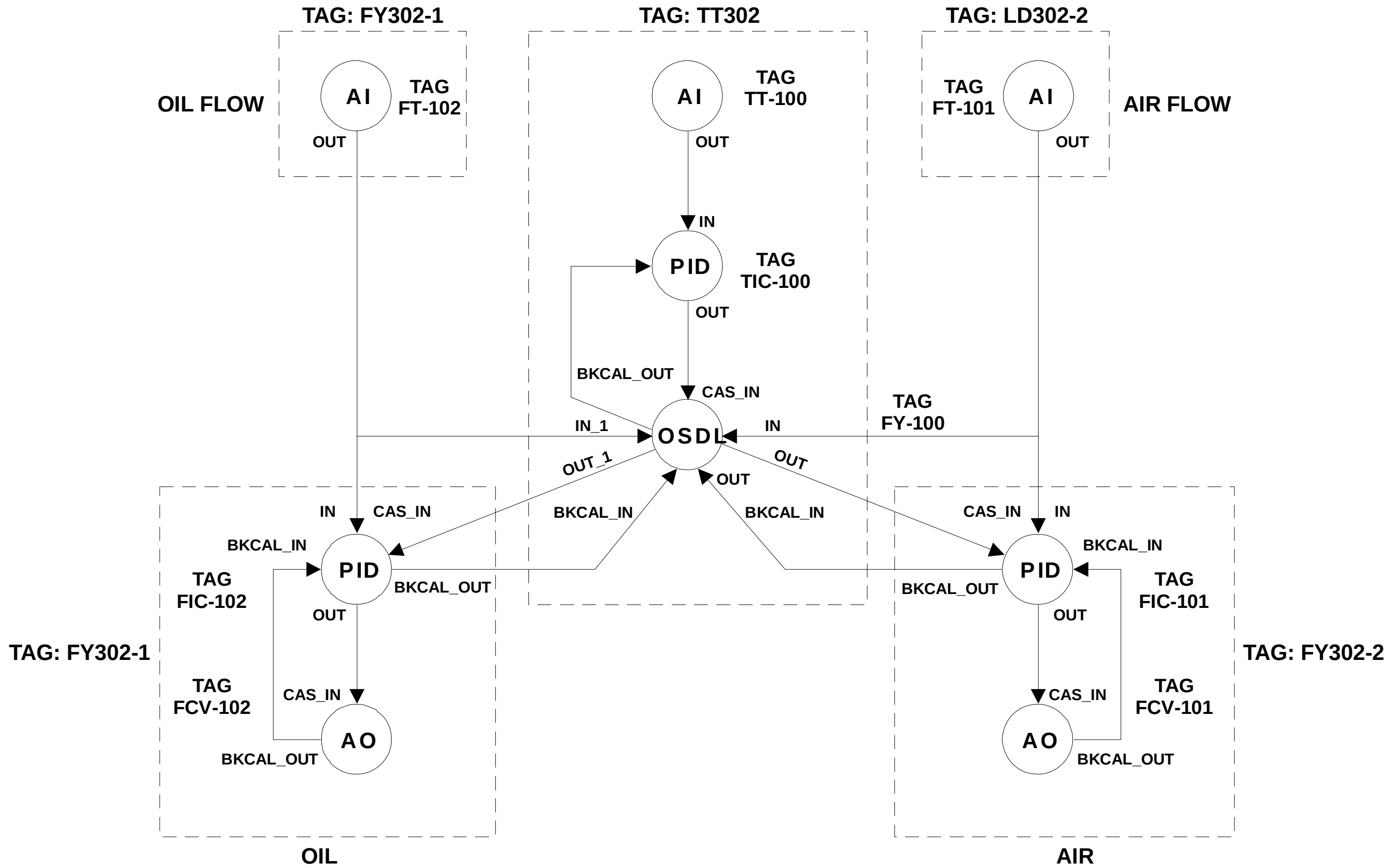


Figure 3.19 - Combustion Control with Double Cross Limits Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
LD302-1	AI	FT-102	MODE_BLK	Target	AUTO
			XD_SCALE		0-300 mm H2O
			OUT_SCALE		0-100 %
LD302-2	AI	FT-101	MODE_BLK	Target	AUTO
			XD_SCALE		0-200 inH2O
			OUT_SCALE		0-100 %
TT302	AI	TT-100	MODE_BLK	Target	AUTO
			XD_SCALE		0-600 ºC
			L_TYPE		direct
	PID	TIC-100	MODE_BLK	Target	AUTO
			PV_SCALE		0-600 ºC
			OUT_SCALE		0-100 %
			CONTROL_OPTS	Direct-acting	Reverse
	OSDL	FY-100	MODE_BLK	Target	CAS
			OUT_TYPE		Dynamic limiter
			HI_GAIN		1
			HI_BIAS		5%
			LO_GAIN		1

Device	Block	Block Tag	Parameter	Element	Value
			LO_BIAS		2%
			HI_GAIN_1		1
			HI_BIAS_1		2%
			LO_GAIN_1		1
			LO_BIAS_1		5%
			GAIN		1
			GAIN_1		1
FY302-1	PID	FIC_102	MODE_BLK	Target	CAS
			PV_SCALE		0-100 %
			OUT_SCALE		0-100 %
			CONTROL_OPTS	Direct-acting	Reverse
	AO	FCV-102	MODE_BLK	Target	CAS
			PV_SCALE		0-100 %
			XD_SCALE		0-100 %
FY302-2	PID	FIC-101	MODE_BLK	Target	CAS
			PV_SCALE		0-100 %
			OUT_SCALE		0-100 %
			CONTROL_OPTS	Direct-acting	Reverse
	AO	FCV-101	MODE_BLK	Target	CAS
			PV_SCALE		0-100 %
			XD_SCALE		0-100 %

3 Element Boiler Level / Feedwater Control

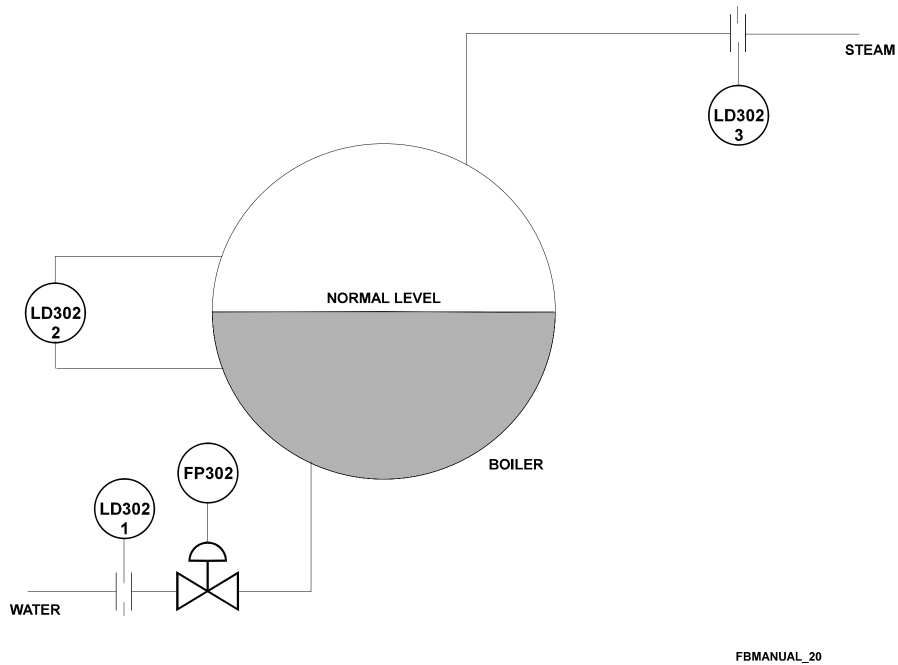


Figure 3.20 – 3 Element Boiler Level / Feedwater Control

This control loop uses feed forward control combined with cascade control. In this case the feed forward steam flow correction is done for steam flow and the feedback is done through the transmitter and the level controller LIC-100, whilst the feed water flow is maintained by the secondary cascade control loop of water.

In this loop the drum level controller LIC-100 provides the setpoint for the feedwater controller FIC-100 in cascade. Any disturbance in feed water flow is corrected by a feed forward arrangement in FIC-100. By connecting FT-101 to the FF_VAL input of FIC-100, any change in flow adjusts the FIC-100 output directly. The FF_SCALE is set -100 to +100 % to provide a fixed 50 % bias, giving a 50 % setpoint when load and manipulated flow are perfectly matched.

Corresponding Configuration

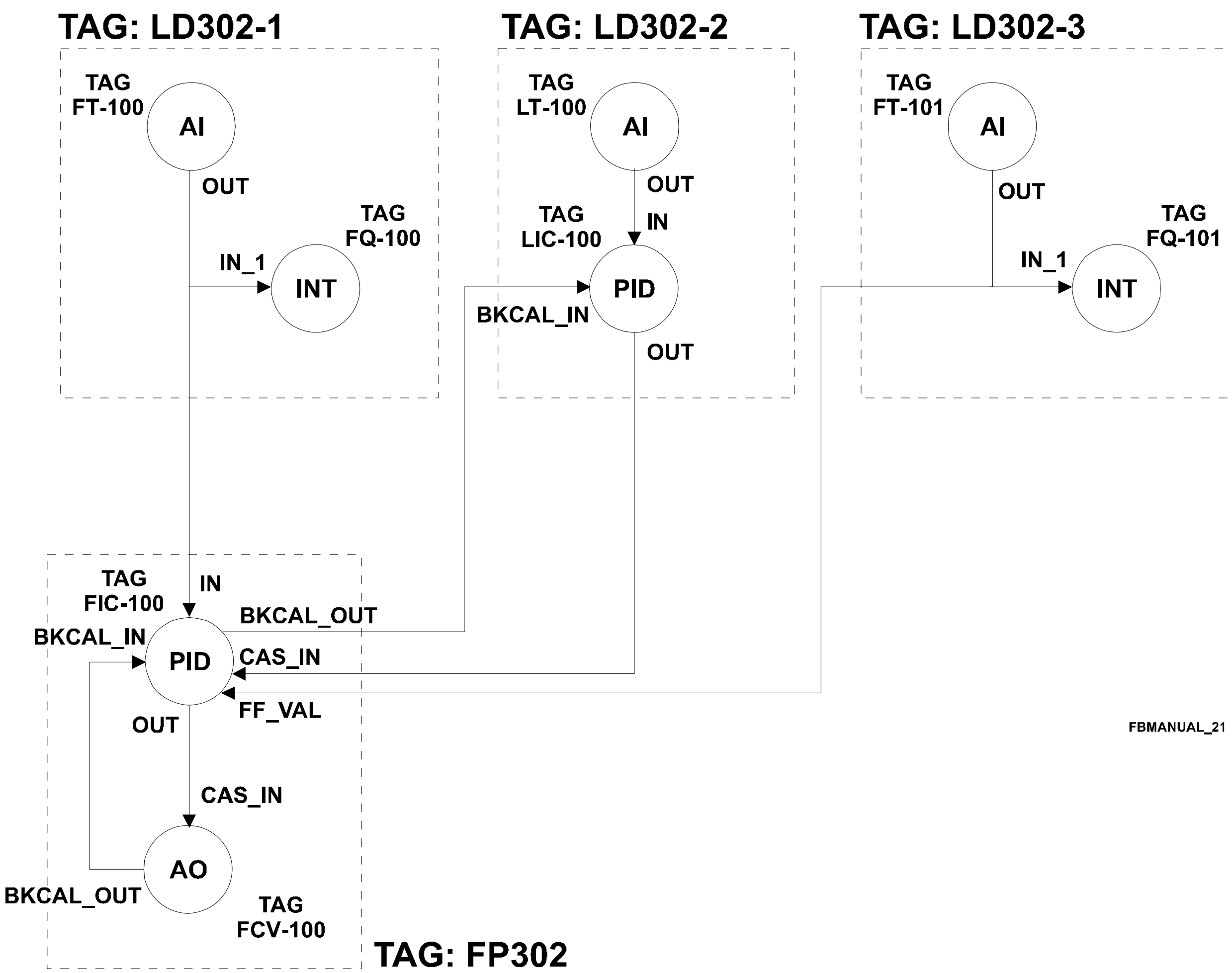


Figure 3.21 – Element Boiler Level Configuration

Parameterization

Device	Block	Block Tag	Parameter	Element	Value
LD302-2	AI	LT-100	MODE_BLK	Target	AUTO
			XD_SCALE		642 -140 mmH2O
			OUT_SCALE		0-100 %
	PID	LIC-100	MODE_BLK	Target	AUTO
			PV_SCALE		0-100 %
			OUT_SCALE		0-150 Ton/hr
			CONTROL_OPTS	Direct-acting	Reverse
LD302-3	AI	FT-101	MODE_BLK	Target	AUTO
			XD_SCALE		0-9500 mm H2O
			OUT_SCALE		0-150 Ton/hr
			L_TYPE		Indirect, Square Root
	INTG	FQ-101	MODE_BLK	Target	AUTO
			TIME_UNIT1		Hours
			OUT_UNITS		Ton
LD302-1	AI	FT-100	MODE_BLK	Target	AUTO
			XD_SCALE		0-3500 mmH2O

Device	Block	Block Tag	Parameter	Element	Value
			OUT_SCALE		0-150 m^3/hr
			L_TYPE		Indirect, Square Root
	INTG	FQ-100	MODE_BLK	Target	AUTO
			TIME_UNIT1		Hours
			OUT_UNITS		m^3
FP302	PID	FIC-100	MODE_BLK	Target	CAS
			PV_SCALE		0-150 m^3/hr
			OUT_SCALE		0-100 %
			CONTROL_OPTS	Direct-acting	Reverse
			FF_SCALE		-100 to + 100 %
			FF_GAIN		1
	AO	FCV_100	MODE_BLK	Target	CAS
			PV_SCALE		0-100 %
			XD_SCALE		3-15 psi