FOUNDATION Fieldbus
ST 700 Pressure Transmitter
User's Guide

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About This Document

This guide provides the details of programming Honeywell ST 700 SmartLine Pressure Transmitters for applications involving FOUNDATION Fieldbus protocol. For installation, wiring, and maintenance information, refer to the *ST 700 SmartLine Pressure Transmitter User Manual*.

The configuration of your transmitter depends on the mode of operation and the options selected for it with respect to operating controls, displays and mechanical installation.

An ST 700 FF pressure transmitter can be digitally integrated with one of two systems:

- Experion PKS, you need to supplement the information in this document with the data and procedures in the Experion PDF Collection.

Release Information

Document Name/ID **ST 700 Pressure Transmitter User's Guide - 34-ST-25-48**	**Release Number**	**Publication Date**
First Release	1.0	February 2013
	2.0	July 2014

References

The following list identifies all documents that may be sources of reference for material discussed in this publication.

ST 700 SmartLine Pressure Transmitter User Manual, # 34-ST-25-44

SmartLine Pressure Transmitter Quick Start Installation Guide, # 34-ST-25-36

ST 800 & ST 700 SmartLine Pressure Transmitter w/ HART Comms Safety Manual, # 34-ST-25-37

ST 700 Series HART/DE Option User Manual, Document # 34-ST-25-47

Patent Notice

The Honeywell ST 700 SmartLine Pressure Transmitter family is covered by one or more of the following U. S. Patents: 5,485,753; 5,811,690; 6,041,659; 6,055,633; 7,786,878; 8,073,098; and other patents pending.

Support and Contact Information

For Europe, Asia Pacific, North and South America contact details, see back page or refer to the appropriate Honeywell Solution Support web site:

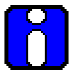
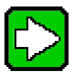
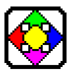
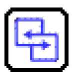
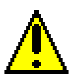
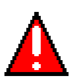
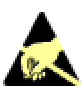
Honeywell Corporate	www.honeywellprocess.com
Honeywell Process Solutions	www.honeywellprocess.com/pressue-transmitters/
Training Classes	http://www.automationccollege.com

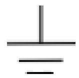
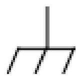
Telephone and Email Contacts

Area	Organization	Phone Number
United States and Canada	Honeywell Inc.	1-800-343-0228 Customer Service 1-800-423-9883 Global Technical Support
Global Email Support	Honeywell Process Solutions	ask-ssc@honeywell.com

Symbol Definitions

The following table lists those symbols used in this document to denote certain conditions.

Symbol	Definition
	**ATTENTION:** Identifies information that requires special consideration.
	**TIP:** Identifies advice or hints for the user, often in terms of performing a task.
	**REFERENCE -EXTERNAL:** Identifies an additional source of information outside of the bookset.
	**REFERENCE - INTERNAL:** Identifies an additional source of information within the bookset.
CAUTION	Indicates a situation which, if not avoided, may result in equipment or work (data) on the system being damaged or lost, or may result in the inability to properly operate the process.
	**CAUTION**: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. **CAUTION** symbol on the equipment refers the user to the product manual for additional information. The symbol appears next to required information in the manual.
	**WARNING**: Indicates a potentially hazardous situation, which, if not avoided, could result in serious injury or death. **WARNING** symbol on the equipment refers the user to the product manual for additional information. The symbol appears next to required information in the manual.
	**WARNING, Risk of electrical shock**: Potential shock hazard where HAZARDOUS LIVE voltages greater than 30 Vrms, 42.4 Vpeak, or 60 VDC may be accessible.
	**ESD HAZARD:** Danger of an electro-static discharge to which equipment may be sensitive. Observe precautions for handling electrostatic sensitive devices.
	**Protective Earth (PE) terminal**: Provided for connection of the protective earth (green or green/yellow) supply system conductor.
	**Functional earth terminal**: Used for non-safety purposes such as noise immunity improvement. NOTE: This connection shall be bonded to Protective Earth at the source of supply in accordance with national local electrical code requirements.

Symbol	Definition
	**Earth Ground**: **Functional earth connection.** NOTE: This connection shall be bonded to Protective Earth at the source of supply in accordance with national and local electrical code requirements.
	**Chassis Ground**: Identifies a connection to the chassis or frame of the equipment shall be bonded to Protective Earth at the source of supply in accordance with national and local electrical code requirements.

Terms and Acronyms

Term	Definition
Alarm	The detection of a block leaving a particular state and when it returns back to that state.
Analog Input (function block)	One of the standard function blocks define by the Foundation Fieldbus
AP	Absolute Pressure
Application	A software program that interacts with blocks, events and objects. One application may interface with other applications or contain more than one application.
AWG	American Wire Gauge
Block	A logical software unit that makes up one named copy of a block and the associated parameters its block type specifies. It can be a resource block, transducer block or a function block.
Configuration (of a system or device)	A step in system design: selecting functional units, assigning their locations and identifiers, and defining their interconnections.
Device	A physical entity capable of performing one or more specific functions. Examples include transmitters, actuators, controllers, operator interfaces.
Device Description	Description of FBAPs within a device. Files that describe the software objects in a device, such as function blocks and parameters. The DD binary are created by passing DD source files through a standard tool called a tokenizer.
Device Description Language	A standardized programming language (similar to C) used to write device description source files.
Device Tag	The Physical Device Tag of the device as specified in the Foundation Fieldbus specifications.
DP	Differential Pressure
EEPROM	Electrically Erasable Programmable Read Only Memory
EMI	Electromagnetic Interference
Event	An instantaneous occurrence that is significant to scheduling block execution and to the operational (event) view of the application.
Field Device	A fieldbus-compatible device that contains and executes function blocks.
Foundation Fieldbus	Communications protocol for a digital, serial, two-way system which interconnects industrial field equipment such as sensors, actuators and controllers.
FTA	Field Termination Assembly
Function Block	An executable software object that performs a specific task, such as measurement or control, with inputs and outputs that connect to other function blocks in a standard way.
Function Block Application Process	The part of the device software that executes the blocks (function, transducer, or resource blocks).
GP	Gauge Pressure
HP	High Pressure (also, High Pressure side of a Differential Pressure Transmitter)

Term	Definition
Hz	Hertz
inH2O	Inches of Water
LGP	In-Line Gauge Pressure
Link Active Scheduler	A device which is responsible for keeping a link operational. The LAS executes the link schedule, circulates tokens, distributes time messages and probes for new devices.
LP	Low Pressure (also, Low Pressure side of a Differential Pressure Transmitter)
LRL	Lower Range Limit
LRV	Lower Range Value
Macrocycle	The least common multiple of all the loop times on a given link.
mAdc	Milliamperes Direct Current
Manufacturer's Signal Processing	A term used to describe signal processing in a device that is not defined by FF specifications.
mmHg	Millimeters of Mercury
mV	Millivolts
Network Management	A part of the software and configuration data in a Foundation Fieldbus device that handles the management of the network.
Network Management Agent	Part of the device software that operates on network management objects.
Network Management Information Base	A collection of objects and parameters comprising configuration, performance and fault-related information for the communication system of a device.
Nm	Newton. Meters
NPT	National Pipe Thread
NVM	Non-Volatile Memory
Object Dictionary	Definitions and descriptions of network visible objects of a device. There are various object dictionaries within a device. The dictionaries contain objects and their associated parameters which support the application in which they are contained.
Objects	Entities within the FBAP, such as blocks, alert objects, trend objects, parameters, display lists, etc.
P	Pressure
Pa	Measured static pressure in PV4 algorithm
Parameters	A value or variable which resides in block objects
Pc	Absolute critical pressure of the gas
Pd	Static pressure at downstream point
Pdp	Measured differential pressure in Pascals in PV4 algorithm
Pf	Absolute pressure of flowing gas
PM	Process Manger

Term	Definition
Pr	Reduced pressure
Proportional Integral Derivative control	A standard control algorithm. Also refers to a PID function block.
PSI	Pounds per Square Inch
PSIA	Pounds per Square Inch Absolute
Pu	Static pressure at upstream point
PV	Process Variable
PWA	Printed Wiring Assembly
RFI	Radio Frequency Interference
RTD	Resistance Temperature Detector
Stack	The software component that implement the Foundation Fieldbus communications protocol specifications, including FMS, FAS, DLL, SM and NM.
Status	A coded value that qualifies dynamic variables (parameters) in function blocks. This value is usually passed along with the value from block to block. Status is fully defined in the FF FBAP specifications.
STIM	Pressure Transmitter Interface Module
STIMV IOP	Pressure Transmitter Interface Multivariable Input / Output Processor
System Management	Provides services that coordinate the operation of various devices in a distributed fieldbus system.
System Management Agent	Part of the device software that operates on system management objects.
System Management Information Base	A collection of objects and parameters comprising configuration and operational information used for control of system management operations.
TAC	Technical Assistance Center
Trim Point	A selected reference point at which a measurement is calibrated.
URL	Upper Range Limit
URV	Upper Range Value
US	Universal Station
Vac	Volts Alternating Current
Vdc	Volts Direct Current
Virtual Communication Reference	A defined communication endpoint. Fieldbus communications can primarily only take place along an active communications "path" that consists of two VCR endpoints.
Virtual Field Device	A logical grouping of "user layer" functions. Function blocks are grouped into a VFD, and system and network management are grouped into a VFD.
	For example, to establish communications between a transducer block and a function block, a VCR must be defined at the transducer block and a VCR must be defined at the function block.

Contents

Tables

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1. Introduction

1.1 About the ST 700 FF Pressure Transmitter

The newly designed Honeywell ST 700 is a smart pressure transmitter that has a wide range of additional features along with supporting the FOUNDATION^{TM} Fieldbus (FF) communication protocol. The ST 700 pressure transmitter with FF protocol provides a FOUNDATION^{TM} Fieldbus interface to operate in a compatible distributed Fieldbus system. The transmitter includes FOUNDATION^{TM} Fieldbus electronics for operating in a 31.25 Kbit/s Fieldbus network and can interoperate with any FOUNDATION^{TM} Fieldbus registered device.

The STD700 is a high performance pressure transmitter featuring Piezo-resistive sensor technology. By combining differential pressure sensing with on-chip static and temperature compensation, the STD700 offers high accuracy and stability over a wide range of application pressures and temperatures. The STG700 and STA700 are high performance pressure transmitters featuring Piezo-resistive sensor technology combining pressure sensing with on-chip temperature compensation capabilities providing high accuracy, stability and performance over a wide range of application pressures and temperatures.

The SmartLine family is also fully tested and compliant with Experion ® PKS providing the highest level of compatibility assurance and integration capabilities. The ST 700 easily meets the most demanding application needs for pressure measurement applications. This transmitter is used in the process automation industry for sensing and transmitting pressure over intelligent communication networks.

The transmitter comes in a variety of models for measurement applications involving one of these basic types of pressure:

- Differential Pressure (DP)
- Gauge Pressure (GP)
- Absolute Pressure (AP)

1.2 ST 700 major assembly and electronic housing components

The following illustrations depict the major assembly and electronic housing components.

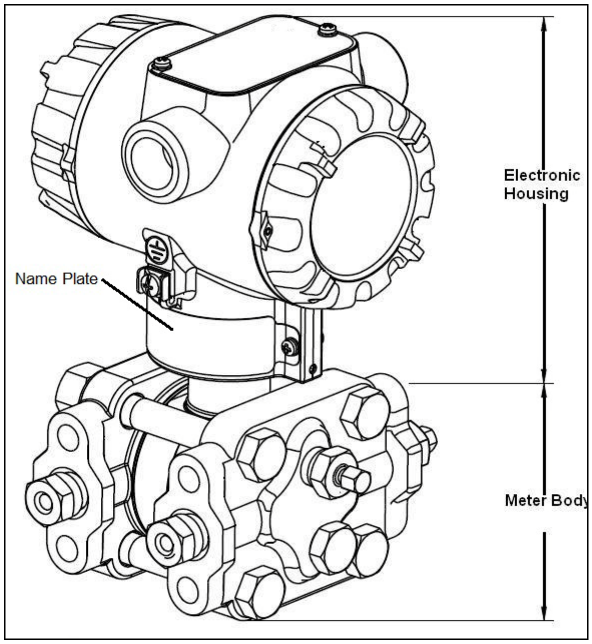


Figure 1: ST 700 Major assemblies

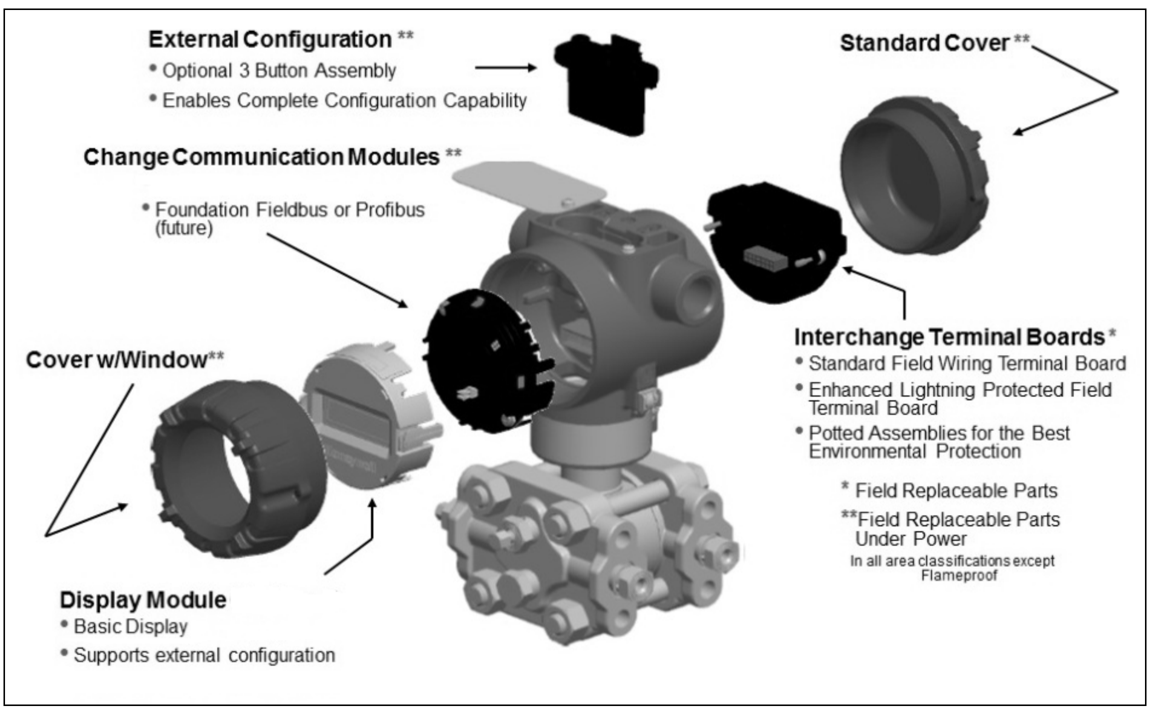


Figure 2: Electronic Housing components

1.3 Features of the transmitter

The transmitter is a configurable intelligent field device that acts as a pressure sensor, and is capable of performing control algorithms on process variables. The core functionalities of the field device include:

- Process Variable (PV) measurement
- Function Block Application Process (FBAP)
- Device diagnostics

The ST 700 features standard fieldbus function blocks with manufacturer-specific additions for enhanced operation. The transmitter can function as a Link Active Scheduler (LAS) in a Fieldbus network.

It supports the following features:

- Link-master capability
- Supports the following standard function blocks apart from the Resource and Transducer blocks.
  - Analog Input block
  - Input Selector block
  - Integrator block
  - Signal Characterizer block
  - PID with auto tune block
  - Arithmetic block
- Function block instantiation is supported by the following blocks
  - Analog Input block
  - Input Selector block
  - Signal Characterizer block
- Supports the following Transducer blocks
  - Pressure Transducer block
  - LCD Transducer block
  - Diagnostic Transducer block
  - Flow Transducer block
- Supports class 3 type firmware download through commercial hosts.

DD and EDDL Features

The ST 700 supports DD and EDD file formats, and the data is displayed using the EDDL features in the form of menus, graphs, charts, and pictures.

2. Getting started

2.1 Verifying the installation

Verifying transmitter installation tasks

After the transmitter is installed and powered up, you can verify communication between the transmitter and the field devices on the network. Table 1 outlines the steps for identifying and checking the transmitter on a Fieldbus network.

Table 1: Transmitter installation verification tasks

Task	Description	Comment
Verify device location	Check that the device is installed in the correct physical location.	
Verify device ID	Match the device ID with the physical location. The device serial number is the PROM ID which is stamped on the transmitter housing nameplate.	
Verify connection with host computer to device	On the operator interface, check and make sure communications are established with the device on the Fieldbus network.	
Verify or assign Device Tag and address	Check that the Device Tag and node address are set. If not, assign the Device Tag and the correct node address. The Device Tag and address can be set and viewed using the Fieldbus device configurator application. Use a Device Tag name (up to 16 characters) that does not contain spaces.	
Configure device	Using a Fieldbus configuration program, create a function block application as part of the device configuration and process control strategy.	
Verify device operation	Bring the network online, verify operation, tune loops, and so on.	

2.2 Verifying communication with the transmitter

On the operator interface, establish communication with the device on the Fieldbus network. If the device is not visible on the network, verify that the device has been installed properly.

Identify the transmitter

Verify the Device ID of the transmitter by checking the device parameters. The parameters contain the following information:

- Transmitter type (pressure transmitter, temperature transmitter, and flow transmitter)
- Device Tag (tag description of the transmitter)
- Sensor serial number
- Firmware revision level (revision level of the firmware elements)

Check the transmitter parameters listed in Table 2 and note down the values to identify the transmitter.

ATTENTION

It is recommended to verify the correct version of the Device Description file is present on the host computer. (Refer to the document on the diskette shipped with the transmitter.) This helps in getting the correct parameter names and its corresponding descriptions, while viewing the device parameters.

Table 2: Transmitter parameters

Parameter	To verify
Resource block **DEV_TYPE**	That the transmitter is of the proper device type. For all the ST 700 type pressure transmitters, the value is 0003.
Device Tag (Physical device tag name of the transmitter) **ATTENTION** The Device Tag name can be set and viewed using the Fieldbus device configurator application. Use a device tag name (up to sixteent characters) that does not contain spaces.	The Device Tag is correct. Device Tag name ___________________
Transducer Block **SENSOR_SN**	Sensor serial # _________________ The **SENSOR_SN** value, when viewed as a hexadecimal number, is the same number as the first sixteen digits of the PROM ID stamped on the transmitter housing nameplate.

ATTENTION

Note that the eight digit serial number in the **SENSOR_SN** parameter does not display the last two digits of the PROM ID stamped on the nameplate of the transmitter housing. The Device ID contains the full 10-digit PROM ID.

2.3 Establishing communication with host systems

The transmitter establishes communication with the host systems using DD or DTM.

Device Description (DD)

DD is a binary file that provides the definition for parameters in the FBAP of the transmitter. For example, DD refers to the function blocks that a transmitter contains, and the corresponding parameters in the blocks that are critical to the interoperability of Fieldbus devices. They define the data required to establish communications between different Fieldbus devices from multiple vendors with control system hosts. The DD provides an extended description of each object in the Virtual Field Device (VFD).

The Fieldbus Foundation provides the DD for all standard function blocks and transducer blocks on a CD-ROM. The Fieldbus Foundation also provides this information on its website, www.fieldbus.org.

Enhanced Device Description (EDD)

There are two types of EDDs are available, namely .ff5/.sy5 and .ffo/sym. The.ffo/.sym binary files are generated for the legacy hosts to load the device DD that is generated using latest tokenizer. Few constructs like Images that are supported in .ff5/.sy5 binaries, are not supported in .ffo/.sym binary files.

Device Type Manager (DTM)

DTM is similar to a device driver that enables usage of devices in all the asset management and device configuration software like FDM, with the help of the FDT-DTM technology.

The DTM has the following primary functions:

- Provides a graphic user interface for device configuration.
- Provides device configuration, calibration, and management features for the particular device.

DTM provides functions for accessing device parameters, configuring and operating the devices, calibrating, and diagnosing problems.

3. ST 700 FF Pressure Transmitter Configuration

3.1 Importing the ST 700 FF Device Description (DD) files

Importing the DD to Experion PKS

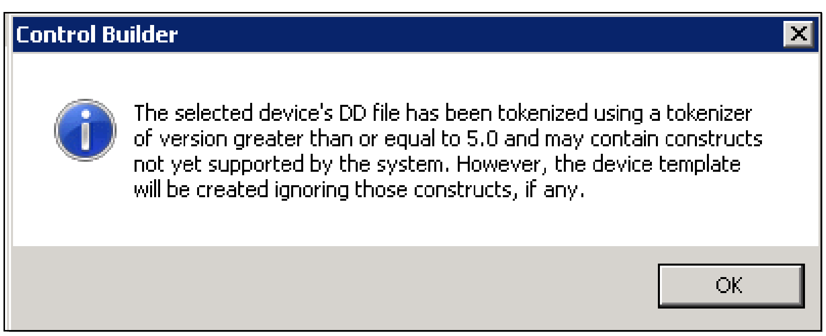
ATTENTION

Experion release compatibility

Experion Release	DD Compatibility
410	Yes
400.2 + CP3	Yes
311.3	Yes

The steps in the following procedure are specific to Experion only.

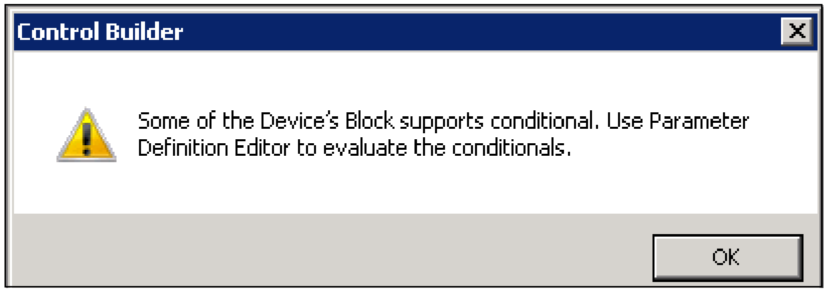
Step	Action
1	From the **Control builder** main screen, click **Fieldbus Device Description Import** . OR Select **File > New > Type >Fieldbus Device**
2	You can Import the **DD** using one of the following steps: • Choose **Browse** to locate the folder where you have stored the DD file. • Select the required folder, and click **OK**. • Select the **DD** from the **Device List**, and click **OK**.
2	The following dialog box appears,



Step	Action
	Click **OK**
3	Type the **Device Type Name**, and then click **Save As**.

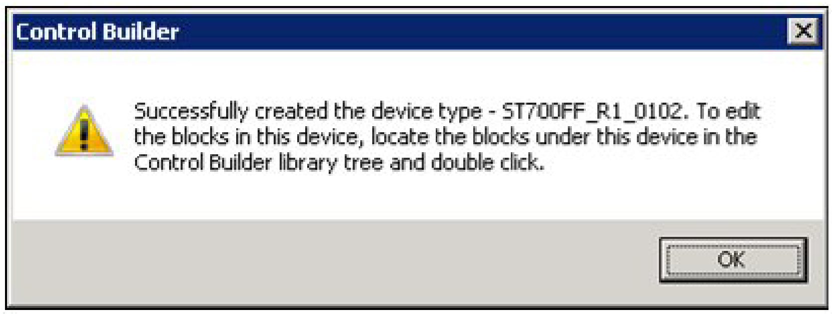
Step	Action

4 The following dialog box appears,



Click **OK**.

5 The following dialog box appears,



Click **OK**.

ATTENTION

The device type – **ST700FF_R1_0102** is used as an example.

6 The device is created in the **Library-Containment** window under the folder named **Honeywell**.

7 From the **Library-Containment** window, drag and drop the device into the corresponding FF link on the **Project-Assignment** window.

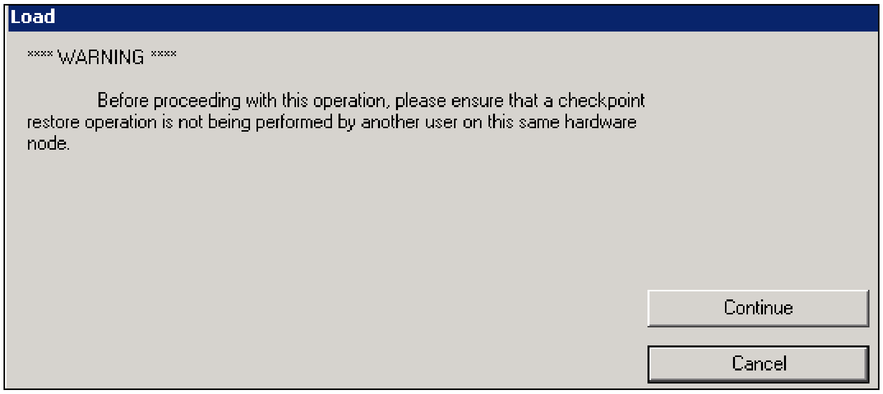
8 You are prompted to name the new function block. If you want to change the name in the destination column, type the new name or if you want to use the default name, click **Finish**.

The device is added on the FF link on the **Project-Assignment** window.

9 Right-click the new device and then click **Load**.

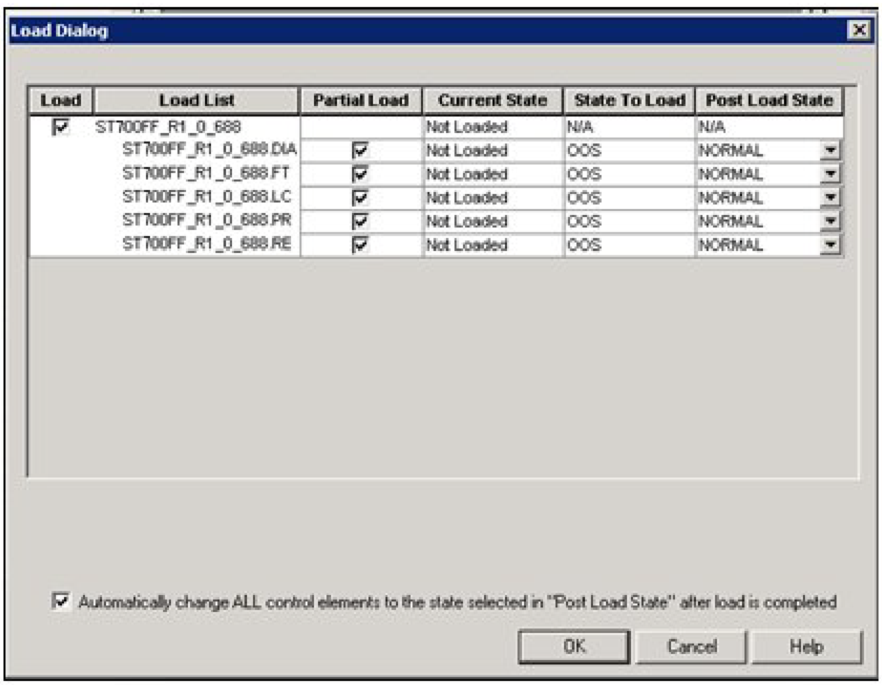
Step	Action

10 The following **WARNING** appears.



Click **Continue**.

11 The following dialog box appears,



Select the **Automatically change ALL control elements to the state selected in "Post Load State" after load is completed** checkbox and click **OK**.

11 On the **Monitoring-Assignment** window, you can notice that device on the **Project-Assignment** window has been loaded to the corresponding FF link.

12 Right-click the device, and then click **Activate >> Selected Item(s) and Content(s)**. The device is commissioned.

ATTENTION

Note that after importing the DD, you have to create control strategies.

Control strategy

A control strategy is an organized approach to define a specific process using detailed information to:

- create control modules in an associated controlled environment
- configure function blocks to enable control applications, and
- runs in a control software infrastructure

To build a control strategy, a Control Module (CM) must be created where function blocks are inserted and connected with other function blocks.

Creating control strategy

For information on creating control strategy, refer to the corresponding DCS document.

ATTENTION

When control strategy is loaded by deselecting the partial download option in the Experion, parameter check errors will appear. Ignore the errors and continue the loading of control strategy.

3.2 Configuring the function block application process

About the Function Block Application Process (FBAP)

The transmitter has one resource block, four transducer blocks, and six function blocks respectively. The DD-View feature supports all the 11 permanent blocks. The FBAP provides the block related information in a much more organized way. The FBAP defines blocks to represent different types of application functions.

In addition, the blocks have a static revision parameter. The revision level of the static data is associated with the function block. To support tracking changes in static parameter attributes, the associated block's static revision parameter is incremented each time a static parameter attribute value is changed. In addition, the associated block's static revision parameter is incremented, if a static parameter attribute is written but the value is not changed.

The FBAP supports two types of alarms: block alarms and process alarms. A block alarm is generated whenever the **BLOCK_ERR** has an error bit set. The types of block error for the AI block are shown in Table 3. The following alarms are supported by each function block:

Block Alarms

Table 3: Bit mapping of the BLOCK_ERR

Block_ERR Bit	Block Alarms	Description
0	Other	Least significant bit (LSB). **NOTE:** It is not applicable to the transmitter.
1	Block Configuration error	A feature in **FEATURES_SEL** is set that is not supported by features or an execution cycle in **CYCLE_SEL** is set that is not supported by **CYCLE_TYPE**.
2	Link Configuration error	If the link is not configured properly.
3	Simulation Active	The jumper or switch that enables simulation within the resource is ON. The individual I/O function blocks disable the simulation.
4	Local Override	The block output is being set to track the value of the track input parameter. **NOTE:** It is not applicable to the transmitter.
5	Device Fault State Set	If the Device Fault State condition is True. **NOTE:** It is not applicable to the transmitter.

Block_ERR Bit	Block Alarms	Description
6	Device Needs Maintenance Soon	A diagnostic algorithm has found a warning condition. The NV memory is approaching the maximum number of reliable writes. **NOTE:** It is not applicable to the transmitter.
7	Input Failure	When a sensor failure (open thermocouple) or sensor conversion not accurate.
8	Output Failure	Output Failure detected by this block/back calculation input has a status of Bad or Device Failure. **NOTE:** It is not applicable to the transmitter.
9	Memory Failure	A diagnostic algorithm has found a failure in memory (includes all types) and the device is still able to communicate that condition.
10	Lost Static data	If the object's static data is Bad, then the object's database is set to its default values.
11	Lost NV data	The NV and static parameters are saved periodically. This alarm occurs, if new data was supposed to be saved to NV at the next NV write cycle, but prevented the write due to power failure.
12	Readback Check failed	This indicates the readback of the actual continuous valve or other actuator position in transducer units has failed.
13	Device needs maintenance now	A diagnostic algorithm has found an invalid condition, but the device is still able to operate and communicate. The NV memory has reached the maximum number of reliable writes. **NOTE:** It is not applicable to the transmitter.
14	Power-up	The resource is performing its first normal execution, after power was applied to the device. It is not an error but generates an alarm that says that normal operation was interrupted and is now being restored. **NOTE:** It is not applicable to the transmitter.
15	Out-of-Service	The actual mode is OOS. No control function blocks are being processed.

Process Alarms

A set of alarms that indicates a process value has exceeded a certain threshold. Process Alarm detection is based on the **OUT** value. The alarm limits can be configured for the following standard alarms:

- High (HI_LIM)
- High High (HI_HI_LIM)
- Deviation High Limit (DEV_HI_LIM)
- Deviation Low Limit (DEV_LO_LIM)
- Low (LO_LIM)
- Low Low (LO_LO_LIM)

When the value **OUT** oscillates, **ALARM_HYS** is used to avoid alarm triggering. The priority of each alarm is set by the following parameters:

- HI_PRI
- HI_HI_PRI
- DV_HI_PRI
- DV_LO_PRI
- LO_PRI
- LO_LO_PRI

The following is the order of priority for alarms.

Table 4: Priority for Alarms

Priority	Description
0	To disable the triggered alarm, the priority of an alarm condition is changed to 0.
1	Alarm condition with a priority 1 is reported to the system, but not reported as an event and alarm
2	Alarm condition with priority of 2 is reported to the system and event, but not reported as an alarm.
3-7	Alarm conditions of priority 3 to 7 are reported as advisory alarms.
8-15	Alarm conditions of priority 8 to 15 are reported as critical alarms.

ATTENTION

Process alarms are not supported by all blocks.

3.3 Resource block

The Resource block is used to describe characteristics of the Fieldbus device such as the device name, manufacturer, and serial number. The block does not contain any input or output parameters. The block contains data that is specific to the hardware associated with the resource. The resource block monitors and controls the general operation of the device hardware. For example, if the resource block is in out of service mode, it affects all the other blocks. The **ITK_VER** parameter is used to identify the version of the Interoperability Tester. The transmitter's Revision and Versions, Model Number, and Material of Construction of the meterbody can be obtained by executing the methods available in the resource block.

The block modes are used to control major states of the resource:

- The OOS mode stops all function block execution.
- The Actual mode of the function blocks changes to OOS but the target mode does not change.
- The AUTO mode allows normal operation of the resource.

Configuring the Resource block

The Resource block supports scalar input only as **HARD_TYPES**. This parameter is a read-only bit string that indicates the types of hardware that are available for this resource. The **RS_STATE** parameter contains the operational state of the Function Block Application for the data containing that resource block.

RESTART

The **RESTART** parameter allows degrees of initialization of the resource.

Restart	Operation
Run (1)	The passive state of the parameter.
Restart resource (2)	Discards unnecessary alarms, and also discards the resource dynamic values.
Restart with defaults (3)	Resets all configurable function block application objects to their initial value, which is their value before any configuration is done.
Restart processor (4)	Provides a way to press the reset button on the processor associated with the resource.

Execution

CYCLE TYPE

The parameter **CYCLE_TYPE** is a bit string that defines the types of cycles that are available for the resource and supports scheduled and block execution. **CYCLE_SEL** allows the person doing the configuration to indicate that one or more of these execution types can be used by the device. **MIN_CYCLE_T** is the minimum time to execute a cycle; the minimum cycle time supported is 100 ms.

MEMORY

MEMORY_SIZE is the size of the resource for configuration of function blocks; it is represented in kilobytes. **SHED_RCAS** and **SHED_ROUT** set the time limit for loss of communication from a remote device. These constants are used by each function block and are configurable values.

MAX NOTIFY

The **MAX_NOTIFY** parameter value is the maximum number of alert reports that this resource can send without getting a confirmation, and to control alert flooding, adjust the **LIM_NOTIFY** parameter to a lower value. If **LIM_NOTIFY** is set to zero, 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.

FEATURES

The bit strings **FEATURES** and **FEATURE_SEL** determine optional behaviour of the resource. **FEATURES** bit string defines the available features; it is read-only. **FEATURE_SEL** is used to turn on an available feature by configuration.

Reports

If the Reports option is set in the Features bit strings, the transmitter actively sends alerts to host/master. If it is not set, the host/master must poll for alerts.

SOFT W LOCK and HARD W LOCK

There are two types of write locks: Hardware write lock and Software write lock. The software write lock is used to lock the device. The software write lock does not need a jumper. A hardware write lock is provided with a jumper in the device to perform the write lock operation.

If the **WRITE_LOCK** parameter is set, it prevents any external change to the static or non-volatile database in the Function Block Application of the resource. Block connections and calculation results proceeds normally but the configuration is locked. A hard write lock is provided by a jumper in the device as indicated in the **FEATURES** bit string. Clearing **WRITE_LOCK** generates the discrete alert **WRITE_ALM** at the **WRITE_PRI** priority.

If the soft write lock bit is not set as True in the features bit strings, the writing to the parameter **WRITE_LOCK** is rejected by the device. For devices that support hard write lock and have the associated **FEATURE_SEL** attribute enabled, the parameter **WRITE_LOCK** is only an indicator of the state of write-lock. The writing to **WRITE_LOCK** is rejected by the device.

Software write lock

To activate write lock, the soft write lock supported bit in **FEATURE_SEL** must be set, and then set the **WRITE_LOCK** to locked. To deactivate write lock, set the **WRITE_LOCK** to unlocked.

Hardware write lock

To activate write lock, the hard write lock supported bit in **FEATURE_SEL** must be set, and additionally the write lock jumper must be in the correct position as determined by the manufacturer. When this is detected by the device, **WRITE_LOCK** is set to locked. If hard write lock is enabled in **FEATURE_SEL,** the configured value of soft write lock has no impact on device operation. To deactivate write lock, the jumper must be changed as **FEATURE_SEL** is not writeable during write lock. Once the device detects the change in jumper position, the write-lock is disabled and **WRITE_LOCK** is set to 1.

Install Date

When the device is connected to the master/host, the time at which the device is powered up is taken as the install date. It is a read-only parameter.

Field Diagnostics

The Resource block acts as a coordinator for alarms. There are four alarm parameters: Fail alarm, Offspec alarm, Maintenance alarm, and Check alarm. It contains information of device errors that are detected by the transmitter. Based on the error detected, the device provides the recommended actions; it is a read only parameter. It displays the recommended action text for the reported alarms.

Table 5: Diagnostic Definitions

Name	Description
Maintenance	Although the output signal is valid, the wear reserve is nearly exhausted or a function is soon restricted due to operational conditions. For example, build-up of deposits.
Off Specification	Indicates if the device is operating outside its specified range or internal diagnostics indicate deviations from measured or set values due to internal problems in the device or process characteristics.
Check Function	Output signal temporarily invalid due to on-going work on the device.
Failed	Output signal invalid due to malfunction in the field device or its peripherals.

FAILED_ALARMS

Failed alarms indicate a failure within a device that makes the device or some part of the device non-operational. This implies that the device needs repair and must be fixed immediately.

- **FAILED_MAPPED** parameter contains a list of failures in the device which makes the device non-operational that causes an alarm. There are four parameters mapped by default with **FAILED_MAPPED**: Meterbody fault, Communication board fault, and No communication with meterbody.
- **FAILED_MASK** parameter masks any of the failed conditions listed in **FAILED_MAPPED**. A bit on means that the condition is masked out from alarming and is not reported.
- **FAILED_PRI** parameter designates the alarming priority of **FAILED_ALM**. The default is 0.
- **FAILED_ACTIVE** parameter displays the alarms that are active.
- **FAILED_ALM** parameter indicates a failure within a device which makes the device non-operational.

MAINT_ALARMS

A maintenance alarm indicates either the device or some part of the device needs maintenance. If the condition is ignored, the device eventually fails.

- **MAINT_MAPPED** parameter contains a list of conditions indicating either the device or some part of the device needs maintenance soon. If the condition is ignored, the device eventually fails. There are six parameters mapped by default with **MAINT_MAPPED**: meterbody overload or fault, Communication board over temperature, no factory calibration, low supply voltage, high supply voltage, and unreliable sensor communication.
- **MAINT_MASK** parameter masks any of the failed conditions listed in **MAINT_MAPPED**. A bit on means that the condition is masked out from alarming and is not reported.
- **MAINT_PRI** designates the alarming priority of the **MAINT_ALM**. The default is 0.
- **MAINT_ACTIVE** parameter displays the alarms that are active.
- **MAINT_ALM** parameter indicates that the device needs maintenance. If the condition is ignored, the device fails.

CHECK_ALARMS

It indicates that the output signal is temporarily invalid due to on-going work on the device.

- **CHECK_MAPPED** parameter contains a list of informative conditions that do not have a direct impact on the device's primary functions.
- **CHECK_MASK** parameter masks any of the failed conditions listed in **CHECK_MAPPED**. A bit on means the condition is masked out from alarming and is not reported.
- **CHECK_PRI** parameter designates the alarming priority of the **CHECK_ALM**. The default is 0.
- **CHECK_ACTIVE** parameter displays the check alarms that are active.
- **CHECK_ALM** parameter indicates check alarms. These conditions do not have a direct impact on the process or device integrity.

OFFSPEC_ALARMS

Indicates if the device is operating outside its specified range or internal diagnostics indicates deviations from measured or set values due to internal problems in the device or process characteristics.

- **OFFSPEC_MAPPED** parameter contains a list of informative conditions that do not have a direct impact on the device's primary functions.
- **OFFSPEC_MASK** parameter masks any of the failed conditions listed in **OFFSPEC_MAPPED**. A bit on means the condition is masked out from alarming and is not reported.
- **OFFSPEC_PRI** parameter designates the alarming priority of the **OFFSPEC_ALM**. The default is 0.
- **OFFSPEC_ACTIVE** parameter displays the offspec alarms that are active.
- **OFFSPEC_ALM** parameter indicates offspec alarms. These conditions do not have a direct impact on the process or device integrity.

RECOMMENDED_ACTION

The **RECOMMENDED_ACTION** parameter displays a text string that give a recommended course of action to take based on which type and which specific event of the alarms is active.

FD_SIMULATE

When simulation is enabled the Field Diagnostics conditions are taken from the Diagnostic Simulate Value, or else the conditions are taken from Diagnostic Value, and the **RECOMMENDED_ACTION** parameter displays the text as ‘Simulation Active’.

ATTENTION

Note that **FD_SIMULATE** can be enabled only if the simulation jumper is enabled in the device. For more information refer section 6.5

MAINTENANCE_MODE

It indicates if the device is available for maintenance. When the resource block is in AUTO mode, **MAINTENANCE_MODE** parameter displays the text as 'Chk with Oper', that is the device is in process and is not available for maintenance. When the resource block is in OOS mode, **MAINTENANCE_MODE** parameter displays the text as ‘Avail for Maint' that is the device is out of process and is available for maintenance.

'Chk with Oper'- Check with operator to determine availability.

‘Avail for Maint'- The device is available for maintenance.

Parameter List

Table 6: Resource block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block.
TAG_DESC	The user description of the application of the block.
STRATEGY	Used to identify grouping of blocks.
ALERT_KEY	The identification number of the plant unit.
MODE_BLK	The actual, target, permitted, and normal modes of the block.
BLOCK_ERR	Reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
RS_STATE	Indicates the State of the function block application state machine.
TEST_RW	Read/write test parameter is used only for conformance testing.
DD_RESOURCE	String identifying the tag of the resource, which contains the Device Description for the resource.
MANUFAC_ID	Manufacturer identification number is used by an interface device to locate the DD file for the resource.
DEV_TYPE	Manufacturer model number associated with the resource. It is used by interface devices to locate the DD file for the resource.
DEV_REV	Manufacturer revision number associated with the resource. It is used by an interface device to locate the DD file for the resource.
DD_REV	Revision of the DD associated with the resource. It is used by the interface device to locate the DD file for the resource.
GRANT_DENY	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
HARD_TYPES	The types of hardware available as channel numbers. The supported hardware type is SCALAR_INPUT.
RESTART	Allows a manual restart to be initiated.
FEATURES	Used to show supported resource block options. The supported features are: REPORT, SOFT_WRITE_LOCK, HARD_WRITE_LOCK, and MULTI_BIT_ALARM.

Parameter	Description
FEATURE_SEL	Used to select resource block FEATURE_SEL options
CYCLE_TYPE	Identifies the block execution methods available for this resource. The supported cycle types are: SCHEDULED, and COMPLETION_OF_BLOCK_EXECUTION.
CYCLE_SEL	Used to select the block execution method for this resource.
MIN_CYCLE_T	Time duration of the shortest cycle interval of which the resource is capable.
MEMORY_SIZE	Available configuration memory in the empty resource. It must be checked before starting a download.
NV_CYCLE_T	Minimum time interval specified by the manufacturer for writing copies of NV parameters to non-volatile memory. Zero implies it is never automatically copied. At the end of NV_CYCLE_T, only those parameters that have changed need to be updated in NVRAM.
FREE_SPACE	Percent of memory available for further configuration. Zero in preconfigured resource.
FREE_TIME	Percent of the block processing time that is free to process additional blocks.
SHED_RCAS	Time duration at which to give up on computer writes to function block RCas locations. Shed from RCas does not happen, if SHED_RCAS = 0.
SHED_ROUT	Time duration at which to give up on computer writes to function block ROut locations. Shed from Rout does not happen, if SHED_ROUT = 0.
FAULT_STATE	Condition set by loss of communication to an output block, fault promoted to an output block or a physical contact. When Fault State condition is set, output function blocks perform their FSTATE actions.
SET_FSTATE	Allows the Fault State condition to be manually initiated by selecting Set.
CLR_FSTATE	Writing a Clear to this parameter removes the device fault state if the field condition, if any has cleared.
MAX_NOTIFY	Maximum numbers of unconfirmed notify messages possible.
LIM_NOTIFY	Maximum numbers of unconfirmed alert notify messages allowed.
CONFIRM_ TIME	The time the resource waits for confirmation of receipt of a report before trying again. Retry does not happen when CONFIRM_TIME=0.
WRITE_LOCK	If set, no writes from anywhere are allowed, except to clear WRITE_LOCK. Block inputs continues to be updated.
UPDATE_EVT	This alert is generated by any change to the static data.
BLOCK_ALM	The BLOCK_ALM is used for configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert is reported without clearing the Active status, if the subcode has changed.
ALARM_SUM	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ACK_OPTION	Selection of whether alarms associated with the block is automatically acknowledged.

Parameter	Description
WRITE_PRI	Priority of the alarm generated by clearing the write lock.
WRITE_ALM	This alert is generated if the write lock parameter is cleared.
ITK_VER	Major revision number of the interoperability test case used in certifying this device as interoperable. The format and range are controlled by the Fieldbus Foundation. The current ITK version is 6.0.1.
FD_VER	A parameter equal to the value of the major version of the Field Diagnostics specification that the device is designed for.
FD_RECOMMEN_ACT	Enumerated list of recommended actions displayed with a device alert.
FD_FAIL_PRI	Designates the alarming priority of the FAIL_ALM. The valid range is 0-15.
FD_FAIL_MAP	Mapped FAIL_ALM alarm conditions, and corresponds bit for bit to the FAIL_ACTIVE. A bit on means that the corresponding alarm condition is Mapped and it is detected. A bit off means the corresponding alarm condition is disabled and is not detected.
FD_FAIL_MASK	Mask of FAIL_ALM. It corresponds to the bit of bit to FAIL_ACTIVE. A bit on means that the condition is masked out from alarming.
FD_FAIL_ACTIVE	Enumerated list of failure conditions within a device.
FD_FAIL_ALM	Alarm indicating a failure within a device which makes the device non-operational.
FD_MAINT_PRI	Designates the alarming priority of the MAINT_ALM. The valid range is 0-15.
FD_MAINT_MAP	Mapped MAINT_ALM alarm conditions and corresponds bit for bit to the MAINT_ACTIVE. A bit on means that the corresponding alarm condition is Mapped and is not detected. A bit off means the corresponding alarm condition is disabled and is not detected.
FD_MAINT_MASK	Mask of MAINT_ALM. It corresponds to the bit of bit to MAINT_ACTIVE. A bit on means that the condition is masked out from alarming.
FD_MAINT_ACTIVE	Enumerated list of maintenance conditions within a device.
FD_MAINT_ALM	Alarm indicating the device needs maintenance soon. If the condition is ignored, the device eventually fails.
FD_OFFSPEC_PRI	Designates the alarming priority of the OFFSPEC_ALM. The valid range is 0-15.
FD_OFFSPEC_MAP	Mapped OFFSPEC_ALM alarm conditions. Corresponds bit for bit to the OFFSPEC_ACTIVE. A bit on implies that the corresponding alarm condition is Mapped and detected. A bit off means the corresponding alarm condition is disabled and is not detected.
FD_OFFSPEC_MASK	Mask of OFFSPEC_ALM. It corresponds to the bit of bit to OFFSPEC_ACTIVE. A bit on implies that the condition is masked out from alarming.
FD_OFFSPEC_ACTIVE	Enumerated list of offspec conditions within a device.
FD_OFFSPEC_ALM	Alarm indicating offspec alarms. These conditions do not have a direct impact on the process or device integrity.

Parameter	Description
FD_CHECK_PRI	Designates the alarming priority of the CHECK_ALM. The valid range is 0-15.
FD_CHECK_MAP	Mapped CHECK_ALM alarm conditions. Corresponds bit for bit to the CHECK_ACTIVE. A bit on means that the corresponding alarm condition is Mapped and is detected. A bit off means the corresponding alarm condition is disabled and is not detected.
FD_CHECK_MASK	Mask of CHECK_ALM. It corresponds to the bit of bit to CHECK_ACTIVE. A bit on means that the condition is masked out from alarming.
FD_CHECK_ACTIVE	Enumerated list of check conditions within a device.
FD_CHECK_ALM	Alarm indicating check alarms. These conditions do not have a direct impact on the process or device integrity.
FD_SIMULATE	When simulation is enabled, the Field Diagnostics conditions are taken from Diagnostic Simulate Value, or else the conditions are taken from Diagnostic Value.
HARDWARE_REV	The hardware revision number of the communications module.
SOFTWARE_REV	The software revision number of the communications module.
MODEL_KEY	The key number of ST 700 pressure transmitter (Example: STD 810).
MOD_PART_1	First part of the Material of Construction Information.
MOD_PART_2	Second part of the Material of Construction Information.
MOD_PART_3	Third part of the Material of Construction Information.
MOD_PART_4	Fourth part of the Material of Construction Information.
HW_SIMULATE_JUMPER_STATE	State of Hardware Simulation Jumper (Enabled / Disabled).
INSTALL_DATE	The date and time when the device is installed in the field. The date and time is directly acquired from the FF Host.
MAINTENANCE_MODE	It indicates whether device is ready for maintenance.'Chk with Oper'- Check with operator to determine availability. ‘Avail for Maint'- The device is available for maintenance.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • IMAN (Manual) • OOS (Out of Service).
Alarm Types	The block supports standard block alarms (see section 3.2), and added to it, a discrete alarm for write lock.

3.4 Pressure Transducer block

The Pressure Transducer block is used to sense and display pressure. It contains details of the primary process variable, secondary process variables, tertiary variables, and quaternary variables. The primary measurement is differential, absolute or gauge pressure. For example, in a Differential Pressure transmitter, meter body temperature is the secondary variable and static pressure the tertiary variable. In addition, it can measure onboard electronics temperature.

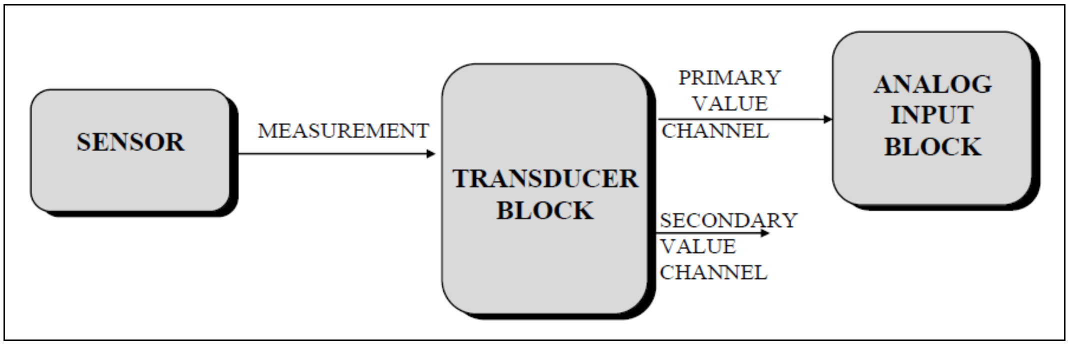


Figure 3: Pressure Transducer Block

Execution

The block has firmware revision parameter that indicates the revision of the sensor module that is the firmware revision details. The primary measurement is represented by **PRIMARY_VALUE_TYPE** parameter. The sensor provides more than one pressure measurement type, such as Differential pressure/Gauge pressure/Absolute pressure and Static pressure. The block computes its output using primary sensor data and parameters. The calculation is modeled as shown in Figure 3.

The Transducer block supports the following process variables:

- Primary Value – DP/GP/ AP
- Secondary Value – Meterbody temperature
- Tertiary Value – Static pressure is applicable only for DP
- Quaternary Value – Fluid level
- Electronic Housing temperature

PRIMARY_VALUE is the value and status of Differential pressure/Gauge pressure/Absolute pressure. **PRIMARY_VALUE_RANGE** is the limits of the **PRIMARY_VALUE,** the units of the **PRIMARY_VALUE (**changing the units of the value automatically changes the limits), and the decimal point position (number of significant digits to the right of the point). The engineering units must match the units selected in the parameter **XD_SCALE** of the Analog Input block that reads the channel with this value.

SECONDARY_VALUE is the value and status of the meterbody temperature. **SECONDARY_VALUE_RANGE** is the limits of the **SECONDARY_VALUE,** and it is a read only parameter, while the units of the **SECONDARY_VALUE** can be changed as desired **(**changing the units of the value automatically changes the limits). The engineering units must match the units selected in the parameter **XD_SCALE** of the Analog Input block that reads the channel with this value.

TERTIARY_VALUE is the value and status of the static pressure. **TERTIARY_VALUE_RANGE** is the limits of the **TERTIARY_VALUE,** and it is a read only parameter, while the units of the **TERTIARY_VALUE** can be changed as desired **(**changing the units of the value automatically changes the limits). The engineering units must match the units selected in the parameter **XD_SCALE** of the Analog Input Block that reads the channel with this value.

Electronics housing temperature

Electronics housing temperature is the value and status of the temperature of the electronic housing. The units can be changed as desired. The engineering units must match the units selected in the parameter **XD_SCALE** of the Analog Input block that reads the channel with this value.

Level Calculation

The transmitter has the ability to put the measured pressure value through a fifth-order polynomial equation. This calculation allows the transmitter to closely approximate the level of an irregularly shaped tank or vessel.

Enabling the Level Calculation

When the channel is fluid level, calculation is enabled in AI block.

Parameters used in the Level Calculation

The following parameters are used do the level calculation and these values are derived from the particular application:

- **LEVEL_COEFF** contains an array of floating point values (coefficients) to be used in the equation.
- **TANK_RANGE** contains the upper and lower ranges of the tank measurements (that is for a full and empty tank) and the engineering units.

LEVEL_COEFF Parameter

The **LEVEL_COEFF** parameter contains the coefficients used in the polynomial level equation. These coefficients must be generated for the application. In addition, the result of the calculation is expressed in percent.

If the AI block's **XD_SCALE** is not configured with the engineering units in percent value (and **CHANNEL** = Fluid level), then a block configuration error is generated in the AI block and it remains in Out of Service (OOS) mode.

The polynomial can also be used for measuring flow,

Where flow = f (Δp).

TANK_RANGE Parameter

The **TANK_RANGE** parameter is configured with the upper and lower range values of the pressure coming from the tank measurement. This must also take into account the head pressure of any fill fluid in remote seal tubing (wet legs).

Level Calculation Formula

The level is calculated in the following way:

$V = 100 \bullet [C_0 + (C_1 \bullet H^1) + (C_2 \bullet H^2) + (C_3 \bullet H^3) + (C_4 \bullet H^4) + (C_5 \bullet H^5)]$

Where:

- V = Volume (%)
- H = height of process tank fluid, in fraction (0.0 - 1.0) of TANK_RANGE
- C_i = LEVEL_COEFF[i]

ATTENTION

Note that the coefficients must be provided for this equation, as the transmitter has no knowledge of the shape of the tank.

The result of the calculation, V is placed in **CALC_VAL** and passed to the AI block. The engineering units are always expressed as a percent (%).

Calibration

Calibration is performed in order to get the precise value. If there is any offset in value it can be eliminated by performing calibration. For example, if zero pressure is applied, but the sensor indicates a value of 0.1, then it can be made zero by performing calibration. Hence, when zero pressure is applied next time, it indicates exactly zero.

ATTENTION

Note that calibration is performed only for the primary variable.

Calibration methods

There are 4 types of sensor calibrations: LRV Correct, URV Correct, Zero correct, and Corrects Reset.

LRV Correct

LRV Correct is used to correct the Lower range value. For LRV correct, use **CAL_POINT_LO**.

URV Correct

URV Correct is used to correct the Upper range value. For URV Correct, use **CAL_POINT_HI**.

Zero Correct

Zero correct is used to perform zero correction to the value.

CAL_POINT_HI is the upper calibrated value. The value must be at least **CAL_MIN_SPAN** away from **CAL_POINT_LO**, and at or below the high range value of **SENSOR_RANGE**.

CAL_POINT_LO is the lower calibrated value. The value must be at least **CAL_MIN_SPAN** away from **CAL_POINT_HI**, and at or above the low range value of **SENSOR_RANGE**.

CAL_MIN_SPAN is the absolute minimum span between **CAL_POINT_HI** and **CAL_POINT_LO**. **CAL_VALUE** shows the **PRIMARY_VALUE** in the units defined by **CAL_UNIT**. **CAL_UNIT** is the engineering unit to be used when calibrating the device.

Calibration diagnostics

The block contains the date and time when the:

- LRV calibration method was last run
- LRV calibration method was run prior to last time
- URV calibration method was last run
- URV calibration method was run prior to last time
- Restore calibration method was last run, and
- Calibration Zero method was last run.

Sensors

SENSOR_RANGE is the absolute maximum end of the sensor range, the units of those limits, and the decimal point position (number of significant digits to the right of the point). **SENSOR_SN** shows the sensor serial number. **SENSOR_CAL_METHOD** is the last calibration method. **SENSOR_CAL_LOC** is the last calibration location. **SENSOR_CAL_DATE** is the last calibration date. **SENSOR_CAL_WHO** identifies the person that last calibrated the sensor.

SENSOR_ISOLATOR_MTL is the material used in the sensor isolation diaphragms. **SENSOR_FILL_FLUID** shows the type of fill fluid used in the sensor.

Parameter List

Table 7: Pressure Transducer block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block.
TAG_DESC	The user description of the application of the block.
STRATEGY	Used to identify grouping of blocks.
ALERT_KEY	The identification number of the plant unit.
MODE_BLK	The actual, target, permitted, and normal modes of the block.
BLOCK_ERR	Reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
UPDATE_EVT	This alert is generated by any change to the static data.
BLOCK_ALM	The BLOCK_ALM is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. After 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.
TRANSDUCER_DIRCTORY	A directory that specifies the number and starting indices of the transducers in the transducer block.
TRANSDUCER_TYPE	Identifies the transducer that follows.
COLLECTION_ DIRECTORY	A directory that specifies the number, starting indices, and DD Item IDs of the data collections in each transducer block.
PRIMARY_VALUE	The measured value and status available to the function block.
PRIMARY_VALUE_TYPE	The type of measurement represented by the primary value.
PRIMARY_VALUE_RANGE	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 to display the final value.
CAL_POINT_HI	The highest calibrated value.
CAL_POINT_LO	The lowest calibrated value.
CAL_MIN_SPAN	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points are not too close together.
CAL_UNIT	The Device Description engineering units code index for the calibration values.
CAL ACTION	Used by the calibration methods to initiate a calibration on a device.
XD_ERROR	Provides additional error codes related to transducer blocks.

Parameter	Description
SENSOR_ISOLATOR_MTL	Defines the construction material for the isolating diaphragms.
SENSOR_TYPE	The type of sensor connected with the transducer block.
SENSOR_RANGE	The high and low range limit values, the engineering units code, and the number of digits to the right of the decimal point for the sensor.
SENSOR_SN	The sensor serial number.
SENSOR_CAL_METHOD	The method of last sensor calibration.
SENSOR_CAL_LOC	The location of the last sensor calibration. This describes the physical location at which the calibration was performed.
SENSOR_CAL_DATE	The date of the last sensor calibration. It shows the calibration of that part of the sensor that is usually wetted by the process.
SENSOR_CAL_WHO	The name of the person who did the last sensor calibration.
SENSOR_FILL_FLUID	It defines the type of fill fluid used in the sensor.
SECONDARY_VALUE	The secondary value that is related to the sensor.
SECONDARY_VALUE_UNIT	The engineering unit to be used with the SECONDARY_VALUE.
SECONDARY_VALUE_TYPE	The type of measurement represented by the Secondary value. For example, Pressure, Temperature.
SECONDARY_VALUE_UPPER_RANGE	The High range limit value of the Secondary value.
SECONDARY_VALUE_LOWER_RANGE	The Low range limit value of the Secondary value.
TERTIARY_VALUE	The measured value and status available to the function block.
TERTIARY_VALUE_UNIT	The engineering units code of the Tertiary value.
TERTIARY_VALUE_TYPE	The type of measurement represented by the Tertiary value. For Example: Pressure, Temperature.
TERTIARY_VALUE_UPPER_RANGE	The High ranges limit value of the Tertiary value.
TERTIARY_VALUE_LOWER_RANGE	The Low range limits value of the Tertiary value.
EL_TEMPERATURE	The value and status of the measured temperature inside the electronics housing.
EL_TEMP_UNIT	The engineering units code used to display the Electronics Temperature.
CAL_STATUS	The current status of the last performed calibration.
QUATENARY_VALUE	The value and status of the fluid level calculated as a polynomial of differential pressure.
TANK_RANGE	Tank Range scaling: It contains the upper and lower range of pressure measurement of a tank. It is used primarily in level applications specifically for the polynomial calculation.

Parameter	Description
LEVEL_COEFF	Indicates the Level Coefficient.
MET_BOD_BCODE	The bar code value of the installed meter body.
SENSOR_MAX_OP	The maximum over pressure that the device can resist.
SENSOR_MAX_SP	The maximum static pressure that the device can resist.
CHAR_DATE	Represents the date in which the meter body was characterized.
HARD_REV	The Hardware revision of the sensor electronics module.
FIRM_REV	The Firmware revision of the sensor electronics module.
CURR_TIME_DATE	Represents the date and time of the last performed calibration. This parameter is to be used in conjunction with the Upload Cal History.
LAST_TIME_DATE	Represents the date and time of calibration performed prior to the current calibration.
PREV_TIME_DATE	Represents the date and time of calibration performed prior to the last calibration.
UPLOAD_CALIB_DATA	Selection of appropriate calibration, updates the current, last and previous calibration dates performed on the device.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • OOS (Out of Service).
Alarm Types	The block supports standard block alarms (see section 3.2).

3.5 Diagnostic Transducer block

The Diagnostics Transducer block is used to monitor or track Process Variables (PV) of the device. The block can be linked to any function block. The block supports several types of diagnostics: Process Variable, Meter body, Static pressure, Calibration and Transmitter Electronics.

ATTENTION

The PV's and core temperature diagnostics is tracked in 7 ways**:**

- Maximum in lifetime
- Minimum in lifetime
- Accumulated time above a limit
- Accumulated time below a limit
- Time stamp of last transition above a limit
- Time stamp of last transition below a limit

Execution

The block has Sensor and Device diagnostics. The block is executed as follows:

Sensor

Sensor Diagnostics

Sensor Diagnostics has two components **Sensor Diagnostics** and **Sensor Voltage diagnostics**. These are updated based on the selection in the **Upload Track Data.**

The device updates the PV tracking data of sensor module and processes the rest of the diagnostic data such as electronic temperature, Time-in-Servic, etc.

PV diagnostics and Sensor Core temperature diagnostics are displayed in the **Sensor Diagnostics** record based on the selection in the Upload Track Data. **Maximum Value** and **Minimum Value** are the maximum and minimum values reached during the life time of the device. **Process Variable Unit** is the engineering unit of the process variable currently under use. The **Over Range Counter** is the accumulation of minutes that device's PV (or Sensor Core temperature) has been above the value of maximum specification limit less 10% of range. (Example: for pressure for range of -800inH2O to 800inH2O, 800 inH2O – 160 inH2O = 640 inH2O). The **Over Range Date** is the date and time when the PV (or Sensor Core temperature) last passed above the value of maximum specification limit less 10% of range. (Example: for pressure for range of -800inH2O to 800inH2O, 800 inH2O – 160 inH2O = 640 inH2O). **Under Range Counter** is the accumulation of minutes that device's PV (or Sensor Core temperature) has been below the value of minimum specification limit plus 10% of range. (Example: for pressure for range of -800inH2O to 800inH2O, 800 inH2O + 160 inH2O = -640 inH2O). **Under Range Date** is the date and time when the PV (or Sensor Core temperature) pressure last passed below the value of minimum specification limit plus 10% of range. (Example: for pressure for range of -800inH2O to 800inH2O, -800 inH2O + 160 inH2O = -640 inH2O).

The **Sensor Voltage Diagnostics** are also updated based on the selection in the Upload Track Data. **Max AVDD** and **Min AVDD** are the maximum and minimum values of the VDD recorded by the sensor module in its life time and **Max AVDD Time stamp** and **Min AVDD Time stamp** are the corresponding time stamps at maximum and minimum values.

Sensor General Diagnostics

ATTENTION

Note that the sensor stress monitor is different from the device stress monitor. The stress monitor of the sensor depends on other parameters such as pressure, temperature, and meterbody temperature.

Stress monitor

It is the amount of time the device has been used under stressful conditions. For example, say temperature of the sensor. The stress monitor is based on the temperature of the sensor. The Stress monitor is calculated in percentage.

$$\text{Stress monitor of sensor} = \frac{\text{Temperature conditions + Pressure conditions}}{\text{Timing service of the device}}$$

Time in Service

It is the amount of time the sensor is in operation and is shown in minutes.

Service Life

Service life indicates the amount of service life that has been consumed by the sensor. Service Life is dependent on the temperature of the sensor only. The Service life is calculated in percentage.

Device Diagnostics

Electronic Temperature Diagnostics

Similar to the sensor diagnostics, the **Electronic Temperature Diagnostics** are also tracked in 7 ways: **Max Electronic Temperature** and **Min Electronic Temperature** are the maximum and minimum electronics temperatures recorded by the communication module electronics in its life time and **Electronic Temperature Unit** is the engineering unit currently under use which is set in the pressure basic block. **ET Over Range CTR** is the accumulation of minutes the device is above the maximum specification limit less 10% of range (for the range of -40 Deg C to 85 Deg C it is 85Deg C – 12.5Deg C = 72.5 Deg C) and **ET Over Range Date** is the date and time when the electronic temperature last passed above the maximum specification limit less 10% of the range. The **ET Under Range CTR** is the accumulation of minutes the device is below the minimum specification limit plus 10% of range (for the range of -40 Deg C to 85 Deg C it is -40Deg C + 12.5Deg C = -27.5 Deg C) and **ET Under Range Date** is the date and time when the electronic temperature last passed above the maximum specification limit less 10% of the range.

Time in Service

This is the amount of time the device is in operation and is displayed in minutes.

Service Life

This is the average service life of the device under ideal conditions is 27.3 years. But, the service life varies depending on external factors such as temperature. Service life indicates the amount of service life that has been used by the device. Service Life is dependent on the temperature of the device only. The Service life is calculated in percentage.

Stress monitor

This is the amount of time the device has been used under stressful conditions. For example, say temperature of the device. The stress monitor is based on the temperature of the device. The Stress monitor is calculated in percentage.

$$\text{Stress monitor} = \frac{\text{Amount of time the device was under stressful conditions}}{\text{Time in Service of the device}}$$

Power Cycle Track

The power cycle track gives diagnostics related to the power up information of the device. The **Power Cycles** is the number of power ups experienced by the device after leaving factory. The **Last Power Up Cycle time** is the date and time of the last power up.

Operating Voltage Track

The statistics data for the supply voltage are tracked in the Operating voltage track. **Supply Voltage** is the current value of the voltage at the device input terminals. The status of the supply voltage whether it is normal or below operating value is indicated in **the Status of Current Voltage** parameter. **Minimum Voltage** is the value of the least voltage experienced by the device at the input terminals in its life time. **Last Minimum Voltage Time** is the date and time of the last minimum voltage experienced by the device. The **Minimum Voltage** can be reset by using the **Reset Minimum Voltage** parameter.

Parameter List

Table 8: Diagnostic Transducer block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block.
TAG_DESC	The user description of the application of the block.
STRATEGY	Used to identify grouping of blocks.
ALERT_KEY	The identification number of the plant unit.
MODE	The actual, target, permitted, and normal modes of the block.
BLOCK_ERR	Reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
UPDATE_EVT	This alert is generated by any change to the static data.
BLOCK_ALM	The BLOCK_ALM is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
EL_TEMP_DIAGNOSTIC	Electronic Temperature Diagnostic parameters.
SENSOR_DIAGNOSTICS	Sensor Diagnostics parameters.
POWER_TRAC	Power Up Track Data.
OP_VOLTAGE	Operating Voltage.
TIME_IN_SERVICE	Summation of time in minutes that power has been applied to the device since leaving the factory.
SENS_TIME_IN_SERVICE	Summation of time in minutes that power has been applied to the sensor since leaving the factory.
SERVICE_LIFE	It is the elapsed Service life of device in percentage.
SENS_SERVICE_LIFE_HELP	The elapsed Service life of the sensor in percentage.
STRESS_MONITOR	It monitors various diagnostic parameters which are then input into an algorithm to calculate an estimated percent of time that the transmitter has spent in stressful conditions.
SENS_VOLT_DIAGNOSTICS	Sensor Voltage Diagnostics.
SENS_GEN_DIAGNOSTICS	Sensor General Diagnostics.
UPLOAD_TRACK_DATA	Process Variable selection for uploading the Track data from sensor device.
HON_RES_1	Reserved for Honeywell use only.
HON_RES_2	Reserved for Honeywell use only.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • OOS (Out of Service).
Alarm Types	The block supports standard block alarms (see section 3.2).

3.6 LCD Transducer block

The LCD Transducer block supports Basic Display. The block is used to configure the basic display connected to the ST 700 transmitter. The block stores the LCD configurations, and sends these values to the Display while the transmitter is powered up or restarted.

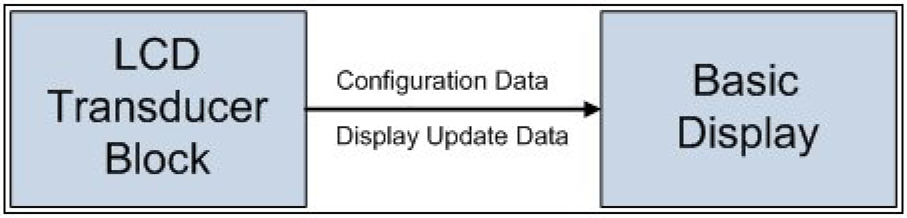


Figure 4: LCD Transducer Block

ATTENTION

The initial configuration of LCD transmitter is configured to show four screens with Primary Value, Secondary Value, Tertiary Value and Electronics temperature.

The Display shows the available set of process variables, and all function block inputs/outputs. In addition, the block reports the current device status and errors. If a function block parameter which is not currently a part of the control strategy is selected, an error appears in the display.

Execution

Basic Display

The PV value is user-configurable. This field has 7 characters. The maximum allowable numeric value is 9999999 or -999999. If fractional decimals are configured, the fractional positions are dropped, as desired. If the PV value exceeds the above limits, it is divided by 1000 and “K” is appended to the result, allowing a maximum value with multiplier of 999999K or -99999K. This field is user-configurable. This field has 8 characters.

Table 9 lists the allowed parameters that can be configured using the LCD block.

Table 9 LCD parameters

Block	FF Parameter
PRESSURE TRANSDUCER BLOCK	PRIMARY_VALUE
	SECONDARY_VALUE
	TERTIARY_VALUE
	EL_TEMP
RESOURCE BLOCK	EL_TEMPERATURE
ANALOG INPUT BLOCK (AIX - X stands for AI number can be blank or range from 1-2)	PV
	OUT
	FIELD_VAL
PID BLOCK (PID)	SP
	PV
	OUT
	IN
	CAS_IN
	BKCAL_IN
	BKCAL_OUT
	RCAS_IN
	ROUT_IN
	RCAS_OUT
	ROUT_OUT
	FF_VAL
	TRK_VAL
ARITHMETIC FUNCTION BLOCK	OUT
	IN
	IN.LO
	IN1
	IN2
	IN3
INTEGRATOR BLOCK	OUT
	IN1

Block	FF Parameter
	IN2
SIGNAL CHARACTERIZER BLOCK	OUT_1
	OUT_2
	IN_1
	IN_2
INPUT SELECTOR BLOCK	OUT
	IN_1
	IN_2
	IN_3
	IN_4

Parameters List

Table 10: LCD Transducer block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block.
TAG_DESC	The user description of the application of the block.
STRATEGY	Used to identify grouping of blocks.
ALERT_KEY	The identification number of the plant unit.
MODE	The actual, target, permitted, and normal modes of the block.
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
UPDATE_EVT	This alert is generated by any change to the static data.
BLOCK_ALM	The BLOCK_ALM is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
DISP_SEQ_TIME	Periodic rotation time of the display screens in seconds. Range 4-30 sec.
LANGUAGE	Language selection for the Display. Supported Languages: English, French, German, and Spanish.
DISPLAY_TYPE	Type of Display Connected. Possible Values: No Display Connected, Basic Display.
LCD_CONTRAST	Contrast of the LCD screen can be controlled by this parameter. Its range is 1-9.
DISP_FW_VER	Version Number of Display Firmware.
BLOCK_TYPE	Block type selection for screen process value. The BLOCK_TYPE is present in all the eight screens: BLOCK_TYPE_1, BLOCK_TYPE_2, BLOCK_TYPE_3, BLOCK_TYPE_4, BLOCK_TYPE_5, BLOCK_TYPE_6, BLOCK_TYPE_7 and BLOCK_TYPE_8.
PARAM_INDEX	Parameter selection for screen process value. Parameters need to be chosen based on Block type. The PARAM_INDEX is present in all the eight screens: PARAM_INDEX_1, PARAM_INDEX_2, PARAM_INDEX_3, PARAM_INDEX_4, PARAM_INDEX_5, PARAM_INDEX_6, PARAM_INDEX_7 and PARAM_INDEX_8

Parameter	Description
UNIT_TYPES	Unit selection for screen process value. Appropriate units need to be selected based on the configured parameter. If desired units are not present, 'custom' may be selected. The UNIT_TYPES is present in all the eight screens: UNIT_TYPES_1, UNIT_TYPES_2, UNIT_TYPES_3, UNIT_TYPES_4, UNIT_TYPES_5, UNIT_TYPES_6, UNIT_TYPES_7 and UNIT_TYPES_8
CUSTOM_UNIT	Character string to represent custom units. This value is used when Unit type of 'custom' is selected. Size: 8 Characters. The CUSTOM_UNIT is present in all the eight screens: CUSTOM_UNIT_1, CUSTOM_UNIT_2, CUSTOM_UNIT_3, CUSTOM_UNIT_4, CUSTOM_UNIT_5, CUSTOM_UNIT_6, CUSTOM_UNIT_7 and CUSTOM_UNIT_8
CUSTOM_TAG	Tag to be displayed for the screen. Length: 14 Characters. The CUSTOM_TAG is present in all the eight screens: CUSTOM_TAG_1, CUSTOM_TAG_2, CUSTOM_TAG_3, CUSTOM_TAG_4, CUSTOM_TAG_5, CUSTOM_TAG_6, CUSTOM_TAG_7 and CUSTOM_TAG_8.
DISPLAY_TEMPLATE	Represents the display screen template. Possible Values: a) PV : Regular PV value is displayed b) None: Screen will not be seen. The DISPLAY_TEMPLATE is present in all the eight screens: DISPLAY_TEMPLATE_1, DISPLAY_TEMPLATE_2, DISPLAY_TEMPLATE_3, DISPLAY_TEMPLATE_4, DISPLAY_TEMPLATE_5, DISPLAY_TEMPLATE_6, DISPLAY_TEMPLATE_7 and DISPLAY_TEMPLATE_8.
DECIMALS	Number of digits to display after the decimal point. Range: 0 - 3. DECIMALS is present in all the eight screens: DECIMALS_1, DECIMALS_2, DECIMALS_3, DECIMALS_4, DECIMALS_5, DECIMALS_6, DECIMALS_7 and DECIMALS_8
PV_LOLIM	Not applicable for ST 700.
PV_HILIM	Not applicable for ST 700.
TREND_DURATION	Not applicable for ST 700.
PREF_UNITS	Preferred Units.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • OOS (Out of Service).
Alarm Types	The block supports standard block alarms (see section 3.2).

3.7 Flow Transducer block

The Flow Transducer block (FTB) measures the flow rate of the fluid in the process. The block supports both volumetric and mass flow. The block is supported only by the Differential Pressure (DP) transmitter.

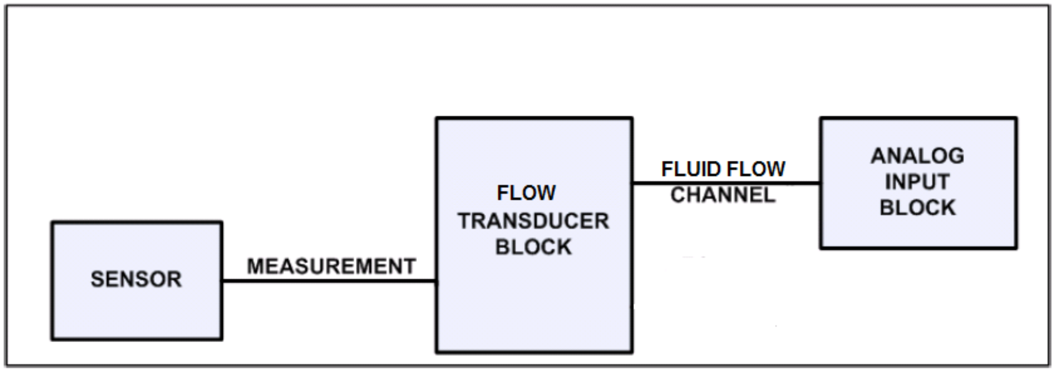


Figure 5: Flow Transducer Block

ATTENTION

If XD (Transducer) primary value type is not Differential Pressure, the block raises a block configuration error and must not be used. Absolute and Gauge Pressure units are not supported by the block.

Execution

The flow transducer block calculates the flow rate based on the rated flow input provided, with the specified standard FF units. The rated flow refers to the fluid flow rate at the rated pressure, which is the URV of the transmitter. The output of the flow is channelized through the AI block so that the other function blocks like integrator block can use it to totalize the flow.

The equation used for Flow transducer block is:

$$F \propto \sqrt{\Delta P}$$

$$\frac{F}{F_{URV}} = \frac{\sqrt{\Delta P}}{\sqrt{\Delta P_{URV}}}$$

$$F = F_{URV}\frac{\sqrt{\Delta P}}{\sqrt{\Delta P_{URV}}}$$

Where,

- F = Flow F in specified units.
- F_{URV} = Rated flow or design flow at Rated Pressure (URV) in same units.
- ΔP = Orifice delta P. This is available from Pressure Basic Block PV.
- ΔP_{URV} = Design orifice delta P. This is the URV ΔP of the transmitter.

The assumptions for using this equation are:

1. The density of the fluid is close to design, or error in the flow measurement due to density changes are within acceptable limits.

2. The orifice is designed for service, and transmitter calibration is done for the design rated flow.

3. The orifice is operated close to the rated flow or in the region where discharge coefficient is fairly constant, and does not vary with the changes in velocity.

ATTENTION

Note that FTB goes out of service when **PRESS_BASIC** is OOS, as flow rate is calculated from Differential Pressure.

Configuration

Configuration of the FTB involves entering values for Flow type, Rated Flow at URV, and flow units. When flow type is changed, the flow units are set internally to default units for the corresponding flow type, and rated flow set to NaN (Not a Number). When units are changed, they are validated against the flow type and 'Parameter check error' is raised on failure. The block supports only unidirectional flow. LRV of Differential Pressure must be 0 and URV a finite positive value for correct operation.

Parameter List

Table 11: Flow Transducer block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block.
TAG_DESC	The user description of the application of the block.
STRATEGY	Used to identify grouping of blocks.
ALERT_KEY	The identification number of the plant unit.
MODE	The actual, target, permitted, and normal modes of the block.
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
UPDATE_EVT	This alert is generated by any change to the static data.
BLOCK_ALM	The BLOCK_ALM is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

Parameter	Description
PRESSURE_UNITS	Pressure Units.
DIFFERENTIAL_PRESSURE	Differential Pressure.
FLOW_TYPE	Flow Type-Volumetric or Mass Flow.
FLOW_UNITS	Flow Rate Units.
RATED_FLOW	Flow rate at upper range value of Differential Pressure.
FLOW_RATE	Present value of Flow rate.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • OOS (Out of Service). In AUTO mode, the FTB constantly calculates the volumetric flow rate based on the equation described and updates the values based on change in ΔP of the flow units. In OOS mode, no calculation is done; and the rated flow value can be changed. The block goes out of service: • When target mode is changed to OOS (or) • RB is OOS (or) • **PRESS_BASIC** is OOS (This is done because flow rate is calculated from DP and is meaningless when **PRESS_BASIC** is OOS).
Alarm Types	The block supports standard block alarms (see section 3.2).

3.8 Analog Input block

The Analog Input (AI) block takes the transducer's input data, selected by channel number, and makes it available to other function blocks at its output. The variables to be used by the block are defined through the available channels: DP/AP/GP, Electronic Housing Temperature, Fluid Flow, Fluid Level, Meterbody Temperature, and Static Pressure.

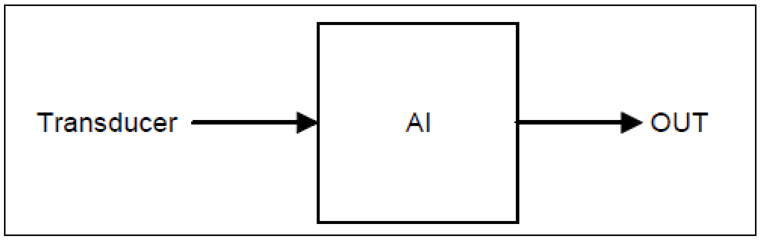


Figure 6: Analog Input Block

Execution

Transmitter Output Signal and Status

Viewing certain parameters and their values and status in the transmitter and understanding their relationship to each other is helpful in understanding transmitter output signal and status. The following paragraphs and tables describe transducer and AI block parameters which directly determine the way the transmitter output is presented.

Pressure Sensor Signal

In Transducer block, the pressure signal is represented as **PRIMARY_VALUE**. This pressure signal uses the elements in **PRIMARY_VALUE_RANGE** to determine the engineering units, the decimal places for the display and also the high and low scale of the value. This pressure signal becomes the PV value in the AI block, and uses the elements of **OUT_SCALE** in determining the units, decimal places and also the high and low scale values of PV. The pressure signal leaves the AI block as **OUT** value, which also uses the elements of **OUT_SCALE**.

The Transducer scaling (**XD_SCALE**) is applied to the value from the channel to produce the **FIELD_VAL** in percent. The **XD_SCALE** unit's code must match the channel unit's code or be supported by the device, if this is not the case the block remains in OOS mode, after being configured.

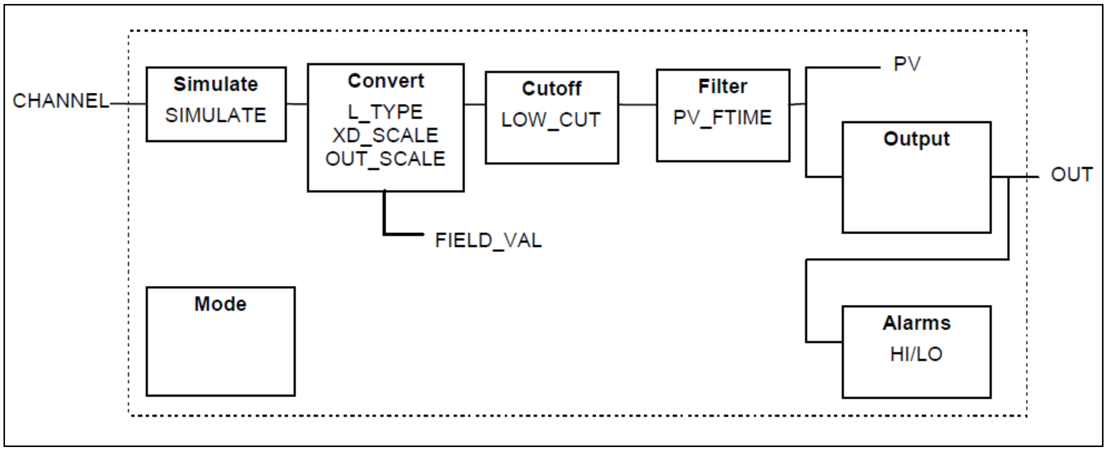


Figure 7: Analog Input Block Schematic Diagram

The **OUT_SCALE** is normally the same as the transducer, but if **L_TYPE** is set to Indirect or Ind Sqr Root, **OUT_SCALE** determines the conversion from **FIELD_VAL** to the output. PV and **OUT** always have identical scaling. **OUT_SCALE** provides scaling for PV. The block places the value in **OUT** if the mode is AUTO. If MAN mode is allowed, write a value to the output. The status prevents any attempt at closed loop control using the **MAN** value, by setting the Limit value to Constant.

The **LOW_CUT** parameter has a corresponding "**Low cut-off**" option in the **IO_OPTS** bit string. If the option bit is set as True, any calculated output below the low cut-off value changes to zero. This is only useful for zero based measurement devices, such as flow. The PV filter, whose time constant is **PV_FTIME**, is applied to the PV, and not the **FIELD_VAL**.

Equations

FIELD_VAL = 100*(channel value - EU@0%) / (EU@100% - EU@0%) [XD_SCALE]

Direct: PV = channel value

Indirect: PV = (FIELD_VAL/100) * (EU@100% - EU@0%) + EU@0% [OUT_SCALE]

Ind Sqr Root: PV = sqrt (FIELD_VAL/100) * (EU@100% - EU@0%) + EU@0% [OUT_SCALE]

XD_SCALE Range

In the AI block, **XD_SCALE** values are used when **L_TYPE** is set to Indirect which converts the signal to other units. The high and low scale values of **XD_SCALE** (**EU_100** and **EU_0**) define the range over which the **AI OUT** shows the status as Good.

- When **L_TYPE** is set to either Indirect or Direct, **XD_SCALE** units must match the transducer units.
- When **L_TYPE** is set to Direct, it is recommended that **XD_SCALE** and **OUT_SCALE** must contain the same values.

PV Value

The AI block PV value is determined based on the selected transducer channel's **PRIMARY_VALUE**.

AI OUT

AI in Manual Mode

When the AI block is in manual mode, **OUT** can be written as a fixed value between -10% and +110% of the **OUT_SCALE** range. **OUT** values between 0 and 100% shows a status of Good. **OUT** values outside the range shows a status of Uncertain. The "limit" field is marked as Constant for all values. PV shows the live pressure signal in manual mode.

AI in AUTO Mode

L_TYPE determines whether the signal is taken directly from the transducer block and passed to the AI block output (**L_TYPE** = Direct) or converted into different units before it is passed to the AI block output (**L_TYPE** = Indirect or Ind Sqr Root). **OUT_SCALE** determines the units' conversion of the signal presented to the output.

- When **L_TYPE** is Direct, **OUT** is the same as the value passed from the transducer block.
- When **L_TYPE** is Indirect, the **PRIMARY_VALUE** is converted to **XD_SCALE** and that value is set equal to **OUT** (**FIELD_VAL** = %). The **OUT** in % is re-ranged to a value using the **OUT_SCALE**.

OUT status

The following table provides the resulting status of AI block **OUT** for a given status of **PRIMARY_VALUE** in the transducer block.

If . . .	Then . . .
PRIMARY_VALUE status = Good::[alarm status]:Not Limited	**OUT** value is tested against **OUT_SCALE** range values: If **OUT** value is within the **OUT_SCALE** range, then **OUT** status = Good Non Cascade::[alarm status]:Not Limited If **OUT** exceeds **OUT_SCALE** range, then **OUT** status = Uncertain:: Engineering Units Range Violation:& High or Low Limited
PRIMARY_VALUE status = Uncertain	**OUT** status = Uncertain
2nd field in the **PRIMARY_VALUE** status = Non Specific	**OUT** status = Non Specific
PRIMARY_VALUE status = High or Low	**OUT** status = High or Low

Parameters List

Table 12: Analog Input block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block. The revision value is incremented each time a static parameter value in the block is changed.
TAG_DESC	The user description of the application of the block.
STRATEGY	It is used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, and so on.
MODE_BLK	The actual, target, permitted, and normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
PV	The process variable used in block execution.
OUT	The block output value and status.
SIMULATE	A group of data that contains the current transducer value and status, the simulated transducer value and status, and the enable/disable bit.

Parameter	Description
XD_SCALE	Elements used to display the value obtained from the transducer block. The elements are: • High and low scale values (EU_100 and EU_0). • Engineering units to display the value (UNITS_INDEX). • Decimal places to display the value (DECIMAL).
OUT_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT.
GRANT_DENY	Normally, the operator has permission to write to parameter values, but Program or Local remove that permission and give it to the host controller or a local control panel.
IO_OPTS	Allows the selection of input/output options used to alter the PV. Low cutoff enabled is the only selectable option.
STATUS_OPTS	Helps select options for status handling and processing. The supported status options for the AI block are Propagate Fault Forward Uncertain, if Limited Bad, if Limited and Uncertain if MAN mode.
CHANNEL	The CHANNEL value is used to select the measurement value. Configure the CHANNEL parameter before configuring the XD_SCALE parameter.
L_TYPE	The state (Direct or Indirect) values that are passed from the transducer block to the AI block. When L_TYPE = Direct, the values are passed directly from the transducer block to the AI block. (No units conversion.) When L_TYPE = Indirect, values from the transducer block are in different units, and must be converted either linearly (Indirect) or in square root (Ind Sqr Root) using the range defined by the transducer and the OUT_SCALE range.
LOW_CUT	If percentage value of transducer input fails below this, PV = 0.
PV_FTIME	The time constant of the first-order PV filter. It is the time required for a 63% change in the IN value.
FIELD_VAL	The value and status from the transducer block or from the simulated input when simulation is enabled.
UPDATE_EVT	This alert is generated by any change to the static data.
BLOCK_ALM	The block alarm is used for all configuration, hardware, and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status parameter. 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.
ALARM_SUM	The summary alarm is used for all process alarms in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status parameter. 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.
ACK_OPTION	Used to set AUTO acknowledgment of alarms.

Parameter	Description
ALARM_HYS	The amount the alarm value must return within the alarm limit before the associated active alarm condition clears.
HI_HI_PRI	The priority of the HI HI alarm.
HI_HI_LIM	The setting for the alarm limit used to detect the HI HI alarm condition.
HI_PRI	The priority of the HI alarm.
HI_LIM	The setting for the alarm limit used to detect the HI alarm condition.
LO_PRI	The priority of the LO alarm.
LO_LIM	The setting for the alarm limit used to detect the LO alarm condition.
LO_LO_PRI	The priority of the LO LO alarm.
LO_LO_LIM	The setting for the alarm limit used to detect the LO LO alarm condition.
HI_HI_ALM	The HI HI alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
HI_ALM	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
LO_ALM	The LO alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
LO_LO_ALM	The LO LO alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • MAN (Manual) • OOS (Out of Service).
Alarm Types	The block supports standard block alarms (see section 3.2). Additionally it supports, standard **HI_HI, HI, LO**, and **LO_LO** alarms applied to **OUT**.
Status Handling	**Uncertain** - **EU** Range Violation status is always set if the **OUT** value exceeds the **OUT_SCALE** range and no worse condition exists. The following options from **STATUS_OPTS** apply, where Limited refers to the sensor limits: • **Propagate Fault Forward** If the status from the sensor is Bad, Device failure or Bad, Sensor failure, propagate it to **OUT** without generating an alarm. The use of these sub-status in **OUT** is determined by this option. Through this option, the user may determine whether alarming (sending of an alert) is done by the block or propagated downstream for alarming. • **Uncertain, if Limited** Set the output status of the Analog Input block to uncertain if the measured or calculated value is limited. • **Bad if Limited** Set the output status to Bad if the sensor is violating a high or low limit. • **Uncertain if MAN Mode** Set the output status of the Analog Input block to uncertain if the actual mode of the block is MAN.

3.9 Proportional Integral Derivative (PID) block with auto tune

The PID block is the key to many control schemes, and it is commonly used. The PID function integrates the errors. If there is difference in process time constants of a primary process and secondary process measurement, then the block can be cascaded if required. Auto tuning is a feature that tunes the PID constants as per the process automatically.

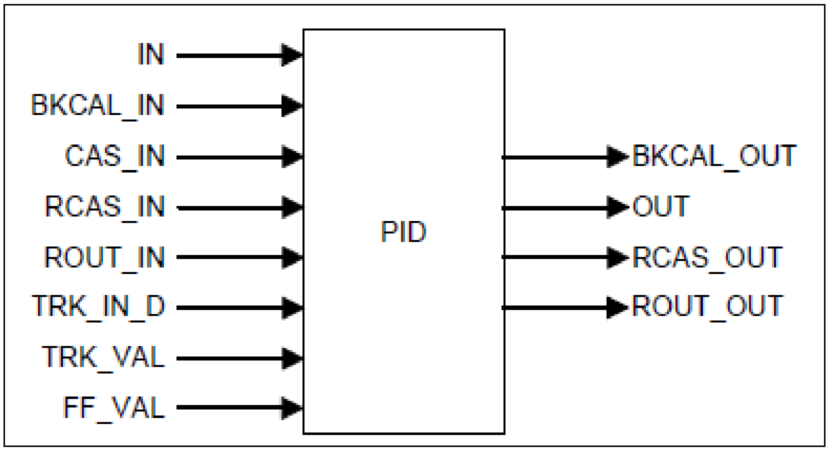


Figure 8: PID block

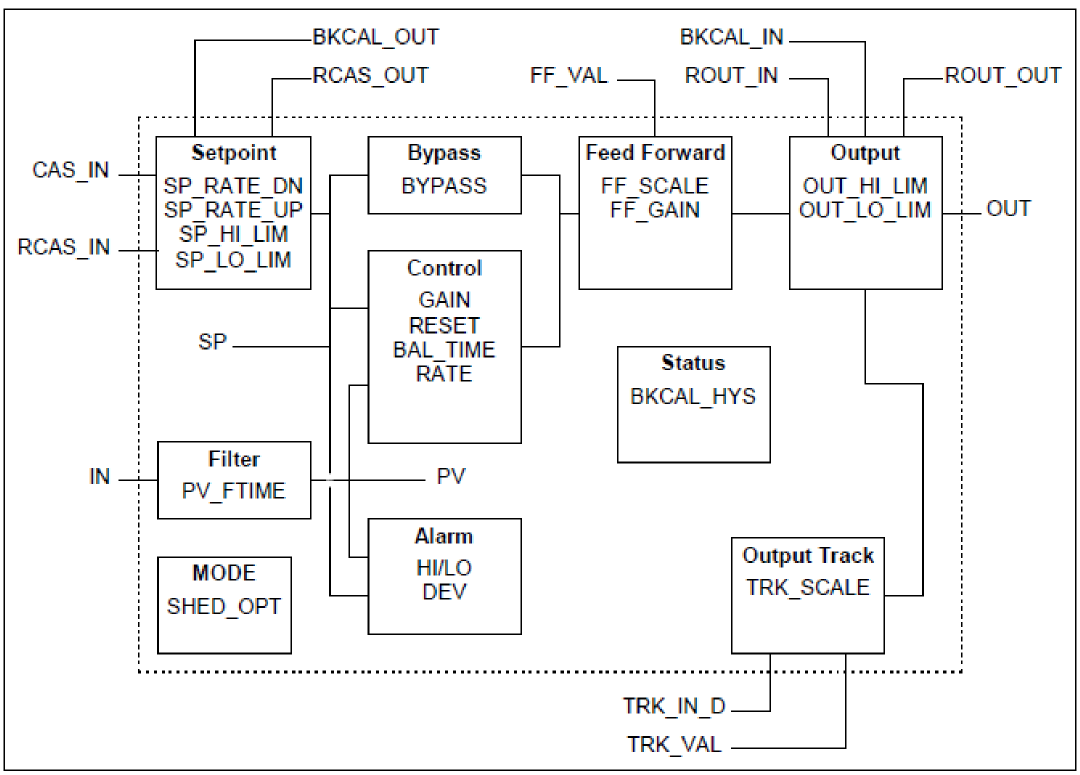


Figure 9: PID block schematic diagram

Execution

The Process Value to be controlled is connected to the **IN** input. The value is passed through a filter, and its time constant is **PV_FTIME**. The value is then shown as the PV, which is used in conjunction with the **SP** in the PID algorithm. A PID does not integrate if the limit status of **IN** input is constant, or if further control action based on the PID error proceeds **IN** input further towards its active status limit. A full PV and DV alarm sub-function is provided. The PV has a status, although it is a contained parameter. This status is a copy of **IN**'s status, unless **IN** is Good and there is a PV or block alarm.

The full cascade **SP** sub-function is used with rate and absolute limits. The block has additional control options which cause the **SP** value to track the PV value. The **SP** value tracks the PV value while the block is in Actual mode of IMan, LO, or ROut, or when the target mode of the block is MAN.

The block provides a switch for **BYPASS**, which is available to the operator if the Bypass Enable control option is set as True. **BYPASS** can be used in secondary cascade controllers that have a Bad PV. The **BYPASS Enable** option is required, so if **BYPASS** is set as True, not all cascade control schemes are stable. **BYPASS** can only be changed when the block mode is in MAN or OOS mode. When **BYPASS** is set, the value of **SP**, in percent of range, is passed directly to the target output, and the value of **OUT** is used for **BKCAL_OUT**. When the mode is changed to Cas, the upstream block is requested to initialize to the value of **OUT**. When a block is in Cas mode, on the transition out of BYPASS, the upstream block is requested to initialize to the PV value, irrespective of the "**Use PV for BKCAL_OUT**" option.

GAIN, **RESET**, and **RATE** are the tuning constants for the **P**, **I**, and **D** terms, respectively. The block provides 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 must be able to display the user's preference.

BAL_TIME parameter can be used to set the rate at which the **I** term moves towards balancing the difference between the previous integral term and the limited output. The **Direct Acting** control option, if set as True, causes the output to increase when the PV exceeds the **SP**. If set as False, the output decreases when the PV exceeds the **SP**. The **Direct Acting** control option must be set carefully, as it can cause a difference between positive and negative feedback.

ATTENTION

The **Direct Acting** control option can never be changed while in AUTO mode. The setting of the option must also be used in calculating the limit state for **BKCAL_OUT**.

The output supports the feed forward algorithm. The **FF_VAL** input brings in an external value which is proportional to some disturbance in the control loop. The value is converted to percent of output span using the values of parameter **FF_SCALE**.

This value is multiplied by the **FF_GAIN** and added to the target output of the PID algorithm. If the status of **FF_VAL** is Bad, the last usable value is used as this prevents bumping the output. When the status returns to Good, the block adjusts its integral term to maintain the previous output. The output supports the track algorithm. The block provides an option to use either the **SP** value after limiting or the PV value for the **BKCAL_OUT** value.

PID Control block is an algorithm that produces an output signal in response to the measured variable and the setpoint. The PID block allows you to choose either a standard PID control equation (Ideal) or a robust PID equation defined by Honeywell. This selection is defined in the PID_FORM parameter.

The output has three terms, namely Proportional, Integral, and Derivative. The output is adjusted by tuning constants. There are three tuning constants in the ideal PID equation. The robust PID uses four tuning constants:

1. **GAIN** is the tuning constant of the Proportional term.
2. **RESET** is the tuning constant of the Integral.
3. **RATE** is the tuning constant of the Derivative. **RATE** is usually modified by a lag, which is set at some fixed ratio higher than the rate time, to create a rate gain. There is no lag with the rate in this implementation.
4. **OUT_LAG** is the fourth tuning constant used in the robust PID; it adds roll off to the output response. The action is similar to PID with rate gain.

PID Ideal and PID Robust

The ideal equation is a parallel or non-interacting implementation of PID control using three tuning constants. It automatically fixes **OUT_LAG** to 16 times the **RATE** time constant. This produces response characteristics equivalent to the algorithms used in TPS products.

The robust equation is the same parallel implementation of ideal PID control but allows the engineer to set the **OUT_LAG** and effectively change the rate gain.

ALGO_TYPE is a configuration parameter that contains one of three selected algorithm types, A, B, or C.

Where:

- A **- RATE**, **GAIN** and **RESET** all act on the error between set point and measured variable.
- B **- RATE** acts on the measured variable only, **GAIN** and **RESET** use the error.
- C **- RATE** and **GAIN** act on the measured variable only, and **RESET** uses the error.

PID Tuning Parameters

Table 13 lists the valid ranges for the tuning parameters for the PID block. Note that **OUT_LAG** parameter is not configurable when Ideal PID is selected (**PID_FORM** = 1) and can be configured when Robust PID is selected (**PID_FORM** = 2).

The values given for these tuning parameters are valid under the following conditions:

- The values assume that the minimum configurable PID function block execution period (T_s) is 0.125 seconds.
- Algorithm typesetting (A, B, or C) has no effect on the validation of these tuning parameters.

The PID function block rejects all values outside the following ranges:

Table 13: PID Tuning parameters

Parameter	Initial Value	Minimum Value	Maximum Value	Comment
PV_FTIME	0	0	200	Units: seconds.
GAIN	0	.004	250	
GAIN_NLIN	0	.004	250	
RATE (sec.)	0	32 • T_s	7500	The value of ZERO is permitted to turn off rate action.
RESET (sec.)	+INF	2 • T_s	7500	The value of +INF is permitted to turn off reset action. (Some versions of NI configurator program cannot set +/-INF).
OUT_LAG Ideal PID	N/A	N/A	N/A	Fixed for Ideal PID form - not configurable.
Robust PID	0	2 • T_s	7500	Zero permitted which implies no output lag.
BAL_TIME	0	N/A	N/A	Not used in Honeywell Implementation.

Auto tuning

Cycle tuning

The PID block supports the Cycle tuning algorithm. In Cycle tuning, the tuning parameter values are derived from the process response to the resultant action of causing the PV to oscillate about a **SP** value. The tuning method uses the measured ultimate gain and period to produce tuning parameter values, by using the relationship developed by Ziegles Nichols equations. Cycle tuning does not distinguish between process lags and always results in gain based on PV amplitude, and calculates the values of Reset and Rate based on time of the **SP** crossings using a fixed ratio of 4 to 1. Initially, this method does not require a stable process. Cycle tuning is applicable to Three Position Step control, and is used for integrating process.

Auto tuning procedure

There are nine parameters applicable for auto tuning: **AT_TYPE**, **TUNING_CRITERIA, TUNE_REQ, ATI, AT_MODE, AT_ERR, AT_GAIN, AT_RESET, and AT_RATE.**

AT_Type

There are two types of selections, namely Disable and Cycle Tune. When Disable is selected, **AT_MODE** becomes inactive. When Cycle Tune is selected, **AT_MODE** becomes AT Ready.

TUNING_CRITERIA

There are two types of tuning criteria available for selection: Normal and Fast.

- **NORMAL -** Conservative tuning designed to reduce overshoot as compared to FAST.
- **FAST -** Aggressive tuning designed to provide quarter-dampened response.

TUNE_REQ

TUNE_REQ can be turned ON only in the following modes, namely AUTO, CAS, RCAS, and ROUT. The ATI value becomes 1, and **AT_ERROR** shows the status as Run, this shows that auto tuning is in progress.

If **AT_ERROR** shows **OK**, auto tuning is successful. **AT_GAIN**, **AT_REST**, **AT_RATE** gets updated automatically and same values are copied to **GAIN**, **RESET** and **RATE** respectively.

Parameter list

Table 14: PID block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block. The revision value is incremented each time a static parameter value in the block is changed.
TAG_DESC	The user description of the application of the block.
STRATEGY	Used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	The actual, target, permitted, and normal modes of the block. Target: The mode to "go to" Actual: The mode the "block is currently in" Permitted: Allowed modes that target may take on Normal: Most common mode for target
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string so that multiple errors may be shown.
PV	The process variable used in block execution.
SP	It is the target block setpoint value. It is the result of setpoint limiting and setpoint rate of change limiting.
OUT	The block input value and status.
PV_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with PV.
OUT_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT.
GRANT_DENY	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. Not used by the device.
CONTROL_OPTS	Specify control strategy options. The supported control options for the PID block are Track enable, Track in Manual, SP-PV Track in MAN, SP-PV Track in LO or IMAN, Use PV for BKCAL_OUT, Direct Acting, SP Track retain, SP-PV Track Out, Restrict SP to limits in CAS and RCAS, No output limits in MAN.
STATUS_OPTS	It helps to select options for status handling and processing. The supported status option for the PID block is Target to Manual if Bad IN. IFS if Bad IN, IFS if Bad CAS_IN, Use Uncertain as Good, Target to next permitted mode if Bad CAS_IN, Target to MAN if Bad TRK_IN_D and IFS if Bad TRK_IN_D.
IN	The connection for the PV input from another block.
PV_FTIME	The time constant of the first-order PV filter. It is the time required for a 63 percent change in the IN value.

Parameter	Description
BYPASS	Used to override the calculation of the block. When enabled, the SP is sent directly to the output.
CAS_IN	The remote setpoint value from another block.
SP_RATE_DN	Ramp rate for downward SP changes. When the ramp rate is set to zero, the SP is used immediately.
SP-RATE_UP	Ramp rate for upward SP changes. When the ramp rate is set to zero, the SP is used immediately.
SP_HI_LIM	The highest SP value allowed.
SP_LO_LIM	The lowest SP value allowed.
GAIN	The proportional gain value. This value cannot = 0.
RESET	The integral action time constant.
BAL_TIME	The specified time for the internal working value of bias to return to the operator set bias. Also used to specify the time constant at which the integral term moves to obtain balance when the output is limited and the mode is AUTO, CAS, or RCAS.
RATE	The derivative action time constant.
BKCAL_IN	The analog input value and status from another block's BKCAL_OUT output that is used for backward output tracking for bump less transfer and to pass limit status.
OUT_HI_LIM	The maximum output value allowed.
OUT-LO_LIM	The minimum output value allowed
BKCAL_HYS	The amount the output value must change away from its output limit before limit status is turned off.
BKCAL_OUT	The value and status required by the BKCAL_IN input of another block to prevent reset windup and to provide bump less transfer of closed loop control.
RCAS_IN	Target setpoint and status that is provided by a supervisory host. Used when mode is RCAS.
ROUT_IN	Target output and status that is provided by a supervisory host. Used when mode is ROUT.
SHED_OPT	Defines action to be taken on remote control device timeout.
RCAS_OUT	Block setpoint and status after ramping, filtering, and limiting that are provided to a supervisory host for back calculation to allow action to be taken under limiting conditions or mode change. Used when mode is RCAS.
ROUT_OUT	Block output that is provided to a supervisory host for a back calculation to allow action to be taken under limiting conditions or mode change. Used when mode is RCAS.
TRK_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with the external tracking value (TRK_VAL).
TRK_IN_D	Discrete input that initiates external tracking.

Parameter	Description
TRK_VAL	The value (after scaling from TRK_SCALE to OUT_SCALE) APPLIED to OUT in LO mode.
FF_VAL	The feedforward control input value and status.
FF_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with the feedforward value (FF_VAL).
FF_GAIN	The feedforward gain value. FF_VAL is multiplied by FF_GAIN before it is added to the calculated control output.
UPDATE_EVT	This alert is generated by any changes to the static data.
BLOCK_ALM	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 sets the active status in the status parameter. As soon as the Unreported status is cleared by the alert reporting task and other block alert may be reported without clearing the Active status, if the subcode has changed.
ALARM_SUM	The summary alarm is used for all process alarms in the block. The cause of the alert is entered in the subcode field. The first alert to become active sets the Active status in the Status parameter. 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.
ACK_OPTION	Used to set auto acknowledgment of alarms.
ALARM_HYS	The amount the alarm value must return to within the alarm limit before the associated active alarm condition clears.
HI_HI_PRI	The priority of the HI HI Alarm.
HI_HI-LIM	The setting for the alarm limit used to detect the HI HI alarm condition.
HI_PRI	The priority of the HI alarm.
HI_LIM	The setting for the alarm limit used to detect the HI alarm condition.
LO_PRI	The priority of the LO alarm.
LO_LIM	The setting for the alarm limit used to detect the LO alarm condition.
LO_LO_PRI	The priority of the LO LO alarm.
LO_LO_LIM	The setting for the alarm limit used to detect the LO LO alarm condition.
DV_HI_PRI	The priority of the deviation high alarm.
DV_HI_LIM	The setting for the alarm limit used to detect the deviation high alarm condition.
DV_LO_PRI	The priority of the deviation low alarm.
DV_LO_LIM	The setting for the alarm limit use to detect the deviation low alarm condition.

Parameter	Description
HI_HI_ALM	The HI HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
HI_ALM	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
LO_ALM	The LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
LO_LO_ALM	The LO LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
DV_HI_ALM	The DV HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
DV_LO_ALM	The DV LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
PID_FORM	Configuration parameter specifies the IDEAL or ROBUST PID equation to be used: • IDEAL PID (default): Non-interactive form of a three mode control equation that provides Proportional, Integral and Derivative control action. Linear and non-linear gain parameters are available. • ROBUST PID: The same as Ideal PID. Additionally, the equation supports a user-configurable lag filter applied to calculated output value. (See OUT_LAG parameter.) Linear and non-linear gain parameters are available.
ALGO_TYPE	Configuration parameter specifies algorithm type which can be A, B, or C: • Type “A” equation where Proportional, Integral and Derivative act on ERROR. • Type “B” equation where Proportional and Integral act on ERROR and Derivative acts on PV. • Type “C” equation where Integral acts on ERROR and Proportional and Derivative act on PV.
OUT_LAG	Time constant of single exponential LAG filter applied to the OUT parameter (primary output). Units (in seconds). For Ideal PID equation the lag filter is fixed at 1/16 and is not configurable.
GAIN_NLIN	Dimensionless gain factor. When the gain factor is multiplied by absolute value of the error and added to the linear GAIN, the result is a gain response which is proportional to the deviation. The default value is zero resulting in no response due to non-linear gain action.
GAIN_COMP	The composite gain quantity including both linear and non-linear gain parameters. It is a read only parameter.
ERROR_ABS	Absolute value of the difference between PV and working setpoint. Read only parameter.
WSP	Working setpoint. This is the setpoint value after absolute and rate limits have been applied. Deviation alarms are computed on this value. It is a read only parameter.

Parameter	Description
AT_TYPE	Auto Tune Selection supports two types: Disable, Cycle Tune.
TUNING_CRITERIA	Tuning Criteria supports two types: Normal, Fast.
TUNE_REQ	Tuning Request performs auto tuning process.
ATI	Auto Tune Indicator indicates Auto tune ON/OFF.
AT_MODE	Auto Tune Mode supports two options: AT Ready, Inactive • AT Ready indicates block is ready for auto tune • Inactive indicates auto tuning is disabled.
AT_ERROR	Auto Tune Error supports the following errors: Abort, Not ready, OK, and Run.
AT_GAIN	Auto tuned Gain.
AT_RESET	Auto tuned Reset.
AT_RATE	Auto tuned Rate.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • MAN (Manual) • OOS (Out of Service) • IMan • Cas • RCas • ROut • LO
Alarm Types	The block supports standard block alarms (see section 3.2), in addition to it standard **HI_HI, HI, DV_HI, DV_LO, LO**, and **LO_LO** alarms applied to PV.
Status Handling	Standard, in addition to the following things for the control selector. If Not selected is received at **BKCAL_IN**, the PID algorithm must make necessary adjustments to prevent windup.

3.10 Input Selector block

The Input Selector block performs maximum, minimum, middle, average and 'first good' input selection. The Input Selector block provides selection of up to four inputs and generates an output based on the selected type of input. The block normally receives its inputs from AI blocks, and provides a combination of parameter configuration options. The block functions 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 receives switching information from either the connected inputs or from an operator input. The block supports signal status propagation.

The block is used to provide control input selection in the forward path only, and hence no back calculation support is provided. SELECTED indicates which input has been selected or the number of inputs selected by the algorithm. The block does not support process alarms.

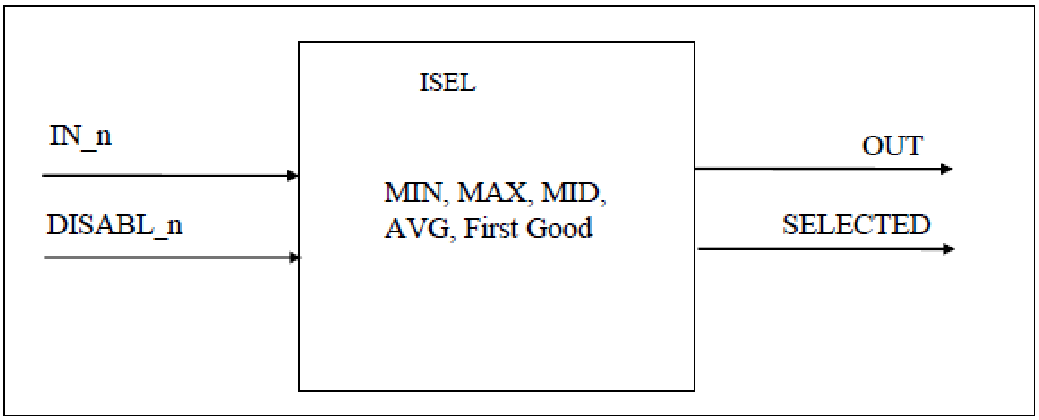


Figure 10: Input Selector block

Execution

Input processing

If **DISABLE_n** is True, the corresponding input **IN_n** is discarded. If there are no inputs left, or if there are inputs fewer than **MIN_GOOD** inputs, then the value of **SELECTED** becomes zero.

Selection Processing

- If **OP_SELECT** is non-zero, the **OP_SELECT** value determines the selected input, irrespective of the **SELECT_TYPE** selection. The value of **SELECTED** is the number of the input used.
- If **SELECT_TYPE** is 'First Good', transfers the value of the first remaining input to the output of the block. The value of **SELECTED** is the number of the input used.

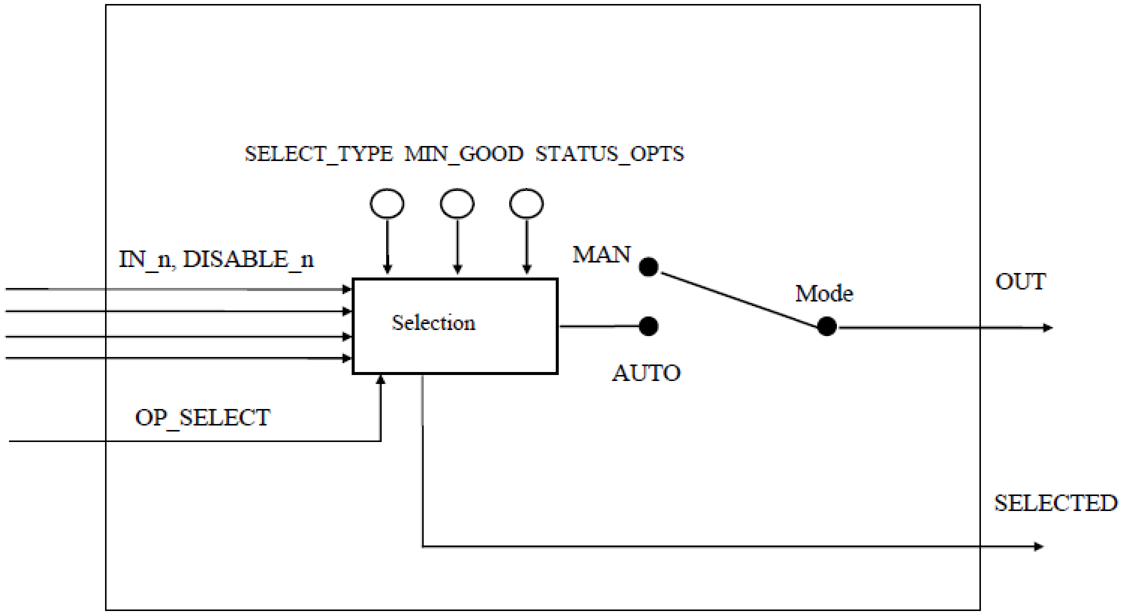


Figure 11: Input Selector schematic diagram

- If **SELECT_TYPE** is Minimum, it transfers the lowest value to the output of the block. The value of **SELECTED** is the number of the input with the lowest value.
- If **SELECT_TYPE** is Maximum, it transfers the highest value to the output of the block. The value of **SELECTED** is the number of the input with the highest value.
- If **SELECT_TYPE** is Middle, if there are 3 or 4 values, the highest and lowest value is discarded. The average of the remaining two values is computed, and the value is transferred to the output of the block. The value of **SELECTED** becomes zero if an average is used, else the value of **SELECTED** is the number of the input with the middle value.
- If **SELECT_TYPE** is Average, computes the average of the remaining inputs and transfers the value to the output of the block. The value of **SELECTED** is the number of inputs used in the average.

Parameters List

Table 15: Input Selector block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block. The revision value increments each time a static parameter value in the block is changed.
TAG_DESC	The user description of the application of the block.
STRATEGY	Used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	The Actual, Target, Permitted, and Normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
OUT	The block output value and status.
OUT_RANGE	High and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT
GRANT_DENY	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. Not used by device.
STATUS_OPTIONS	It helps to select options for status handling and processing. The supported status option for the integrator block is: “Use Uncertain as Good”, “Uncertain if MAN mode.”
IN_1	The block input value and status.
IN_2	The block input value and status.
IN_3	The block input value and status.
IN_4	The block input value and status.
DISABLE_1	Parameter to switch off the input from being used. 0 - On, 1 - Off
DISABLE_2	Parameter to switch off the input from being used. 0 - On, 1 - Off
DISABLE_3	Parameter to switch off the input from being used. 0 - On, 1 - Off
DISABLE_4	Parameter to switch off the input from being used. 0 - On, 1 - Off
SELECT_TYPE	Determines the selector action: First Good, Minimum, Maximum, Middle, and Average.

Parameter	Description
MIN_GOOD	The minimum number of inputs which are “Good” is less than the value of MIN_GOOD then set the OUT status to “Bad”.
SELECTED	The integer indicating the selected input number.
OP_SELECT	An operator settable parameter to force a given input to be used.
UPDATE_EVT	This alert is generated by any change to the static data.
BLOCK_ALM	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 sets the Active status in the Status parameter. 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.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • MAN (Manual) • OOS (Out of Service).
Alarm Types	The block supports standard block alarms, (see section 3.2).
Status Handling	During normal operations, the value and status of the selected input is shown by **OUT**. If the number of inputs with Good status is fewer than **MIN_GOOD**, then the output status is Bad. The **SELECTED** output status is Good (NC), until the block is out of service. The block supports two status option: • **Uncertain as Good**: If the selected input status is Uncertain, set the **OUT** status as Good. • **Uncertain, if in Manual mode**: If the block is set to Manual mode, the status of the Output is set to Uncertain.

3.11 Integrator block

The Integrator block integrates a variable as a function of time, and also accumulates the counts from a Pulse Input block. The block is used as a totalizer that counts up until reset or as a batch totalizer that has a setpoint, and the integrated or accumulated value is compared to pre-trip and trip settings. When the pre-trip and trip settings are reached, the block generates discrete signals. The integrated value can go up, starting from zero, or go down, starting from the trip value depending on the settings. The block has two flow inputs to calculate and integrate net flow, which can be used to calculate volume or mass variation in vessels or as an optimizing tool for flow ratio control. The block does not support process alarms.

ATTENTION

Alternatively **IN_1** and **IN_2** can be used as pulse inputs coming from other blocks. The same general rules for integration applies for the accumulation of pulses.

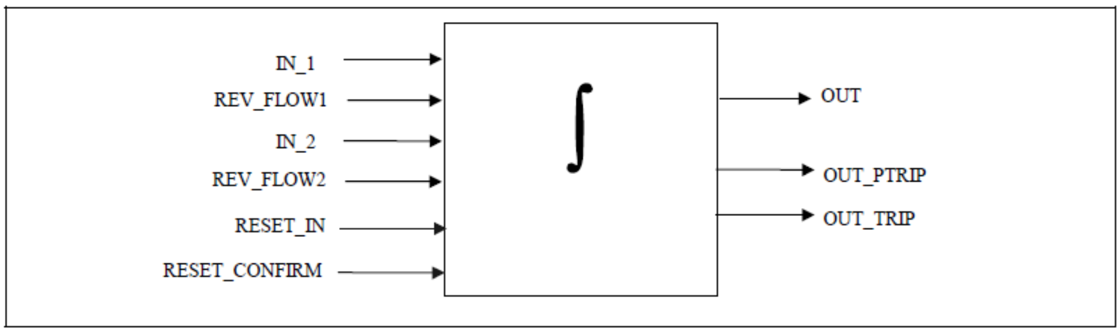


Figure 12: Integrator Block

Execution

The basic function of the Integrator block is to integrate an analog value over time. It can also accumulate the pulses coming from the Pulse Input block or from other Integrator blocks. The 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 inputs: **IN_1** and **IN_2**. If **IN_2** is not connected (does not have a corresponding link object), calculations for **IN_2** can be avoided. Each input can be configured to receive a measurement per unit of time (rate).

The usage is as follows:

Rate

It is used when the variable connected to the input is a rate, that is Kg/s, w, Gal/hour, and so on. This input can come from the rate output **OUT** of an Analog Input block.

Accum

It is used when the input comes from the **OUT_ACCUM** output of a Pulse Input block, which represents a continuous accumulation of pulse counts from a transducer, or from the output of another Integrator block. The bits corresponding to **IN_1** and **IN_2** can be set to False for **Rate**, or can be set to True for **Accum**.

If the input option is Rate

Each input needs a parameter to define the rate time unit: **IN_1**, **IN_2.** The time unit can be selected in seconds/minutes/hours/days. The second analog input must be converted into the same unit as that of the first input**. IN_2** must be converted into the same units of **IN_1**. This can be done by using the parameter **UNIT_CONV**. For example, if **IN_1** is in seconds and if **IN_2** is in minutes, **IN_2** must be converted to seconds before starting the integration. In this case, the value of **UNIT_CONV** is .0166 (1/60).

To find the mass, volume, or energy increment per block execution, each rate must be multiplied by the block execution time. This increment must be added or subtracted in a register.

The following diagram is an example of the use of two Rate inputs:

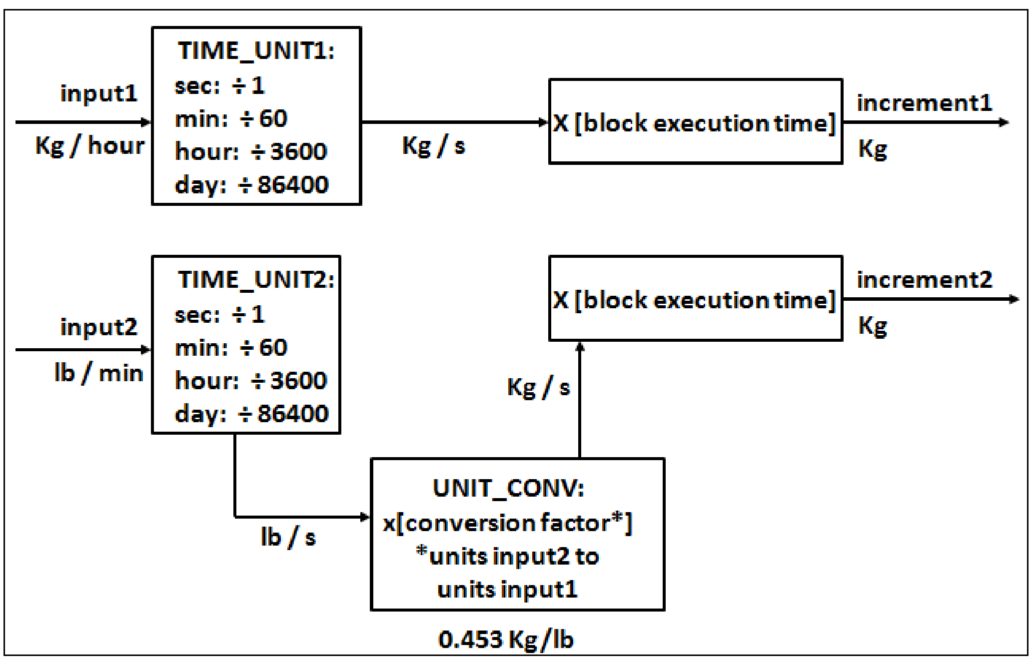


Figure 13: Two Rate Inputs

If the input option is Accum

The Integrator block determines the number of additional counts from the counter input readings from the last execution.

The difference in count is determined as follows:

- If the difference between the reading in one cycle and the reading in the preceding cycle is less than 500,000 or greater than (- 500,000), the difference must be taken as the variation.
- If the difference between the reading in one cycle and the reading in the preceding cycle is greater than or equal to (+500,000), add (-1,000,000), use the result as the variation.
- If the difference between the reading in one cycle and the reading in the preceding cycle is more negative than or equal to (-500,000), add (+1,000,000), use the result as the variation.

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

Net Flow

The Net Flow is calculated by considering the direction of flow. The direction of the flow is calculated by selecting the parameters **REV_FLOW** and **REV_FLOW2**. When the status is set to True for any of these two parameters, the direction of the flow for that input is considered (Increment is negative) to be negative and the net flow is calculated by adding the increments for that cycle of execution.

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 must 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 must be treated as zero. The option bit Reverse must be set to True.

Integration of Inputs

There are three internal registers used for the totalization:

- Total = The net increment is added every cycle, irrespective of the status.
- Atotal = The absolute value of the net increment is added every cycle, irrespective of status.
- Rtotal = The absolute value of the net increments with status as Bad (rejects) are added to this register.

The most significant part of Total can be read in the output **OUT**. **OUT_RANGE** is used only for display of the totals by a host. The high and low range values of **OUT_RANGE** have no effect on the block.

Types of Integration

The value of **OUT** can start from zero and go up or it can start from a Setpoint value (**TOTAL_SP**) and go down. The Reset option can be automatic, periodic, or on demand. This is defined by the enumerated parameter **INTEG_TYPE**:

- **UP_AUTO –** It counts up with automatic reset when **TOTAL_SP** is reached
- **UP_DEM** – It counts up with demand reset, and the block resets only when the operator resets the block.
- **DN_AUTO** – The block is reset when the output becomes zero. The integration starts as **SP** and increments are subtracted from the **SP**.
- **DN_DEM** – The output is calculated even beyond zero till the block is reset. The integration starts from **SP**.
- **PERIODIC –** The integration is done for the assigned period (specified in seconds in **CLOCK_PER**). After that period, the block is reset automatically.
- **DEMAND** – The integration is done (positive or negative depending on the direction of the flow) until the block is reset.
- **PER&DEM** – It is a combination of periodic and demand types. The integration is carried till the end of the specified period and after that period is automatically reset. The block can be reset at any time, before the end of periodic data set.

The first four types indicate use as a batch totalizer with a setpoint **TOTAL_SP**. The count does not stop at **TOTAL_SP** going up or zero going down, as it is important to get the True total of flow. Two outputs, **OUT_TRIP** and **OUT_PTRIP**, are associated with the four types. The next three types indicate that **TOTAL_SP** and the trip outputs are not used. The Periodic type (5) disables reset action based on **RESET_IN**, but has no impact on **OP_CMD_INT**.

The internal registers always add the net increments. Counting down is done by setting **OUT** to the value of **TOTAL_SP** minus the most significant part of Total.

Resetting the totals

The block uses a discrete input **RESET_IN** to reset the internal integration registers. The operator can send a command to reset the same registers by making **OP_CMD_INT** = **RESET**. This is a momentary switch that turns-off when the block is evaluated. The option "Confirm Reset" in **INTEG_OPTS**, if set, prevents another reset from occurring until the value 1 has been written to **RESET_CONFIRM**. This is an input that behaves like a momentary dynamic parameter if it is not connected.

The number of resets is counted in the register **N_RESET**. This counter cannot be written or reset. It provides verification that the total has not been reset since **N_RESET** was last checked. The counter must roll over from 999999 to 0.

The reset always clears the internal registers Total, Atotal, and Rtotal, except that when the option **UP_AUTO** or **DN_AUTO** is selected, a residual value beyond the trip value may be carried to the next integration if the option Carry is set in **INTEG_OPTS**. In this case, **TOTAL_SP** is subtracted from Total, leaving the residual value.

Batch totalizer outputs

When the integration is counting up (type 1 or 2) and the value of **OUT** equals or exceeds a value given by **TOTAL_SP** minus **PRE_TRIP**, the discrete output **OUT_PTRIP** is set. When it equals or exceeds a value given by the parameter **TOTAL_SP**, the discrete output **OUT_TRIP** is set. **OUT_PTRIP** remains set.

When the integration is counting down (type 3 or 4), it starts from a value given by **TOTAL_SP**. When the value of **OUT** is equal to or less than **PRE_TRIP**, the discrete output **OUT_PTRIP** is set. When the count reaches zero, the discrete output **OUT_TRIP** is set. **OUT_PTRIP** remains set. When a reset occurs, the comparisons that set **OUT_PTRIP** and **OUT_TRIP** are no longer True; so they are cleared. **OUT_TRIP** shall remain set for five seconds after an automatic reset (type 1 or 3), if **RESET_CONFIRM** is not connected or the option to Confirm Reset in **INTEG_OPTS** is not set.

ATTENTION

To determine the amount of **Uncertain** or **Bad** readings, the block integrates the variables with **Bad,** or **Bad** and **Uncertain** status separately. The values used in this second integration are the values with **Good** status, just before the status changed from **Good** to **Bad** or **Good** to **Uncertain**.

The ratio of **Good** to total counts determines the output status. Absolute values are used to avoid problems with changing signs.

Integration options

Any or all of the following integration options can be selected:

INTEG_OPTS: 0 (Input1 Accumulate)

When this option is selected, the accumulation of pulses is done instead of the rate input, integration.

INTEG_OPTS: 0 (Input2 Accumulate)

When this option is selected, the accumulation of pulses is done instead of the rate input, integration.

Note:

One input for rate and input for Accumulation can be selected.

INTEG_OPTS: 0 (Flow forward)

When this option is selected, only positive flows is considered for integration. If there is no forward flow inputs (whose value is positive value), and if one inputs is negative (whose value is positive value) the integration continues.

Note:

If both the inputs are negative, then the integration stops.

INTEG_OPTS: 0 (Flow reverse)

When this option is selected, only reverse flows is considered for integration. If there is no reverse flow inputs (whose value is negative), and if one inputs is forward (whose value is positive) the integration continues.

Note:

If both the inputs are forward, then the integration stops.

INTEG_OPTS: 0 (Use uncertain)

When this option is selected, the input (**IN_1/IN_2**) whose status is Uncertain is considered for integration.

INTEG_OPTS: 0 (Use Bad)

When this option is selected, the input (**IN_1/IN_2**) whose status is Bad is considered for integration.

INTEG_OPTS: 0 (Carry)

This option is used only for **UP_AUTO** and **DN_AUTO** kind of integrations only. When this option is selected, the residual value after the integration is added / subtracted from the integral value in the next cycle of integration.

INTEG_OPTS: 0 (Add Zero if Bad)

When this option is selected, if **IN_1/IN_2** is bad, the input value is zero for that input and integration does not happen. Integration stops at the last value.

INTEG_OPTS: 0 (Confirm reset)

This option is to be selected in conjunction with **RESET_CONFIRM.VALUE**. When the value of **RESET_CONFIRM.VALUE** is 1, and “Confirm Reset” is selected, the block gets reset. This is not applicable to **UP_AUTO** and **DN_AUTO** types.

Parameters List

Table 16: Integrator block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block.
TAG_DESC	The user description of the application of the block.
STRATEGY	Used to identify grouping of blocks. This data is not checked of processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms.
MODE_BLK	The actual, target, permitted, ad normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take Normal: Most common mode for target.
BLOCK_ERR	The summary of active error conditions associated with the block. The block error for the Integrator function block is Out of service.
TOTAL_SP	The set point for a batch totalization.
OUT	The block output value and status.
OUT_RANGE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT.
GRAND_DENY	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block (not used by the device).
STATUS_OPTS	It helps to select option for status handling and processing. The supported status options for the Integrator block are: “Uncertain if Manual mode.”
IN_1	The block input value and status.
IN_2	The block input value and status.
OUT_TRIP	The first discrete output.
OUT_PTRIP	The second discrete output.
TIME_UNIT1	Converts the rate time, units in seconds.
TIME_UNIT2	Converts the rate time, units in seconds.
UNIT_CONV	Factor to convert the engineering units of IN_2 into the engineering units of IN_1.
PULSE_VAL1	Determines the mass, volume or energy per pulse.
PULSE_VAL2	Determines the mass, volume or energy per pulse.
REV_FLOW1	Indicates reverse flow when “True”; 0-Forward, 1-Reverse

Parameter	Description
REV_FLOW2	Indicates reverse flow when “True”; 0-Forward, 1-Reverse
RESET_IN	Resets the totalizers
STOTAL	Indicates the snapshot of OUT just before a reset
RTOTAL	Indicates the totalization of “Bad” or “Bad” and “Uncertain” inputs, according to INTEG_OPTIONS.
SRTOTAL	The snapshot of RTOTAL just before a reset
SSP	The snapshot of TOTAL_SP.
INTEG_TYPE	Defines the type of counting (up or down) and the type of resetting (demand or periodic)
INTEG_OPTIONS	A bit string to configure the type of input (rate or accumulative) used in each input, the flow direction to be considered in the totalization, the status to be considered in TOTAL and if the totalization residue must be used in the next batch (only when INTEG_TYPE=UP_AUTO or DN_AUTO).
CLOCK_PER	Establishes the period for periodic reset, in hours.
PRE_TRIP	Adjusts the amount of mass, volume or energy that should set OUT_PTRIP when the integration reaches (TOTAL_SP-PRE_TRIP) when counting up of PRE_TRIP when counting down.
N_RESET	Counts the number of resets. It cannot be written or reset.
PCT_INC	Indicates the percentage of inputs with Good status compared to the ones with Bad or Uncertain and Bad status.
GOOD_LIMIT	Sets the limit for PCT_INC. Below this limit OUT receives the status Good
UNCERTAIN_LIMIT	Sets the limit for PCT_INC. Below this limit OUT receives the status Uncertain
OP_CMD_INT	Operator command RESET Resets the totalizer
OUTAGE_LIMIT	The maximum tolerated duration for power failure
RESET_CONFIRM	Momentary discrete value with can be written by a host to enable further resets, if the option “Confirm reset” in INTEG_OPTIONS is chosen.
UPDATE_EVT	This alert is generated by any changes to the static data.
BLOCK_ALM	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 sets the active status in the status parameter. As soon as the unreported status is cleared by the alert reporting task other block alerts may be reported without clearing the Active status, if the subcode has changed.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • MAN (Manual) • OOS (Out of Service).
Alarm Types	The block supports standard block alarms, (see section 3.2).
Status Handling	If an input has status as Uncertain or Bad, then the limit status of the inputs is ignored, as is the sub status. Either Good(C) or Good (NC) is accepted as Good. The increment calculated from an input has an internal status that is either Good or Bad. If the input status is Good(C) or Good (NC), the increment status is Good. If the input status is Uncertain, the increment status is Bad, and the last Good value is used unless the option Use Uncertain is set in **INTEG_OPTS**, and then the increment status is Good and the new value is used. If the input status is Bad, the increment status is Bad, and the last Good value is used unless the option Use Bad is set in **INTEG_OPTS**, and then the increment status is Good and the last Good value is used. The two increments are added together, and the resulting status is the worst of the two. The option Add zero if Bad in **INTEG_OPTS** causes the net increment to be zero if its status is Bad. The percentage of Bad or Uncertain and Bad counts can be determined by calculating the value of PCT_INCL from Rtotal and Atotal. As Atotal is the sum of increments with Good and Bad status, and Rtotal is the sum of increments with Bad status, Atotal minus Rtotal is exactly equal to the total of increments with Good status. If **most significant part** (msp) and Atotal is not zero then the percent of Good values may be calculated as: **PCT_INCL** = 100 * (1 - (msp of Rtotal) / (msp of Atotal)) If Atotal is zero, then PCT_INCL shall be 100 if Rtotal is also zero or 0 if Rtotal is not zero. If the block mode is AUTO, if **PCT_INCL** ≥ **GOOD_LIM**, the status of **OUT** is Good, or else if **PCT_INCL** ≥ **UNCERT_LIM**, the status of **OUT** is Uncertain, or else the status of **OUT** is Bad. If the block mode is Manual, then the status of **OUT**, **OUT_PTRIP**, and **OUT_TRIP** is Good (NC) constant when then status option Uncertain, if MAN is not selected. If this status option is selected and the block mode is manual, then the status of these three outputs is for Uncertain constant, and no limits are applied to the output.

3.12 Arithmetic block

The Arithmetic block is designed for using popular measurement math functions easily. The math algorithm is selected by name and the type of function to be performed. The block is used for calculating measurements from a combination of signals from the sensors. The block must not be used in a control path. The block does not support process alarms.

The Arithmetic block supports the following functions:

- Flow compensation, linear
- Flow compensation, square root
- Flow compensation, approximate
- BTU flow
- Traditional Multiply Divide
- Average
- Traditional Summer
- Fourth order polynomial
- Simple HTG compensated level
- Fourth order Polynomial Based on PV

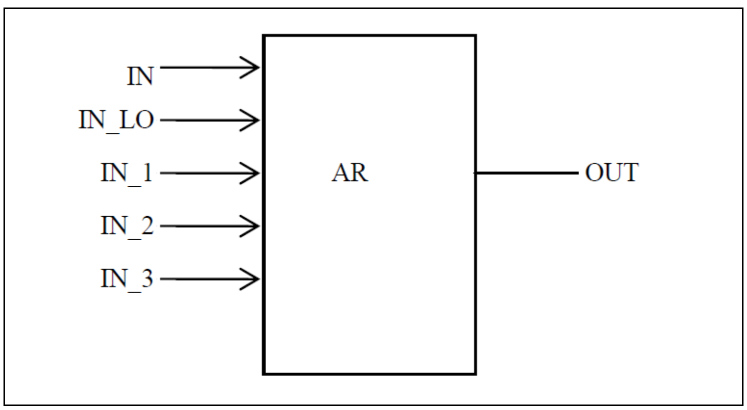


Figure 14: Arithmetic block

Execution

The block has five inputs, namely **IN, IN_LO, IN_1, IN_2,** and **IN_3**. The first two inputs (**IN, IN_LO**) are designed for a range extension function that results in a Process Variable (PV), with the status indicating the input in use.

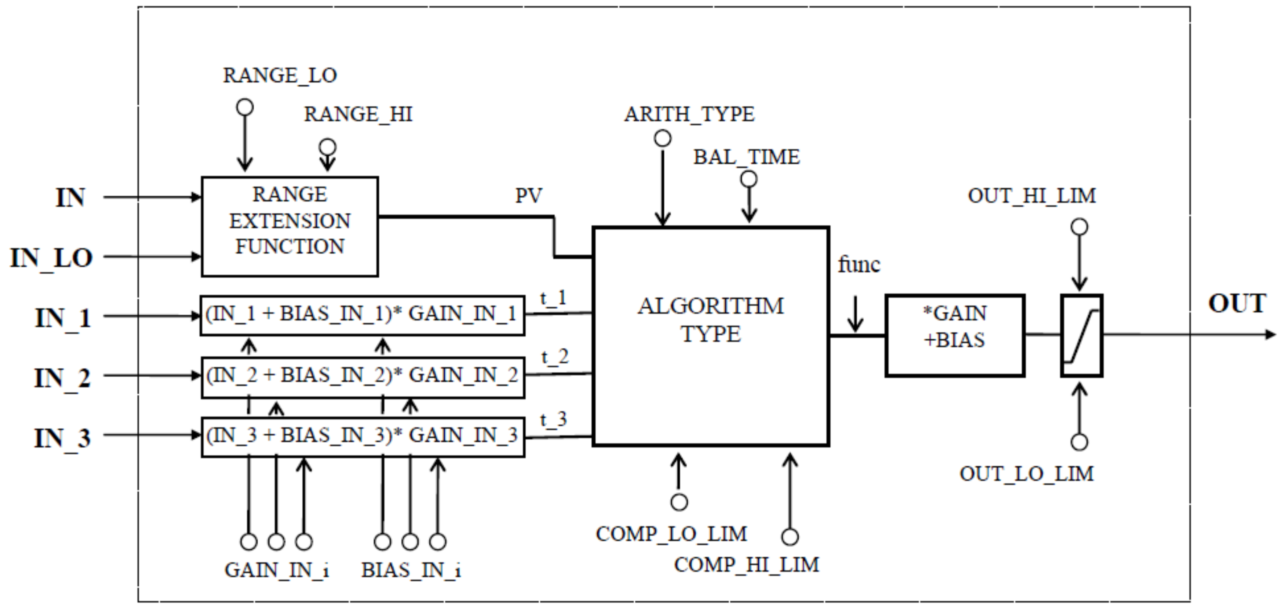


Figure 15: Arithmetic schematic diagram

The remaining three inputs (**IN_1, IN_2, and IN_3**) are combined with the PV in a selection of four term math functions. To ensure that the PV enters the equation with the right units, the inputs used to form the PV must come from devices with the desired engineering units. Each additional input has a bias constant and gain constant. To correct Absolute Pressure, use the bias constant, and to normalize terms within a square root function, use the gain constant.

Calculation of PV

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:

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

If the status of **IN_LO** is not usable and **IN** is usable and greater than **RANGE_LO**, then g is set to one. If the status of **IN** is unusable, and **IN_LO** is usable and less than **RANGE_HI**, then g is set to zero.

For three auxiliary inputs, six constants are used, and each input has a **BIAS_IN_i** and a **GAIN_IN_i**. The output has a **BIAS** and a **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. The equation for each auxiliary input is the following:

$$t\_i = (IN\_i + BIAS\_IN\_i) \times GAIN\_IN\_i$$

If an auxiliary input is unstable, to assure smooth degradation, the flow compensation functions have limits on the amount of compensation applied to the PV. The internal limited value is f.

The following function types are supported:

1. Flow compensation, linear. Used for density compensation of volume flow.

$$func = f \times PV$$

$$f = \frac{(t\_1)}{(t\_2)} \times [limited]$$

2. Flow compensation, square root. Usually, **IN_1** is pressure, **IN_2** temperature, and IN_3 is the compressibility factor Z.

$$func = f \times PV$$

$$f = \sqrt{\frac{\frac{(t\_1)}{(t\_2)}}{(t\_3)}} \times [limited]$$

3. Flow compensation, approximate. Both **IN_2** and **IN_3** would be connected to the same temperature.

$$func = f \times PV$$

$$f = \sqrt{(t\_1) \times (t\_2) \times (t\_3) \times (t\_3)} \times [limited]$$

4. BTU flow, where **IN_1** is inlet temperature, and **IN_2** the outlet temperature.

$$func = f \times PV$$

$$f = (t\_1 - t\_2) \times [limited]$$

5. Traditional Multiply Divide

$$func = f \times PV$$

$$f = \frac{(t\_1)}{(t\_2)} + (t\_3) \times [limited]$$

6. Average

$$func = \frac{(PV + (t\_1) + (t\_2) + (t\_3))}{f}$$

f = number of inputs used in computation (unusable inputs are not used).

7. Traditional Summer

$$func = PV + (t\_1) + (t\_2) + (t\_3)$$

8. Fourth order polynomial. All inputs except **IN_LO** (not used) are linked together.

$$func = \mathrm{PV} + (t\_1)^2 + (t\_2)^3 + (t\_3)^4$$

9. Simple HTG compensated level, where PV is the tank base pressure, IN_1 is the top pressure, IN_2 is the density correction pressure, and GAIN is the height of the density tap.

$$func = \frac{(PV - (t\_1))}{(PV - (t\_2))}$$

10. Fourth order polynomial based on PV

$$func = \text{PV} + \text{GAIN\_IN\_1} \times (PV)^2 + \text{GAIN\_IN\_2} \times (PV)^3 + \text{GAIN\_IN\_3} \times (PV)^4$$

After the value of **func** is calculated, it is multiplied by **GAIN**, and then **BIAS** is added to the result. Then, the high and low output limits are applied as per configured range scaling, and **PRE_OUT** is updated with the calculated value. If the mode is AUTO, **PRE_OUT** is copied to **OUT**.

Parameter List

Table 17: Arithmetic block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block. The revision value increments each time a static parameter value in the block is changed.
TAG_DESC	The user description of the application of the block.
STRATEGY	Used to identify grouping of blocks. This data is not checked of processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	The actual, target, permitted, ad normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take Normal: Most common mode for target.
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string so that multiple errors may be shown.
PV	It calculates the proportions of IN and IN_LO to for PV.
OUT	The analog output value and status.
PRE_OUT	Displays what would be the OUT value if the mode is AUTO or lower.
PV_SCALE	The high and low scale values, the engineering units’ code, and the number of digits to the right of the decimal point associated with the PV.
OUT_RANGE	The high and low scale values, engineering units code, and number of digits to the tight of the decimal point associated with OUT.
GRANT_DENY	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. (Not used by the device)

Parameter	Description
INPUT_OPTIONS	Option bit string for handling the status of the auxiliary inputs.
IN	The block input value and status.
IN_LO	Input of the low range transmitter, in a range extension application.
IN_1	The first block input value and status.
IN_2	The second block input value and status.
IN_3	The third block input value and status.
RANGE_HI	Constant value above which the range extension has switch to the high range transmitter.
RANGE_LO	Constant value below which the range extension has switch to the high range transmitter.
BIAS_IN_1	The bias value for IN_1.
GAIN_IN_1	The proportional gain (multiplier) value for IN_1.
BIAS_IN_2	The bias value for IN_2.
GAIN_IN_2	The proportional gain (multiplier) value for IN_2.
BIAS_IN_3	The bias value for IN_3.
GAIN_IN_3	The proportional gain (multiplier) value for IN_3.
COMP_HI_LIM	Determines the high limit of the compensation input.
COMP_LO_LIM	Determines the low limit of the compensation input.
ARITH_TYPE	The set of 9 arithmetic functions applied as compensation to or augmentation of the range extended input.
BAL_TIME	Specifies the time for a block value to match an input, output, or calculated value or the time for dissipation of the internal balancing bias.
BIAS	The bias value is used to calculate the output.
GAIN	The gain value is used to calculate the output.
OUT_HI_LIM	The maximum output value allowed.
OUT_LO_LIM	The minimum output value allowed.
UPDATE_EVT	This alert is generated by any changes to the static data.
BLOCK_ALM	Used for all configuration, hardware, connection failure, or system problem in the block. The cause of the alert is entered in the subcode field. The first active alarm sets the active status in the status parameter. When the Unreported status is cleared by the alert reporting test, other block alert may be reported without clearing the Active status, if the subcode has changed.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • MAN (Manual) • OOS (Out of Service).
Alarm Types	The block supports standard block alarms, (see section 3.2).
Status Handling	The **INPUT_OPTS** bit string controls the use of auxiliary inputs with less than Good status. The status of unused inputs is ignored. The status of the output is the worst of the inputs used in the calculation after applying **INPUT_OPTS**.

3.13 Signal Characterizer block

The Signal Characterizer block describes the input/output relationship for any type of function. The block has two paths, each with an output that is a non-linear function of the corresponding input. The non-linear function is configured based on a single look-up table with 21 arbitrary x-y pairs. To use the block in a control or process signal path, the status of an input is provided to the corresponding output. To use the backward control path, the block provides an option to swap the axes of the function.

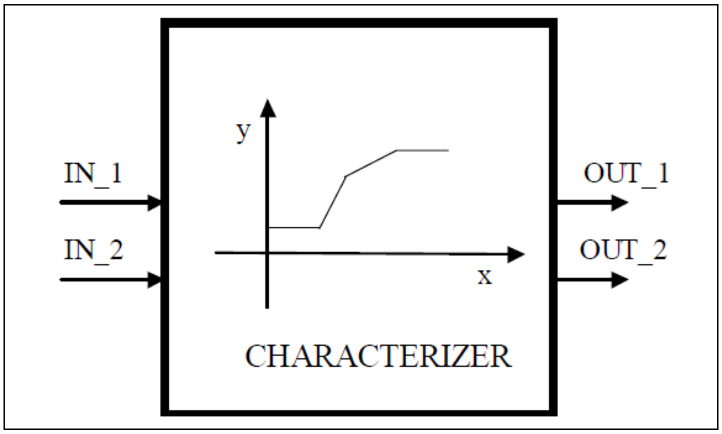


Figure 16: Signal Characterizer Block

The block calculates **OUT_1** from **IN_1** and **OUT_2** from **IN_2** using a curve given by the co-ordinates:

[x1; y1], [x2; y2] ... [x21; y21]

Where,

- x is the Input, and
- y is the Output.

The x-coordinates are given in engineering units of **X_RANGE**. The y-coordinates are given in engineering units of **Y_RANGE.**

Execution

Figure 16 describes the components of the block. The output value is calculated by linear interpolation between two points enclosing the input value. **OUT_1** is associated to **IN_1** and **OUT_2** to **IN_2** by the same curve, but there is no association between **IN_1** and **IN_2** or between **OUT_1** and **OUT_2**.

To derive the output value that corresponds to the input, use the following formula,

$$y = mx + c$$

Where,

- m is the slope of the line.
- c is the y-intercept of the line

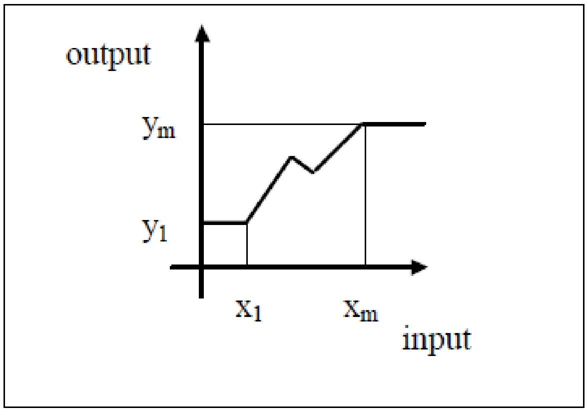


Figure 17: Signal characterizer curve

The values of x must increase sequentially for interpolation to be applicable. If not, a configuration error is set in **BLOCK_ERR**, and the **Actual** mode of the block goes to Out of Service mode.

If the curve has m points, m<21, the non-configured points, [xm+1; ym+1], [xm+2; ym+2], ... [x21; y21] is set to +INFINITY to mark them as unused.

Since x1 is the smallest specified value for the input and x_m is the largest, the output is at y1 when the input is smaller than x1, and the output is at y_m when the input is larger than x_m. Since the ends of the y curve act as limits, the **OUT** status is shown when either limit is active.

Backward Control path

A reverse function swaps the interpretation of **IN_2** and **OUT_2** that provides a way to do reverse calculation using the same curve. If the parameter **SWAP_2** is set to True, the block provides:

IN_1 = x and **OUT_1** = y while **IN_2** = y and **OUT_2** = x

If the function is not sequential in y and SWAP_2 is True, **BLOCK_ERR** indicates a configuration error, and the **Actual** mode goes to **Out of Service** mode for x. A function is said to be sequential when y values always increase or decrease when x values increase.

If **SWAP_2** = False, **IN_1** and **IN_2** have the same engineering units defined in **X_RANGE** and **OUT_1** and **OUT_2** use the units defined in **Y_RANGE**.

If **SWAP_2** = True, **OUT _1** and **IN_2** have **Y_RANGE** and **OUT_2** and **IN_1** have **X_RANGE**.

Parameter list

Table 18: Signal Characterizer block parameters

Parameter	Description
ST_REV	The revision level of the static data associated with the function block. The revision value is incremented each time a static parameter value in the block is changed.
TAG_DESC	The use description of the intended application of the block.
STRATEGY	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	The actual, target, permitted, ad normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string so that multiple errors may be shown.
OUT_1	The block output value and status.
OUT_2	The block output value and status.
X_RANGE	The display scaling of the variable corresponding to the x-axis for display. It has no effect on the block.
Y_RANGE	The display scaling of the variable corresponding to the y-axis for display. It has no effect on the block.
GRANT_DENY	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. (Not used by the device)
IN_1	The block input value and status.
IN_2	The block input value and status.
SWAP_2	Changes the algorithm in such a way that IN_2 corresponds to “y” and OUT_2 to “x”.
CURVE_X	Curve input points. The “x” points of the curve are defined by an array of 21 points.
CURVE_Y	Curve input points. The “y” points of the curve are defined by an array of 21 points.
UPDATE_EVT	This alert is generated by any changes to the static data.
BLOCK _ALM	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 sets the active status in the status parameter. As soon as the Unreported status is cleared by the alert reporting task other block alerts may be reported without clearing the active status, if the subcode has changed.

Attributes

Supported Modes	The block supports the following modes: • AUTO (Automatic) • MAN (Manual) • OOS (Out of Service).
Alarm Types	The block supports standard block alarms, (see section 3.2).
Status Handling	**OUT_1** shows the status of **IN_1** and **OUT_2** shows the status of **IN_2**. The sub-status is also passed to the outputs. If one of the curve limits is reached or the input is limited, the appropriate limit must be indicated in the output sub-status. Limits shall be reversed if the curve slope is negative. If **SWAP_2** is set, cascade initialization is controlled by the lower block. When this block is in OOS mode, the cascade to both the lower and upper blocks is broken by Bad status at the outputs. When the block goes to AUTO mode, the lower block can begin cascade initialization with status values that pass through this block to the upper block. The output status signals from the upper block pass through this block to the lower block. The block does not use **STATUS_OPTS**.

3.14 Configuring the transmitter using Field Device Manager (FDM) system

The transmitter can be configured through Field Device Manager, by using DTM. For more information, refer the FDM manual #EP-FDM-11430, #EP-FDM-11410.

4. ST 700 FF Pressure Transmitter Operation

4.1 Operational considerations

There are a number of considerations that must be noted when configuring a transmitter to operate in a fieldbus network.

LAS Capability

The transmitter is capable of operating as the Link Active Scheduler (LAS). The LAS is a fieldbus feature which controls traffic on the network, such as controlling token-rotation and coordinating data publishing. This fieldbus function is active in only one device at any given time on a network. Devices which can be designated as the LAS may be an operator station or a field device. The transmitter can be designated as LAS, in the event of a failure of the primary LAS, control in the field could continue.

ATTENTION

Note that the transmitter can be used only as "backup" LAS.

Special Non-volatile parameters and NVM Wear-out

All function block parameters designated as Non-Volatile (N) in the FF specifications are updated to non-volatile memory (NVM) on a periodic basis. **NV_CYCLE_T** parameter in the resource block specifies this update interval.

To provide predictable restart behavior in the transmitter, the following Non-Volatile parameters are updated to NVM each time they are written over the fieldbus.

- **MODE.TARGET** for all blocks
- **SP.VALUE** for the PID block

Since these are user-written parameters, these additional updates to NVM contribute negligibly to NVM wear out. However, users are cautioned to not construct control configurations where the above parameters are written continuously (via a computer application for example) or at rates greater than the **NV_CYCLE_T** interval. This consideration helps to minimize the possibility of NVM wear-out.

In the case of MODE this must not be a problem. When users wish to provide set-points to the PID block via a computer application, users should use RCAS mode with its corresponding set point value **RCAS_IN**. **RCAS_IN** is updated only at the **NV_CYCLE_T** update rate and this mode supports full shedding functionality and PID initialization necessary for a robust application.

Mode Restricted Writes to Parameters

Some block parameters have restrictions on having write access to them. These are specified in the FF specifications. Writing to certain function block parameters are restricted based on the block's Target and/ or Actual mode.

4.2 Configuration of the transmitter using Handheld (HH)

Figure 18 graphically represents the connection of the transmitter to the handheld. Each transmitter includes a configuration database that stores its operating characteristics in a non-volatile memory. The handheld is used to establish and/or change selected operating parameters in a Transmitter database. The process of viewing and/or changing database parameters is called configuration.

Configuration can be accomplished both online and offline with the Transmitter powered up and connected to the handheld. The online configuration immediately changes the Transmitter operating parameters. For offline configuration, Transmitter operating characteristics are entered into the handheld memory for subsequent downloading to a Transmitter.

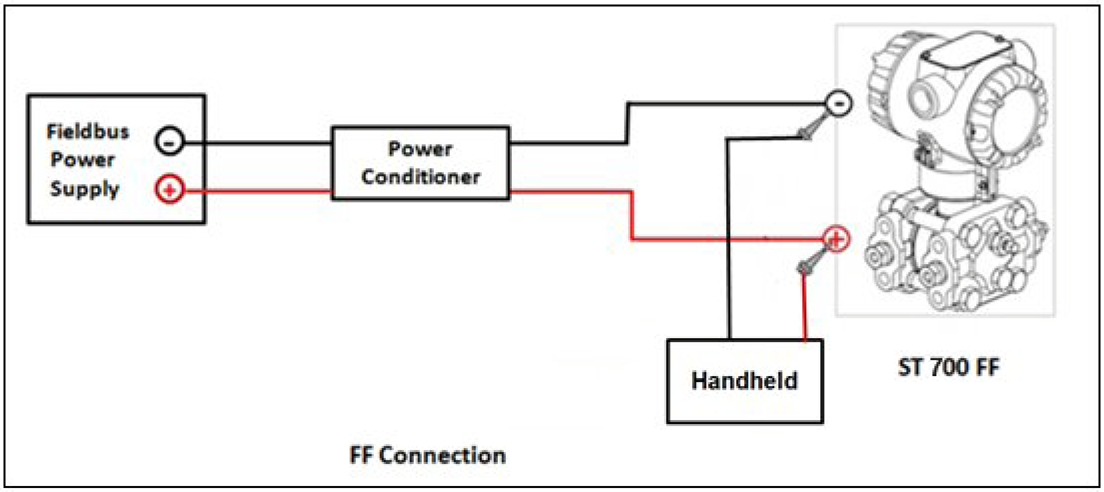


Figure 18: Connecting the transmitter to the handheld

4.3 Performing block instantiation

About block instantiation

A block instance is a copy of an available block in the device, say for example AI block. There are totally 11 permanent blocks, and only three blocks support instantiation in a device. The three blocks that support instantiation are Input Selector block, Signal Characterizer block and Analog Input block. Two instances of the Analog Input block can be instantiated, while the Input Selector block and Signal Characterizer block can be instantiated only once respectively. A block can be instantiated or deleted.

Before block instantiation, the device checks whether the particular block is supported, and if there is sufficient memory to store the parameters. After Instantiation, the instantiated block must be loaded into the device, and then the strategies can be created.

ATTENTION

Note that only two blocks can be instantiated at a time. For example, you can instantiate two AI blocks, or one Input Selector and one Signal Characterizer block.

Block instantiation using Experion PKS

The following are the steps for performing block instantiation using Experion PKS.

Step	Action
1	From the DD at the **Library-Containment** window, select an instantiation block from the supported blocks, that is Analog Input block, or Input Selector block, or Signal Characterizer block.
2	Drag and drop the required instantiation block into the device on the **Project-Assignment** window.
3	After adding the instantiation block into the device in the **Project-Assignment** window, select the device.
4	Right-click the device, and click **Load**. The instantiated block is loaded into the device.

5. ST 700 FF pressure transmitter maintenance

5.1 Replacing the Local Display and Electronic Assembly

For more information about Local Display and Electronic Assembly, refer the ST 700 SmartLine Pressure Transmitter User Manual, #34-ST-25-35.

5.2 Downloading the firmware

About firmware download feature

The download class indicates how the device operation is affected by the download process. There are three types of download classes (1, 2 &3). The transmitter supports only one type of download class as per FOUNDATION Fieldbus specifications. ST 700 device FF variant supports download type Class 3 only. A class-3 firmware download is performed, irrespective of whether the device is ON /OFF process.

Class 3

When class 3 download is performed the device prepares for the download and goes out of the link as the memory of the device is re-written with the new firmware. After the restart of the device, the device comes back to the link automatically. However, the device retains the following credentials,

- Retains its original Device ID
- Retains only its System Management **VFD** in its **VFD_LIST**
- Retains its Node Address and **PD** Tag
- Retains its management **VCR** to provide access to the SMIB.

ATTENTION

Note that the Node Address and **PD** Tag does not retain, when the firmware is upgraded from one version to the other.

ATTENTION

When the device is upgraded using Class-3 Procedure, download may fail for the first time. This can be detected when device comes up on the link with a device ID ending in 'ERR!' and a temporary node address. In this situation, the user is advised to set a permanent node address and retry the download ignoring the warning message from host.

Recommendations

If firmware upgrade is required for a large number of ST 700 devices, the following are the guidelines,

1. **Only one device firmware download is allowed in a given H1 Link process**: Firmware download to multiple devices must happen one after another in the same link. However, parallel downloads can be performed to devices on different H1 links.
2. **Download firmware to one device type at a time in a H1 link:** This reduces the chance for unknown interactions between devices to cause link issues or download failures.
3. **Reduce usage of DTM through tools like FDM in the H1 link:** This reduces the traffic on the link and therefore reduces the time required for the download to complete.
4. **Parallel Firmware downloads from single Control Builder** Firmware downloads to a single FIM should be done from single Control Builder instance. This reduces the chance of initiating multiple downloads to the same H1 link from different users.
5. **FF segment** design (the choice of devices to connect to a FF segment) must consider the maximum current draw of those devices, as well as the potential for inrush current during power-up.

   For reference, the ST 700 provides the following:

   - Max current draw (observed during firmware download): 28 mA
   - Normal quiescent current: 18 mA
   - Inrush when powered on: 28 mA

Downloading the File

The firmware file to be downloaded is called as Gendomain file and have the file extension .ffd.

File Name

The file name is constructed as follows:

“Manufacturer ID” + “_” + “Device Type” + “_” + “Domain Name” ” + “_” +“Software Name” + “_” +“Software Revision” + “.” + “ffd”, where:

- **Manufacturer ID** is represented as six hexadecimal digits (leading and trailing zeroes are included).
- **Device Family** is represented as four hexadecimal digits (leading and trailing zeroes are included). For Multidomain devices, Device Family is replaced by Multidomain Family.
- **Device Type** is represented as four hexadecimal digits (leading and trailing zeroes are included).
- Leading "0"s are not suppressed for **Manufacturer ID** and **Device Type**.
- Trailing blanks are stripped from Device Family, Domain Name, Software Name, and Software Revision.
- If **Software Name** or **Software Revision** is composed of all blanks, then the underscore that would have preceded is omitted to prevent names with two adjacent underscores, or from having the underscore character appear directly before the ".ffd".

For example, if the file contains the following header values,

Manufacturer ID = "48574C"

Device Type = "0003"

Domain Name = "DOM01"

Software Name = "FD-DOM"

Software Revision = "2-41"

Then the file name would be:

"48574C0003_0003_FD-DOM_FD-SW_2-41.ffd".

ATTENTION

In the ST 700 FF pressure transmitter, only communication board firmware can be upgraded using the class 3 download. Display and sensor board firmware upgrade is not possible through FF link in the current release

6. ST 700 FF Pressure Transmitter troubleshooting

6.1 Troubleshooting overview

This section contains information to help you identify the faults in devices and the recommended actions to correct them. Troubleshooting is performed to determine the cause of the fault by analyzing the device indications (such as device not visible on network or not able to write values to parameters.)

Device status and faults

The transmitter constantly runs internal background diagnostics to monitor the functions and status of the device operations. When errors and/or faults are detected, they are reported in the status bits of certain block parameters, (for example, **BLOCK_ERR**). The other parameters can be seen by viewing the status descriptions and/or a value, which may help to identify a fault.

Device status and operational faults are identified by viewing key parameter values or status and then interpreting their meaning using the following tables.

ATTENTION

Additional diagnostics are available through supervisory and control applications that monitor and control fieldbus networks. These diagnostics and messages are dependent upon the capabilities of the application and the control system that is used.

6.2 Troubleshooting the transmitter

Device not visible on the network

If a device cannot be seen on the fieldbus network, the device may not be powered up or possibly the supervisory or control program is not able to find (or polling) the node address of that device. See the following table for possible causes and recommended actions.

Symptoms		
Device not visible on the network		
Possible cause	**Things to check**	**Recommended action**
Device may have a node address that is within the “unpolled range” of addresses.	Verify the following settings: • First Unpolled Node • Number of Unpolled Nodes	Set Number of Unpolled Nodes to “0”.
No power to the device.	Measure the DC voltage at the device’s SIGNAL terminals. Voltage must be within the limits.	If no voltage or voltage is out of operating limits, determine the cause and correct it.
Insufficient current to the device.	Measure the DC current to the device. The DC current must be within the limits.	If the current is insufficient, determine the cause and correct it.
More than two or less than two terminators are wired to fieldbus link.	Check to see that only two terminators are present on a link.	Correct, if necessary.
Insufficient signal to the device.	Measure the peak-to-peak signal amplitude. The output must be 0.75 to 1.0 Vp-p. Measure the signal on the + and - SIGNAL terminals and at a frequency of 31.25k Hz.	If the signal amplitude is insufficient, determine the cause and correct it.
Names of parameters are not visible.	Missing or incorrect version of Device Description file on host computer.	Check the path to the Device Description. Load correct version of DD.

Incorrect or non-compatible tools

If non-compatible versions of fieldbus software tools are used, such as Standard Dictionary or Device Description (DD) files, or if you are using the incorrect revision level of device firmware, then device objects or some block objects may not be visible or identified by name. See the following table for the possible causes and recommended actions.

<table>
<tr><th colspan="3">Symptoms</th></tr>
<tr><td colspan="3">Device and/or block objects not identified (Unknown).

Or

Parameters are not visible or identified by name.

Or

Honeywell-defined parameters are not visible.</td></tr>
<tr><th>Possible cause</th><th>Things to check</th><th>Recommended action</th></tr>
<tr><td>Incorrect Standard Dictionary, Device Description (DD) or Symbols on host computer.</td><td>Verify that the Standard Dictionary, the DD or symbols files are correct for the device.</td><td>Install the compatible version of Standard Dictionary and DD for the device on the host computer.</td></tr>
<tr><td>Incorrect pathnames to descriptions on host computer.</td><td>Check that the pathnames to locations of the Standard Dictionary, and DD files on the host computer are correct.</td><td>Make sure that the pathnames of the Standard Dictionary and DD are in the correct location for the fieldbus software application.</td></tr>
<tr><td>Incorrect version of device firmware</td><td>Read the following Resource block parameters:
• DEV_REV (contains the revision level of the resource block).
• DD_REV (contains the revision level of the resource block).</td><td>Perform a code download of the correct device firmware. See section 5.2.</td></tr>
</table>

6.3 Troubleshooting blocks

Non-functioning blocks

Device block objects may not be running (executing their function block schedules) or the blocks may be in Out of Service (OOS) mode due to block configuration error. For example, if the AI function block is in OOS mode, the block does not provide updated output values, although the AI block may be running. While troubleshooting a non-functioning block objects, it is recommended to start with the resource block. For example, if the resource block is in OOS mode, all other blocks in the device are also in the OOS mode.

Troubleshooting block configuration errors

The block configuration errors prevent a device block from leaving the OOS mode. The **BLOCK_ERR** parameter (bit 1) shows whether a block configuration error is present. The following section explains the troubleshooting for all the function blocks:

Troubleshooting the Resource block

Table 19: Resource block

Problem cause	Things to check	Recommended action
Resource block mode is OOS mode and is not going to AUTO mode.	Read **MODE_BLOCK.PERMITTED**	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK. ACTUAL** of Resource block.	If necessary, Set **MODE_BLOCK.TARGET** to AUTO. **NOTE:** If the mode is set to OOS for maintenance, then do not change the mode to AUTO.
Resource block is not running.	Check **BLOCK_ERR** for errors.	See Table 3 for details on **BLOCK_ERR**.
Incorrect revision level of the device firmware.	Read **REVISION_ARRAY**	See section 6.2.
Block alarms are not reported.	Read **FEATURE_SEL**	**Reports** are not selected in **FEATURE_SEL**. If features do not include Reports then the host must poll for alarms.
	Read **LIM_NOTIFY**	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.
Field diagnostics alarms are not reporting.	Check Field Diagnostics MASK.	If the alarms are MASKED, then the alarms do not report. Unmask the alarms.
	Check Field Diagnostics Priority.	If the priority is zero alarms do not report. For information on how set the priority, see Table 4.
	Check Field Diagnostics MAP.	If alarms are not mapped, then Map alarms to any of the Field Diagnostics alarm parameters.

Troubleshooting the Pressure Transducer block

Table 20: Pressure Transducer block

Problem cause	Things to check	Recommended action
Transducer block mode is in OOS and does not change to AUTO mode.	Read **MODE_BLOCK.PERMITTED**	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK. ACTUAL** of Resource block.	If necessary, Set **MODE_BLOCK.TARGET** to AUTO. **NOTE:** If the mode is set to OOS for maintenance, then do not change the mode to AUTO.
Transducer block does not produce valid primary Value.	Check the Primary value Range.	Ensure that primary Value Range has valid ranges and units assigned.
	Read **BLOCK_ERR**.	See Table 3 for details on **BLOCK_ERR**.
	Verify parameter: **PRIMARY_VALUE** is not valid **STATUS** = Good or Uncertain **VALUE** = active	Isolate transmitter from process. Perform Correct Reset calibration. Recalibrate the transmitter.
	Read **SENSOR_TEMP**. Must contain the sensor temperature.	Report information to Honeywell.
Transducer block does not produce valid Secondary value.	Check the Secondary value Range.	Ensure that Secondary Value Range has valid ranges and units assigned.
Transducer block does not produce valid Tertiary value.	Check the Tertiary value Range.	Ensure that Tertiary Value Range has valid ranges and units assigned.
Transducer block does not produce valid Fluid Level value.	Check the Level co-efficient and Tank range.	Ensure that the Level co-efficient is calculated properly. See Error! Reference source not found..
Transducer block shows incorrect Electronic Housing temperature value.	Check the Electronic Housing temperature units.	Ensure that proper unit is assigned to Electronic Housing temperature.
Zero calibration failed.	Check the Air Pressure applied.	Ensure that the differential pressure input is zero while using a tube to connect the High Pressure (HP) and Low Pressure (LP) heads.
LRV calibration failed.	Check the Air Pressure applied.	Ensure that Air pressure is applied as per the **CAL_POINT_LO** value entered.
URV calibration failed.	Check the Air Pressure input.	Ensure that Air pressure is applied as per the **CAL_POINT_HI** value entered.
Block alarms are not reported.	Read **FEATURE_SEL**.	**Reports** are not selected in **FEATURE_SEL**. If features do not include Reports then the host must poll for alarms.
	Read **LIM_NOTIFY**.	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.

Troubleshooting the Diagnostics Transducer block

Table 21: Diagnostics Transducer block

Problem cause	Things to check	Recommended action
Diagnostic Transducer block mode is in OOS and does not change to AUTO mode.	Read **MODE_BLOCK.PERMITTED**	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK. ACTUAL** of Resource block.	If necessary, Set **MODE_BLOCK.TARGET** to AUTO. **NOTE:** If the mode is set to OOS for maintenance then do not change the mode to AUTO.
Sensor Diagnostics, Sensor voltage diagnostics, Electronic temperature diagnostics values are not updating.	Read **TRACK_UPLOAD_DATA**	Select value other than NONE, and then wait for 10 seconds. If no values are updated (for example, if Max and Min still shows 999) in Sensor Diagnostics and Sensor voltage diagnostics, Contact Honeywell TAC.
Block alarms are not reported.	Read **FEATURE_SEL**	**Reports** are not selected in **FEATURE_SEL**. If features do not include reports then the host must poll for alarms.
	Read **LIM_NOTIFY**	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.

Troubleshooting the Flow Transducer block

Table 22: Flow Transducer block

Problem Cause	Things to check	Recommended Action
Flow Transducer block mode is in OOS and does not change to AUTO mode.	Read **MODE_BLOCK.PERMITTED**	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK. ACTUAL** of Resource block.	If necessary, Set **MODE_BLOCK.TARGET** to AUTO. **NOTE:** If the mode is set to OOS for maintenance, then do not change the mode to AUTO.
Flow Transducer block mode is in OOS mode with block configuration error.	Read **PRESS_BASIC** block's **MODE_BLOCK.ACTUAL**.	If it is in OOS mode, then set **MODE_BLOCK.TARGET** to AUTO. **NOTE:** If the mode is set to OOS for maintenance then do not change the mode to AUTO.
	Read Primary value Range parameters.	**PRIMARY_VALUE_RANGE.EU_0** must be greater than or equal to zero.
Flow transducer block does not produce valid **FLOW_RATE** value.	Check **FLOW_TYPE**, **FLOW_UNIT** and **RATED_FLOW**.	Ensure that **FLOW_TYPE**, **FLOW_UNIT** and **RATED_FLOW** have valid ranges and units assigned.
Block alarms are not reported.	Read **FEATURE_SEL**	**Reports** are not selected in **FEATURE_SEL**. If features do not include Reports, then the host must poll for alarms.
	Read **LIM_NOTIFY**	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.

Troubleshooting the LCD Transducer block

Table 23: LCD Transducer block

Problem Cause	Things to check	Recommended Action
LCD Transducer block mode is in OOS and does not change to AUTO mode.	Read **MODE_BLOCK.PERMITTED**	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK. ACTUAL** of Resource block.	If necessary, Set **MODE_BLOCK.TARGET** to AUTO. **NOTE** If the mode is set to OOS for maintenance, then do not change the mode to AUTO.
Writing to display parameters fails.	Check for local display.	Basic Display is required for **LCD_TB** to work.
		If display is available, remove and reconnect the local display, and check if display powers up.
		If display is not powering up contact Honeywell TAC.
Local display shows Attention as title with some text.	Check the **DISPLAY_MESSAGE** parameters.	Transmitter messaging is activated; to clear the message executed the Clear Message method. For more information see section 3.6
Block alarms are not reported.	Read **FEATURE_SEL**.	**Reports** are not selected in **FEATURE_SEL**. If features do not include Reports then the host must poll for alarms.
	Read **LIM_NOTIFY**	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.

Troubleshooting the Analog Input (AI) block

Table 24: Analog Input block

Problem cause	Things to check	Recommended action
Analog Input block mode is in OOS and does not change to AUTO mode.	Read **MODE_BLOCK.PERMITTED**	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK. ACTUAL** of Resource block.	If necessary, Set **MODE_BLOCK.TARGET** to AUTO. **NOTE:** If the mode is set to OOS for maintenance, then do not change the mode to AUTO.
	Read **WRITE_LOCK** parameter in resource block. Check if device is in Write Protect mode. If **WRITE_LOCK** = Locked (2)	Change Write Protect jumper to “W” position. (See section 6.6) Reset the device. (Cycle power to transmitter or write “Processor” to **RESTART** parameter in Resource block.)
	Schedule	Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
Analog Input block mode is in OOS mode with Block Configuration Error.	Read **CHANNEL** parameter and range.	**CHANNEL** must be set to a valid value and cannot be left at the initial value of zero.
		XD_SCALE.UNITS_INDX must be compatible with the units in the transducer block for the channel.
	Read **L_TYPE** parameter.	**L_TYPE** must be set to Direct, Indirect, or Indirect Square Root and cannot be left at the initial value of zero.
	Check **if L_TYPE**= Direct	When **L_TYPE** = Direct, **XD_SCALE** and **OUT_SCALE** must contain the same range values (**EU_0** and **EU_100**).
Value of output seems wrong.	Read Linearization Type.	Check the **L_TYPE** setting.
	Read Scaling.	Check **XD_SCALE** and **OUT_SCALE**
Process and block alarms do not work.	Read **FEATURE_SEL**.	**Reports** are not selected in **FEATURE_SEL**. If features do not include Reports then the host must poll for alarms.
	Read **LIM_NOTIFY**	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.
	Read Alarm Summary Disable.	Check that process and block alarms are not disabled.
Cannot set alarm limits.	Read Scaling.	Limit values are outside the **OUT_SCALE.EU_0** and **OUT_SCALE.EU_100** values. Set values within range.

Troubleshooting the Proportional Integral Derivative (PID) block

Table 25: PID block

Problem Cause	Things to check	Recommended action
PID block mode is in OOS mode, and does not change to AUTO, CAS, RCAS and ROUT mode.	Read **MODE_BLOCK.PERMITTED**.	Add AUTO, CAS, RCAS and ROUT modes to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK. ACTUAL** of Resource block.	If necessary, Set **MODE_BLOCK.TARGET** to AUTO. **NOTE:** If the mode is set to OOS for maintenance then do not change the mode to AUTO.
	Schedule	Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
PID block mode is in OOS mode with Block configuration Error.	Read parameters: **BYPASS** **SHED_OP**	The default values of these parameters are configuration errors and they must be set to a valid range. See Table 30.
	Read **SP_HI_LIM**, **SP_LO_LIM** **OUT_HI_LIM**, **OUT_LO_LIM**	Check that **SP_HI_LIM < SP_LO_LIM**, **OUT_HI_LIM < OUT_LO_LIM**.
PID block is not running.	Read the first element of **BLOCK_TEST**. Number must be increasing indicating that block is running.	If the second element of **BLOCK_TEST** is nonzero, write all zeroes to element.
Mode does not change from IM, target mode is MAN, AUTO, or Cas.	No path to process.	Assure that the downstream blocks to at least one AO are all in Cas mode and that the path ends in an AO block. All BKCAL connections must be linked.
Mode does not change from MAN; target mode is MAN, AUTO, or Cas.	Check Input blocks.	The status of IN is Bad, not connected.
Mode does not go to Cas, target mode is Cas.	Check Upstream block.	The upstream block cannot not able to complete cascade initialization for some reason. Assure that **BKCAL_OUT** is connected to **BKCAL_IN** of the upstream block.
Value of output does not make sense	Check Cascade Initialization	Assure that the output can move an actuator.
Block alarms are not reported	Read **FEATURE_SEL**	**Reports** are not selected in **FEATURE_SEL**. If features do not include Reports then the host must poll for alarms.
	Read **LIM_NOTIFY**	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.

Troubleshooting the Input Selector block

Table 26: Input Selector block

Problem Cause	Things to check	Recommended Action
Input Selector block mode is in OOS and does not change to AUTO mode.	Read **MODE_BLOCK.PERMITTED**.	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read MODE_BLOCK. ACTUAL of Resource block.	If necessary, Set **MODE_BLOCK.TARGET** to AUTO. **NOTE**: If the mode is set to OOS for maintenance then do not change the mode to AUTO.
	Schedule	Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
Input Selector block mode is in OOS mode with Block configuration Error.	Check **SELECT_TYPE**	**SELECT_TYPE** must be set to a valid value and cannot be left at 0.
Status of output is Bad.	Check Inputs	Make sure at least one input has status as good.
	Check **OP_SELECT**	**OP_SELECT** is not set to 0 (or it is linked to an input that is not used), and it points to an input that is Bad.
	Check **MIN_GOOD**	Make sure that value entered in **MIN_GOOD** is greater or equal to actual number of Good inputs.
Block alarms are not reported.	Read **FEATURE_SEL.**	Reports are not selected in **FEATURE_SEL**. If features do not include Reports then the host must poll for alarms.
	Read **LIM_NOTIFY**.	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.

Troubleshooting the Integrator block

Table 27: Integrator block

Problem Cause	Things to check	Recommended Action
Integrator block mode is in OOS and does not change to AUTO mode.	Read **MODE_BLOCK.PERMITTED**.	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK.ACTUAL** of Resource block.	If necessary, set **MODE_BLOCK.TARGET** to AUTO. **NOTE**: If the mode is to OOS for maintenance, then do not change the mode to AUTO.
	Schedule	Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
Integrator block mode is in OOS mode with Block Configuration Error.	Check **INTEG_TYPE**	**INTEG_TYPE** must not be zero/blank.
	Check **TIME_UNIT 1** and **TIME_UNIT 2**.	**TIME_UNIT1** & **TIME_UNIT 2** must not be zero/blank.
Value of output does not make sense.	Check **TOTAL_SP**.	**TOTAL_SP** must be set to a valid value and cannot be left at 0, if **INTEG_TYPE** is **UP_AUTO**, **DN_AUTO**.
Value of output is going in negative value.	Check **REV_FLOW1** and **REV_FLOW 2**.	For forward flow **REV_FLOW1** and **REV_FLOW 2** must be set as Forward, and for reverse flow **REV_FLOW1** & **REV_FLOW 2** must be set as Reverse.
	Check **INTEG_OPTS** Flow forward and flow reverse	For forward flow in **INTEG_OPTS** flow, forward must be selected and for reverse flow in **INTEG_OPTS** flow, reverse must be selected.
Block alarms are not reported.	Read **FEATURE_SEL**.	**Reports** are not selected in **FEATURE_SEL**. If features do not include Reports, then the host must poll for alarms.
	Read **LIM_NOTIFY**.	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.

Troubleshooting the Arithmetic block

Table 28: Arithmetic block

Problem Cause	Things to check	Recommended Action
Arithmetic block mode is in OOS and does not change to AUTO mode.	Read **MODE_BLOCK.PERMITTED**	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK. ACTUAL** of Resource block.	If necessary, set **MODE_BLOCK.TARGET** to AUTO. **NOTE**: If the mode is set to OOS for maintenance, then do not change the mode to AUTO.
Mode does not change from OOS.	Configuration error.	**BLOCK_ERR** shows the Block Configuration Error condition, since **ARITH_TYPE** is not set.
Value of output is incorrect	Error in configuration.	Ensure that engineering units are correct for the computation. If that fails, see section 3.
Block alarms are not reported.	Read **FEATURE_SEL**.	Reports are not selected in **FEATURE_SEL**. If features do not include reports then the host must poll for alarms.
	Read **LIM_NOTIFY**.	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.

Troubleshooting the Signal Characterizer block

Table 29: Signal Characterizer block

Problem cause	Things to check	Recommended action
Signal characterizer block mode is in OOS and does not change to AUTO mode.	Read **MODE_BLOCK.PERMITTED**.	Add AUTO mode to **MODE_BLOCK.PERMITTED**.
	Read **MODE_BLOCK. ACTUAL** of Resource block.	If necessary, Set **MODE_BLOCK.TARGET** to AUTO. **NOTE**: If the mode is set to OOS for maintenance, then do not change the mode to AUTO.
Mode does not change from OOS	Configuration error.	**BLOCK_ERR** shows the Block Configuration Error condition, due to array configuration errors.
Value of output is incorrect	Error in X or Y array.	See section 3.
Block alarms are not reported.	Read **FEATURE_SEL**	**Reports** are not selected in **FEATURE_SEL**. If features do not include reports then the host must poll for alarms.
	Read **LIM_NOTIFY**	Set **LIM_NOTIFY** to a value higher than zero, but not higher than **MAX_NOTIFY**.

Resolving the block configuration errors

Table 30 lists the parameters of all the blocks that can cause the status bit of Block Configuration Error to be set in their respective **BLOCK_ERR** parameters. The following table provides the initial values and the valid range for the parameters.

ATTENTION

Block configuration errors can only be cleared if the function block is being executed (running). One way of determining block execution is by doing a series of two or three reads of the **BLOCK_TEST** parameter and confirming that the first byte of the parameter is incrementing. This works, if the execute rate is fast relative to the speed of reading **BLOCK_TEST**. A very slowly executing block may not appear to execute as the parameters are updated only when the block executes.

Table 30: Resolving block configuration errors

Parameter	Initial Value	Valid Range	Corrective Action
ALERT_KEY	0	non-zero	Initial Value is a configuration error. Set value to non-zero number.
SIMULATE	1 (disabled)	1-2 (disabled - enabled)	Set value in valid range.
XD_SCALE	0 to 100 inches of water	EU_100 > EU_0, UNITS_INDEX matches output of transducer block	Set values to valid range(s).
OUT_SCALE	0 to 100 inches of water	EU_100 > EU_0	Set values to valid range.
CHANNEL	0	1-2	Initial Value is a configuration error. Set value to valid range.
L_TYPE	0 (Uninitialize)	1,2,3 (direct, indirect, sq. root)	Initial Value is a configuration error. Set value to valid range.
PV_FTIME	0	0-200	Set value to valid range.
ALARM_HYS	0.5 (%)	0-50 (%)	Set value to valid range.
HI_HI_PRI, HI_PRI, LO_LO_PRI, LO_PRI	0	0-15	Set value to valid range.
HI_HI_LIM, HI_LIM	+INF	+INF or within OUT_SCALE range	Set value to valid range.
LO_LIM, LO_LO_LIM	-INF	-INF or within OUT_SCALE range	Set value to valid range.

Parameter	Initial Value	Valid Range	Corrective Action
BYPASS	0	1:OFF, 2:ON	Initial value is a configuration error. Set value in valid range.
SHED_OPT	0	1-8 see Shed Options in the FF specs.)	Initial value is a configuration error. Set value in valid range.
HI_HI_LIM HI_LIM	+INF +INF	PV_SCALE, +INF	Values must be set in rank order. For example, LO_LIM > LO_LO_LIM but < HI_LIM etc.
LO_LIM LO_LO_LIM	-INF -INF	PV_SCALE, -INF	Values must be set in rank order.
OUT_HI_LIM OUT_LO_LIM	100 0	OUT_SCALE +/- 10%	Verify that OUT_HI_LIM > OUT_LO_LIM.
SP_HI_LIM SP_LO_LIM	100 0	PV_SCALE +/- 10%	Verify that SP_HI_LIM > SP_LO_LIM.

6.4 Device Diagnostics

ST 700 FF pressure transmitter memory

The transmitter contains a number of areas of memory. An EEPROM provides a non-volatile memory area for static and non-volatile parameter values. The transmitter also contains areas of RAM and ROM.

Performing diagnostics in the background

Block objects (Resource, Transducer and Function blocks), the communications stack and other device objects, each of them have an allotted area of memory for their corresponding database. Diagnostic routines are performed in the background during device operations that checks the integrity of these individual databases. When a failure is detected, a status bit is set in the **BLOCK_ERR** parameter in the appropriate block object. Diagnostic checks are performed continuously on the device functional databases of the transmitter application shown in Table 31.

Table 31: Diagnostics

Device Functional Area	Location
Block object database (DB)	RAM and EEPROM
Communication stack database (DB)	EEPROM
Boot ROM	ROM
Program ROM	ROM
Trend and link object databases (DB)	ROM

BLOCK_ERR parameter

BLOCK_ERR parameter shows diagnostic faults of hardware and software components within the transmitter. Each block object in the transmitter device application contains a **BLOCK_ERR** parameter. **BLOCK_ERR** is actually a bit string, which provides a means to show multiple status or error conditions. A status message identifying the fault can be viewed by accessing the parameter. Table 3 shows the bit mapping of the **BLOCK_ERR** parameter.

Background Diagnostics Execution, BLOCK_TEST parameter

To verify that block and background diagnostics are executing in a particular block:

View the **BLOCK_TEST** parameter of the block.

- If the first element of the parameter **BLOCK_TEST** is incrementing, the block is executing and the diagnostics are active.
- If the first element value is not increasing, the block is not executing.

Transmitter Diagnostics

Transmitter faults are grouped into one of these three diagnostic categories and could cause the following results:

1. **Non-Critical Fault** — Transmitter continues to calculate PV output.
2. **Critical Fault** — Transmitter drives PV output to failsafe state.
3. **Block Configuration Errors** — Incorrect parameter values causes the transmitter to generate a fault, for example, **BLOCK_ERR** or **MODE_BLK** = OOS.

A description of each condition in each category is provided in Table 32, Table 33 and Table 34. The condition is described, a probable cause is stated and a recommended corrective action is given for each fault.

Function Block Faults

Checking the status and values of key block parameters helps in identifying the type of function block fault whether it is critical or non-critical. Table 32 helps in identifying the type of function block fault and provides corrective action to restore normal operation.

Table 32: Identifying Critical and Non-critical Function block faults

Block. Parameter	Value	Fault Type	Action
AI.OUT =	Bad/sensor failure	Critical	See **AI.BLOCK_ERR** for message. See Table 3 for details on **BLOCK_ERR**. See **BLOCK_ERR** of all blocks in device for message. See Table 34.
STATUS =	Bad/device failure	Critical	See **AI.BLOCK_ERR** for message. See Table 3. See **BLOCK_ERR** of all blocks in device for message. See Table 34
	Good/constant Uncertain	Non-critical	See Table 33
AI.ALARM_SUM. CURRENT =	Block alarm	Critical/ Non-critical	See **BLOCK_ERR** of all blocks in the device in Table 3.
	Process alarm	Non-critical	See Table 33.
All Blocks **BLOCK_ERR**=	Block Configuration Error (1)	Non-critical	Check the value of all configurable parameters in the block and correct if necessary. See Resolving the block configuration errors.
See Table 3 for description of **BLOCK_ERR** (messages)	Simulation Active (3)	Non-critical	Set "simulate jumper" to "N" on the electronics board, and set the **ENABLE_DISABLE** field to “1” of the **SIMULATE** parameter. See section 6.5.
	Input Failure/Process Variable has Bad Status (7)	Critical	Write Processor or (4) to **RESTART** parameter of resource block. If failure continues, replace the meter body.
	Memory Failure (9)	Critical	Set Resource block to OOS.
	Lost Static Data (10)	Critical	Write Processor or (4) to RESTART parameter.
	Lost NV Data (11)	Critical	Wait for 10 seconds.

Block. Parameter	Value	Fault Type	Action
	Readback Check Failed (12)	Critical	See Critical Fault NOTE.
	Out-of-Service (15)	Non-critical	Write proper mode to **MODE_BLK** parameter.
Unable to write values to valid device parameters.		Configuration Error	See "Resolving the block configuration errors".

ATTENTION

Depending on the fieldbus interface application, device operating status and parameter values may appear as text messages. The text in the table is typical of values or messages seen when using the NI-FBUS configurator.

Critical Fault

In the case of a critical fault due to Memory Failure, NV/Static data loss or the readback check failure, writes to the **RESTART** parameter twice, for the transmitter to fully recover from the fault condition. Therefore:

1. Write "4" or "restart processor" to **RESTART** parameter of resource block.
2. Wait until communication is established.
3. If the fault occurs again, repeat the write to the **RESTART** parameter.
4. If the fault occurs again, replace the transmitter electronics module.

Note that if a ROM error (Memory Failure) occurs in the resource block, it may take up to 10 seconds for the fault to reappear.

Table 33 summarizes the conditions that could cause a non-critical fault in the transmitter along with recommended actions to correct the fault.

Table 33: Summary of Function blocks Non-critical Faults

Problem/Fault	Probable Cause	Recommended Action
AI block is executing, but status of OUT parameter is: Good::[alarm status]:Constant	AI block is in Manual mode.	Write AUTO to **MODE_BLK** parameter of AI block.
AI block is executing, but status of OUT parameter is: Uncertain::[alarm status]: inaccurate	Transducer block parameter **CAL_SOURCE** = NONE, or a value of "1" (using default characterization values).	Recalibrate transmitter See Calibration Recalibrate transmitter.
	Excess span correction - correction at **CAL_POINT_HI** is greater than 5% of **CAL_POINT_HI**.	See Calibration Recalibrate transmitter.
	Excess zero correction - correction at **CAL_POINT_LO** is greater than 5% of the "URL" (characterized range of the sensor).	See Calibration for Zero Correct
	Meter-body overload - pressure input is greater than two times the rated sensor pressure.	Reduce pressure at sensor. Check range and, if required, replace the transmitter with one that has a wider range.
	PV value of transducer block is outside range of **XD_SCALE**. When AI block **CHANNEL** = 1(OR) **OUT** value of AI block is outside of **OUT_SCALE** range.	Meter body may have been damaged. Check the transmitter for accuracy and linearity. Replace the meter body and recalibrate, if needed.
AI block is executing, but status of OUT parameter is: One of the following AI alarms is active in **ALARM_SUM.CURRENT**	HI_HI, HI, LO, LO_LO - **OUT** has crossed the corresponding limit HI_HI_LIM, HI_LIM, LO_LIM, LO_LO_LIM, and is either still past the limit or is in the hysteresis range. **ALARM_HYS** is the percentage of **OUT_SCALE** that is used for alarm hysteresis.	Reduce the value or increase limits.
	Block alarm.	Check **BLOCK_ERR** for status bit. See Table 3

Table 34 summarizes the conditions that could cause a critical fault in the transmitter along with recommended actions to correct the fault.

Table 34: Summary of Function blocks Critical Faults

Problem/Fault	Probable Cause	Recommended Action
AI block is executing, but status of output is: Bad:[alarm status]: sensor failure	Transducer board generates: a) Meter body fault. b) Characterization PROM fault. c) Electronics fault. d) Suspect input. e) Sensor over temperature - sensor temperature is greater than 125 °C (257 °F).	a) and b) Write "4" or “restart processor” to **RESTART** parameter of resource block. If failure still exists, replace the meter body. c) and d) Write "4" or “restart processor” to **RESTART** parameter of resource block. If failure still exists, replace the transmitter electronics module. e) Reduce temperature at sensor. Take steps to insulate meter body from temperature source.
AI block is executing, but status of output is: Bad::[alarm status]: device failure	Transducer board has stopped communicating with the stack board.	Write "4" “or “restart processor” to **RESTART** parameter of resource block. If failure is still present, replace transmitter electronics module.

6.5 Understanding simulation mode

About simulation mode jumper

If the process is not running, a simulation mode is available in the transmitter which aids in system debug. When simulation mode is enabled, the **SIMULATE** parameter in the AI block provides a user-selected value as the input to the AI block.

Setting simulation jumper

A hardware jumper on the transducer board is set to enable or disable the **SIMULATE** parameter. See Figure 19 for jumper location.

Table 35 shows how to set the simulation jumper on the transducer board.

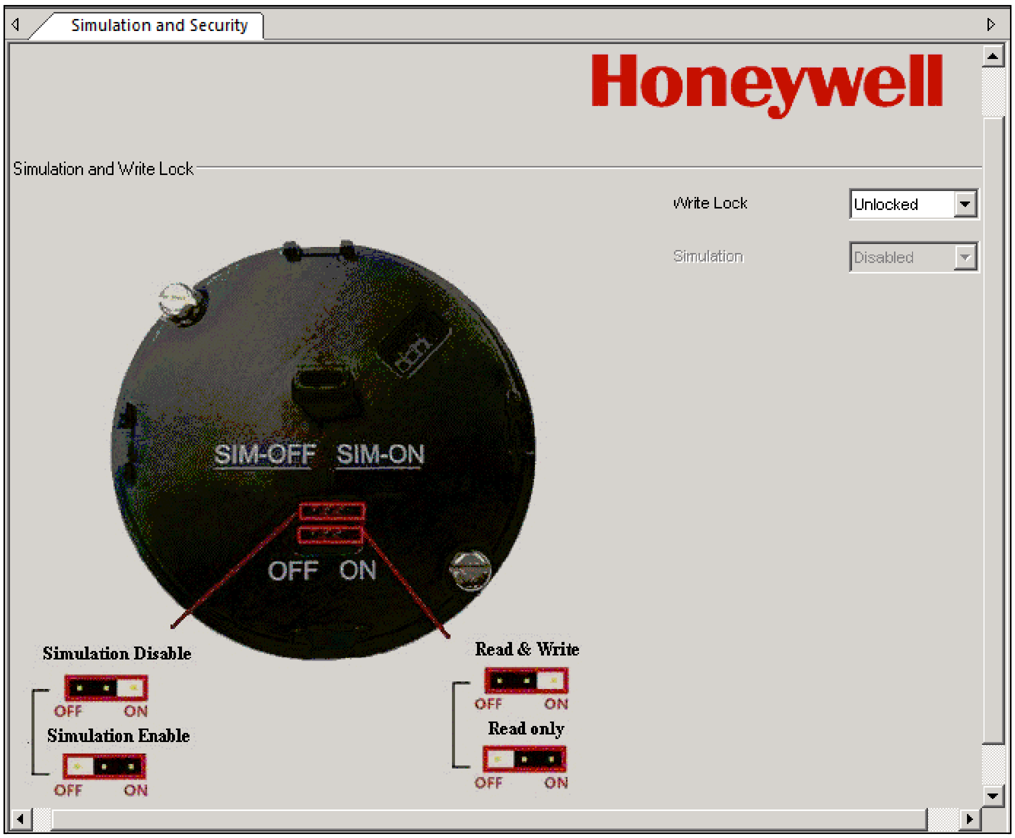
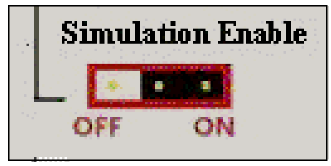


Figure 19: Simulation Jumper Location on Transducer Board

Table 35: Setting the Simulation Jumper

To	Set the Jumper to:
Disable the **SIMULATE** parameter. (Set transmitter for normal operation.)	"OFF" position on the Transducer board. 
Enable the **SIMULATE** parameter. (For testing or debugging purposes.)	"ON" position on the Transducer board. 

Enabling simulation mode

The SIMULATE parameter is enabled by setting the hardware simulation jumper to the "ON" position.

In addition, the AI block **SIMULATE** parameter must be set to the following values:

- **SIMULATE.STATUS** = Good::[alarm status]:constant (suggested setting)
- **SIMULATE.SIMULATE_VALUE** = (supplied by user) Used as the input to the AI block.
- **SIMULATE.ENABLE_DISABLE** = Active Enabled.

Simulation mode truth table

Table 36 shows the states of the simulation jumper and **SIMULATE** parameter shows how to activate the simulation mode.

Table 36: Simulation Mode Truth Table

When the Simulation Jumper on Transducer board is set to:	and the SIMULATE Enable_Disable is set to:	
	(Disabled)	(Active)
"OFF" Position	Simulation Disabled	Simulation Disabled
"ON" Position	Simulation Disabled	Simulation Active

Setting AI block mode

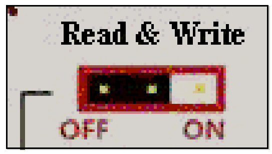
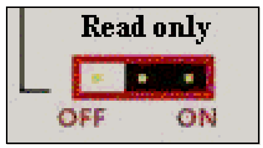
To connect the AI block input to the output, the AI block must be in AUTO mode.

6.6 Understanding write protection

The software write lock feature can be enabled, only if the hardware write lock feature is disabled. If the software write lock feature is enabled without disabling the hardware write lock feature, then the software write lock feature gets disabled automatically. If the hardware write lock feature is selected with the hardware jumper being enabled, the selection is rejected. See Figure 19 for jumper location.

For more information on write protection, see Table 37.

Table 37: Write lock

To	Set the Jumper to:
Disable the Read and Write lock. (In this mode, perform Read and Write operation.)	"OFF" position on the Transducer board. 
Enable the Write lock. (In this mode, read operation can be performed, but the write operation is disabled.)	"ON" position on the Transducer board. 

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