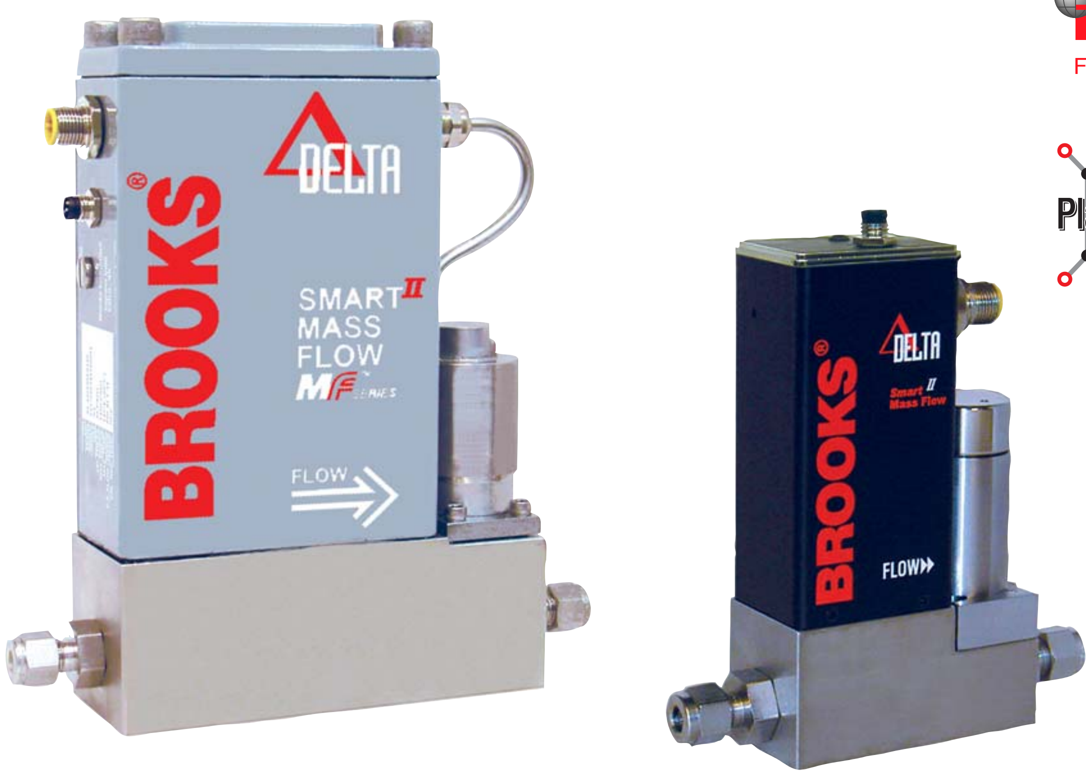
Installation and Operation Manual
X-DPT-Foundation Fieldbus-SLA5800-SLAMf Series-eng
Part Number: 541B115AAG
February, 2009

Supplemental Manual for Brooks® FOUNDATION™ Fieldbus Digital Mass Flow and Pressure Controllers

For SLA5800 Series and SLAMf Series



FOUNDATION

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Essential Instructions

Read this page before proceeding!

Brooks Instrument designs, manufactures and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use and maintain them to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, using and maintaining Brooks Products.

- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, please see back cover for local sales office contact information. Save this instruction manual for future reference.
- If you do not understand any of the instructions, contact your Brooks Instrument representative for clarification.
- Follow all warnings, cautions and instructions supplied with the product.
- Inform and educate your personnel in the proper installation, operation and maintenance of the product.
- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Brooks Instrument. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

ESD (Electrostatic Discharge)

CAUTION

This instrument contains electronic components that are susceptible to damage by electricity. Proper handling procedures must be observed during the removal, installation, or other handling of internal circuit boards or devices.

Handling Procedure:

1. *Power to unit must be removed.*
2. *Personnel must be grounded, via a wrist strap or other safe, suitable means before any printed circuit card or other internal device is installed, removed or adjusted.*
3. *Printed circuit cards must be transported in a conductive container. Boards must not be removed from protective enclosure until immediately before installation. Removed boards must immediately be placed in protective container for transport, storage or return to factory.*

Comments

This instrument is not unique in its content of ESD (electrostatic discharge) sensitive components. Most modern electronic designs contain components that utilize metal oxide technology (NMOS, SMOS, etc.). Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

Dear Customer,

We recommend that you read this manual in its entirety as this will enable efficient and proper use of the FOUNDATION Fieldbus SLA58xx and SLAMfxx Series devices. Should you require any additional information concerning these devices, please feel free to contact your local Brooks Sales and Service Office; see back cover for contact information, or visit us on the web at www.BrooksInstrument.com. We appreciate this opportunity to service your fluid measurement and control requirements, and trust that we will be able to provide you with further assistance in future.

Yours sincerely,

Brooks Instrument

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1. Introduction

1.1. Description

1.1.1. General Description

The SLA58xx and SLAMFxx series offers a complete line of Mass Flow Meter, Controller and Pressure Controller devices to use in you low flow applications.

The SLA series has the ability to support industrial networking and communication. For a complete list, please contact your local Brooks Sales and Service Office; see the back cover for contact information, or visit us on the web at www.BrooksInstrument.com..

1.1.2. FOUNDATION Fieldbus Description

In addition to the features provided by the SLA series devices, Brooks Instrument offers the option of FOUNDATION Fieldbus H1 digital communication. Due to the power consumption of the electronically valve control system, these devices use a separate power source and use only a minimum amount of power from the Fieldbus network to ensure proper communication.

These devices fully comply with FOUNDATION Fieldbus specification, allowing their use with the host of your choice.

Each device contains:

- 1 Standard Resource Block
- 2 Standard Analog Output Blocks
- 4 Standard Analog Input Blocks

- 1 Standard Digital Output Block
- 1 PID Block
- 1 Multivariable Transducer Block

To take advantage of the advanced diagnostics, Brooks Instrument is using the PlantWeb® Alerts platform[1]. These diagnostics include critical information on the device health and may indicate important change in the process. Preventive maintenance information is also available through PlantWeb.

1.2. How to Use This Manual

It is recommended that you read this manual before installing or using the FOUNDATION Fieldbus device.

The manual assumes that you are already familiar with the Brooks Instrument SLA devices and FOUNDATION Fieldbus.

Please refer to the user manual associated to the device for a complete description of usage.

Table 1-1 Manual Cross-Reference

Device Type	Manual	Part number
SLAMfxx (Mass Flow Devices)	X-TMF-SLAMf-MFC-ENG	541B032AHG
SLA58xx (Mass Flow Devices)	X-TMF-5800-MFC-ENG	541B027AHG
SLA58xx (Pressure Devices)	X-TMF-5800-PC-ENG	541B091AHG

For more information on FOUNDATION Fieldbus, please visit the following web site for more detailed information; www.fieldbus.org .

This manual is organized into the following sections:

Section 1: introduction

Section 2: Installation

Section 3: Hardware Information

Section 4: Function Block Implementations

Section 5: FOUNDATION Fieldbus Function Blocks

[1] ∗ PlantWeb® is available only with an Emerson Process host. Data may still be read through other host but, usually, cannot generate alerts and warning automatically

Section 6: FOUNDATION Fieldbus Resource Block

Section 7: Transducer Blocks Reference

Section 8: Troubleshooting

Section 9: (Informative) Calibration

1.3. Glossary

AI	Analog Input
AO	Analog Output
Auto	Automatic state
CFF	Common File Format files
DD	Device Description files
DO	Discrete Output
FF	FOUNDATION fieldbus
ITK	Interoperability Test Kit
Macro Cycle	FOUNDATION Fieldbus token ring cycle time
MFC	Mass Flow Controller
MFM	Mass Flow Meter
OOS	Out of service device state
PC	Pressure Controller
Segment	Single line of communication on FOUNDATION Fieldbus

2. Installation

⚠CAUTION

Safe operation is dependent on proper installation and validation of the system and software.

Installation of the FOUNDATION Fieldbus devices is specific to the host; please refer to the host manual to properly install your device. The latest Device Description (DD) and Common File Format (CFF) files can be found in the Registered Product Catalog section of the FOUNDATION Fieldbus web site: www.fieldbus.org. Our device (click here to directly go to the web site) is filed as "Brooks Instrument SLA Series" under "Emerson Process Management" manufacturer and the "Flow" category

The following diagram represents a typical installation. Brooks Instrument FOUNDATION Fieldbus devices are H1 compatible only.

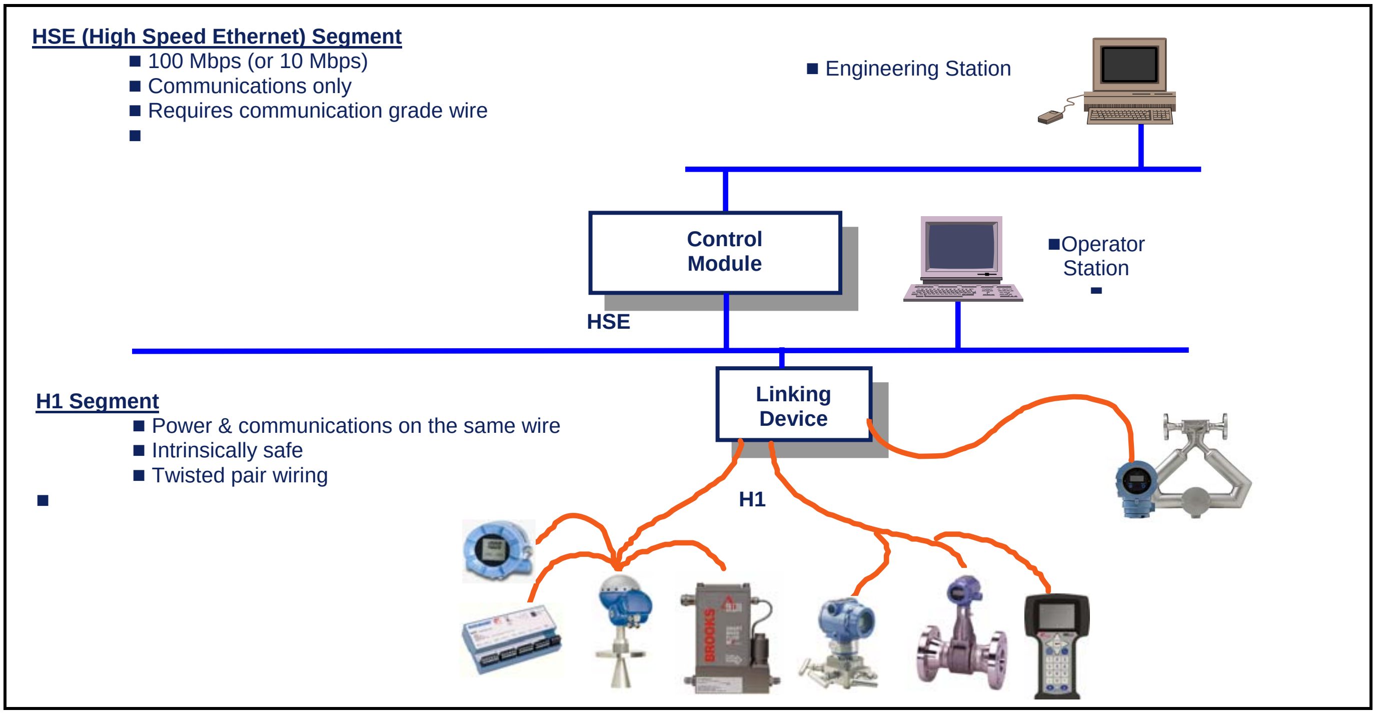

Figure 2-1 Typical FOUNDATION Fieldbus Installation

2.1. FOUNDATION Fieldbus Technology

FOUNDATION fieldbus is an all digital, serial, two-way communication system that interconnects field equipment such as sensors, actuators, and controllers. Fieldbus is a Local Area Network (LAN) for instruments used in both process and manufacturing automation with built-in capability to distribute the control application across the network. The fieldbus environment is the base level group of digital networks in the hierarchy of plant networks.

The fieldbus retains the desirable features of the 4–20 mA analog system, including a standardized physical interface to the wire, bus powered devices on a single wire, and intrinsic safety options, and enables additional capabilities, such as:

- Increased capabilities due to full digital communications
- Reduced wiring and wire terminations due to multiple devices on one set of wires
- Increased selection of suppliers due to interoperability
- Reduced loading on control room equipment with the distribution of some control and input/output functions to field devices

2.2. Requirements

- The device must be used within the range of calibration; failure to do so may lead to hazardous situation endangering the user. Please refer to the device user manual for proper usage and installation.
- FOUNDATION Fieldbus power requirements must be met.

Table 2-1 Device Power Consumption

DC Voltage	Current Consumption
14 to 27 V	491 mA for controllers, 245 mA for meters

- Device grounding must be provided, either by cable shielding or mechanical ground connection.
- Shielded power cable is recommended. Please use part #: PKG 4M-*/S90/S101 from Turck® (www.turck.com) or equivalent.

- The FOUNDATION Fieldbus communication connection must respect the host specification, especially in matter of number of devices allowed per segment and network speed.

- Shielded FOUNDATION Fieldbus Communication cable is recommended. For Eurofast connection, please use part #: RKS 4.4T-* from Turck® (www.turck.com) or equivalent.

- Discrete connections must comply with the FOUNDATION Fieldbus specification. Refer to the FOUNDATION Fieldbus web site, www.fieldbus.org, for more information.

2.3. Device Servicing

Please refer to the associated user manual (for a listing of the manuals, refer to Table 1-1 on page 2) for a complete description on how to properly service the device.

2.4. Device Connection

Wiring of the device is realized through direct connection with the exception of the conduit option. There is no internal device wiring required.

Note: For ease of installation, the Brooks Instrument FOUNDATION Fieldbus devices are designed to be insensitive to the polarity of the network cable. FOUNDATION Fieldbus network polarity may be specified in the rest of this manual for reference only.

2.4.1. FF Communication – EuroFast Connector

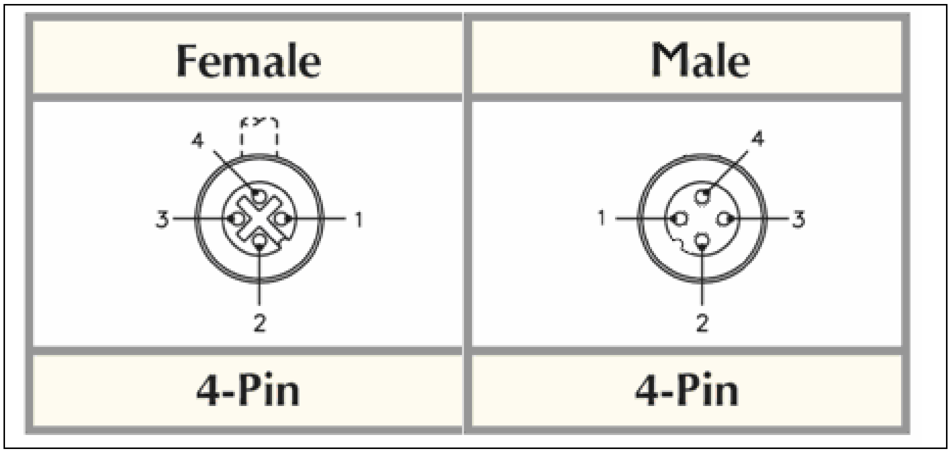

Figure 2-2 EuroFast Connector Pin-outs

Table 2-2 Device Communication Connection

Pin	Color	Detail
1	Brown	Signal
2	White	Signal
3	Blue	Bare
4	Black	Shield

- Pin 3 and 4 are optional.
- Shield is recommended for EMI/RFI protection

2.4.2. Power Connection – PicoFast Connector

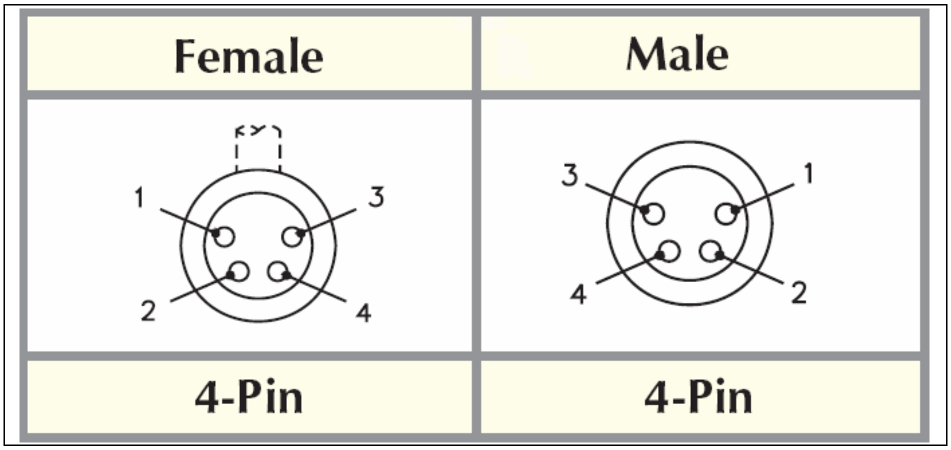

Figure 2-3 PicoFast Connector Pin-outs

Table 2-3 Device Power Consumption

Pin	Color	Detail
1	Brown	VCC (14 to 27 VDC)
2	White	Not Connected
3	Blue	DC Ground
4	Black	Not Connected

- Shield is recommended for EMI/RFI protection.

2.4.3. MFxx Wiring

2.4.3.1. EuroFast Option

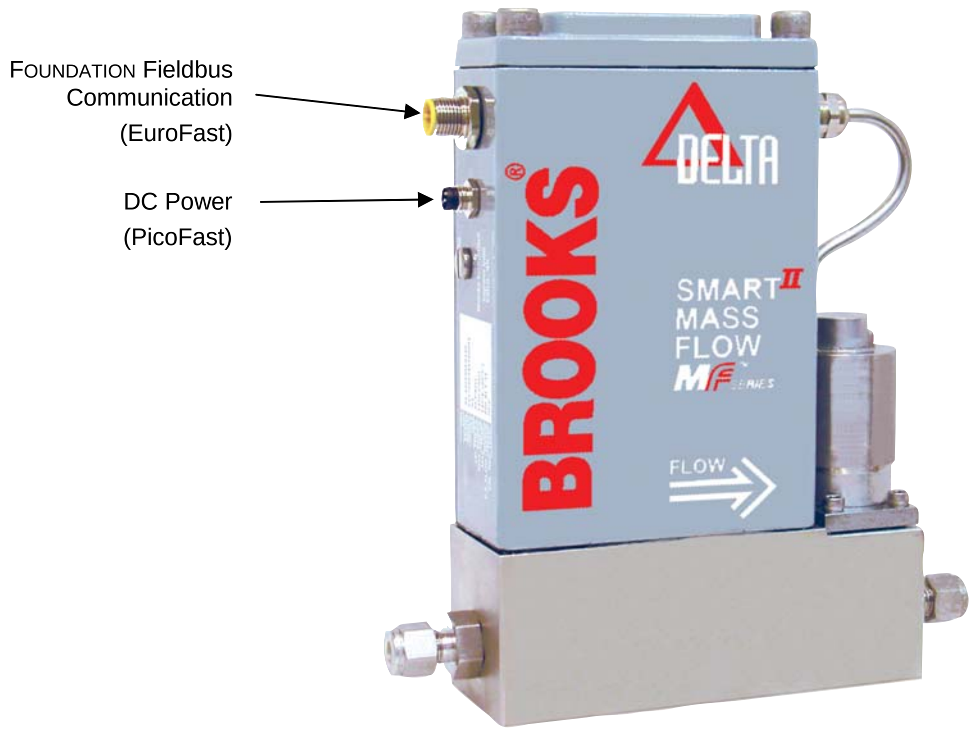

Figure 2-4 EuroFast Option Connections

Refer to the previous topics for wiring details.

2.4.3.2. Conduit Option

Figure 2-5 Terminals for Conduit Option

To connect to the device using a conduit:

1. Open the top part of the MFxx device and the Interface PC will be exposed.
2. Insert the power and communication cable through the appropriate fitting.
3. Use the screw terminals to establish network and power connection.

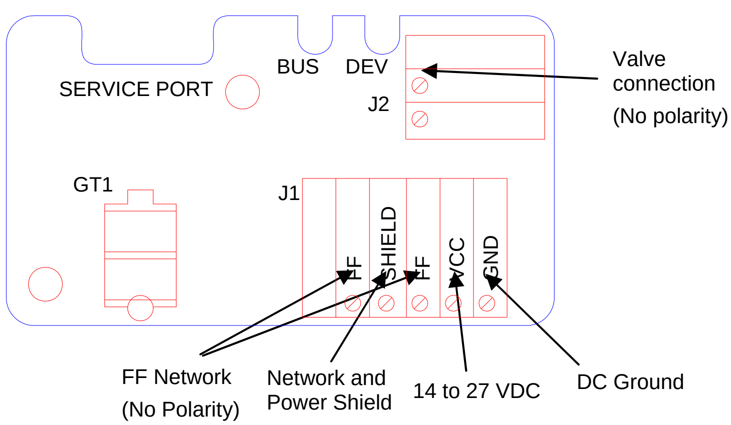

Figure 2-6 Terminals Board Connection

2.4.4. 58xx Wiring

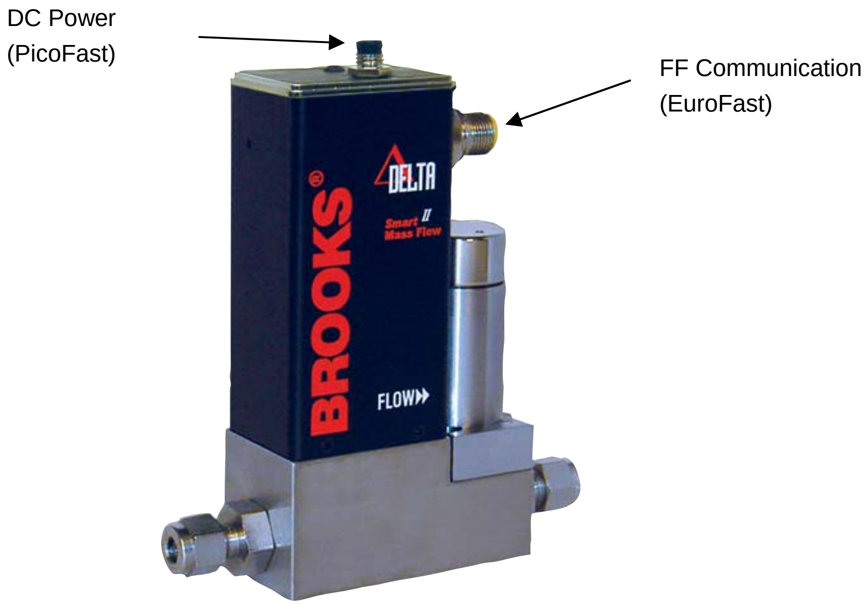

Figure 2-7 58xx Connections

Refer to the previous topics for wiring details.

2.5. Device Addressing

With a new device and depending on the host system, a first time device addressing may take up to 3 minutes. Typically, when the device has been already addressed, the device will appear on the network in less than 45 seconds.

Typically, when the device is connected to the FF, the Master will appear with a unique address (DEV_ID); for example **0002461000-BROOKS-0x…..** , where:

- **000246** is the Brooks Instrument Manufacturer code. This registered with the FOUNDATION Fieldbus.
- **1000-BROOKS** is the device identification. All the devices of the SLAxx series are using the same device identification. Distinction between the devices is represented buy the Module Type in the Resource Block.
- The final part of the DEV_ID is the serial number of the FOUNDATION Fieldbus communication board.

The DEV_ID will be replaced by a unique electronic TAG if requested upon order.

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3. Hardware Information

3.1. Communication System

The SLAxxx series implements a dual processor technique to achieve fast and accurate Fieldbus communication and proper controller or measure. The Sensor board handles the process while the Network board handles the communication. This technique insures a fast and deterministic communication system, allowing the device to perform according to specification under the highest of stress due to communication.

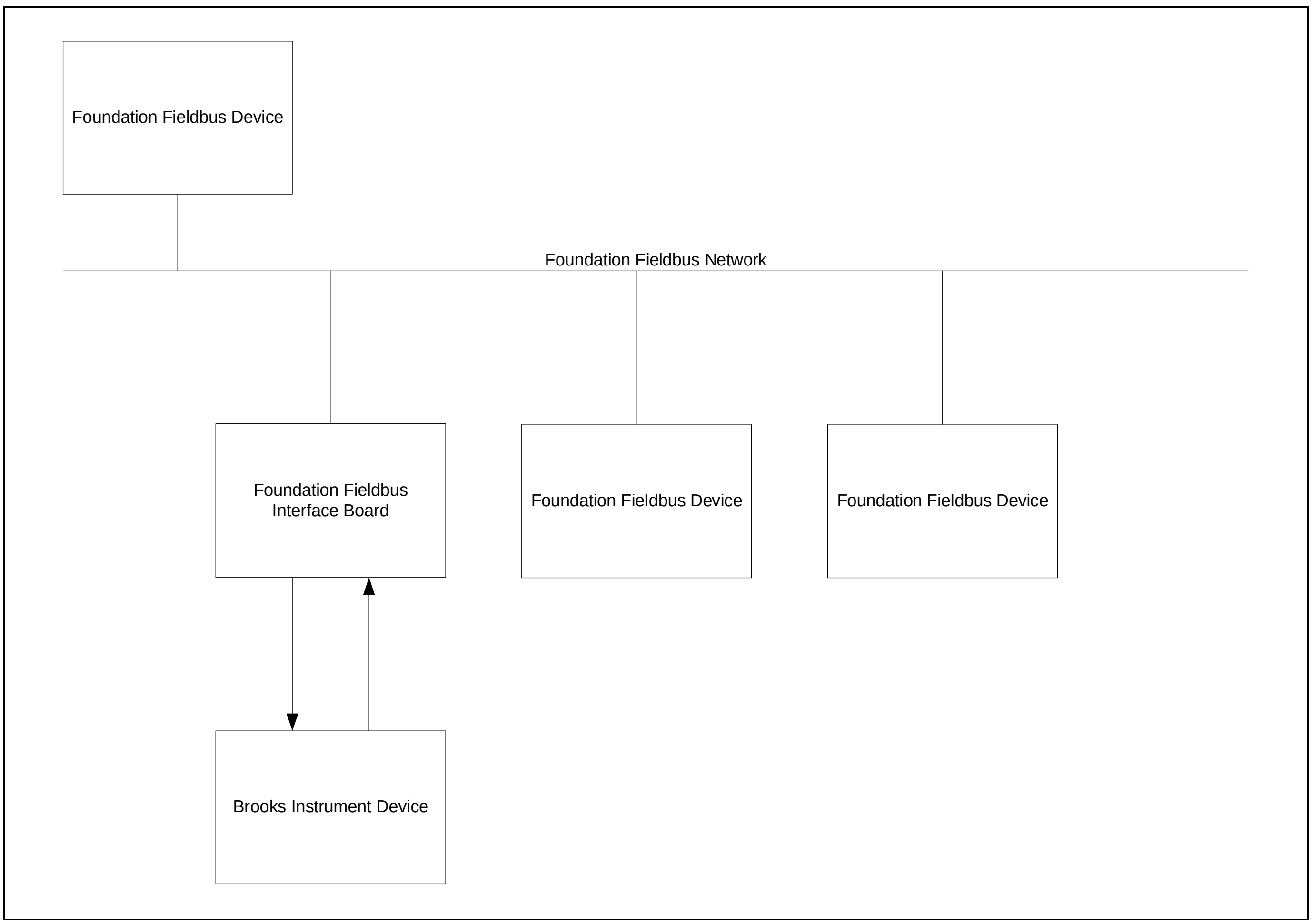

Figure 3-1 Sample FOUNDATION Fieldbus Network Diagram

3.2. LED interface

The SLA58xx series has two LEDs that indicate the device and network status.

Table 3-1 SLA58xx Series LED Indicators

DEV LED	**BUS LED**	**Device Status**
Off	Off	Device is not powered.
Blinking	Off	Device is Resetting.
Green	Blinking	Device is Ready but not connected to a Master.
Green	Green	Device is Ready and is connected to a Master.
Green	Red	Internal communication was lost, the device will not perform.
Green	Off	Internal Communication never occurred, the device will not perform.
Red	Any	Critical Error, the device will not perform.

4. Function Block Implementations

All devices have the ability to support multiple function blocks.

Table 4-1 Function Blocks – General Information

Type	**Quantity**	**Timing**	**Possible Linked**
AO	2	8 ms	Flow or pressure Setpoint Valve position
AI	4	5 ms	Flow Pressure Flow Sensor Temperature Current Valve Position
DO	1	8 ms	Valve override function
PID	1	8 ms	PID control for cascade process

Some hosts will use the Common File Format (CFF) file to link the function blocks to the fixed channel number. If those channels are not set properly, the value will not be readable, the device will stay in Out Of Service (OOS) state, or the value return will have a 'Bad' Status.

Table 4-2 Function Blocks – Channel Number

Device Data Type	**Type**	**Channel**
Setpoint (Flow or pressure)	AO	1
Valve Control	AO	2
Flow	AI	3
Pressure	AI	4
Valve Position	AI	5
Flow sensor Temperature	AI	6
Valve Override	DO	7
Cascade PID	PID	N/A

Note: AO, AI and DO function blocks do not need to be cascaded to use the device.

4.1. Function Block

4.1.1. AI – Flow

The AI – Flow represents the current flow detected by the device sensor. This AI is valid only for MFC and MFM devices. Querying the AI – Flow on a PC will return a Bad status. This information is valid only if the transducer block and the AI – Flow function block are in Auto mode.

If an invalid engineering unit is selected, the function block will stay in 'OOS' mode and the block error will indicate "Configuration Error".

4.1.2. AI – Pressure

The AI – Pressure represents the current pressure detected by the device sensor. This AI is valid only for PC devices. Querying the AI – Pressure on a MFM or a MFC will return a Bad status. This information is valid only if the transducer block and the AI – Pressure function block are in Auto mode.

If an invalid engineering unit is selected, the function block will stay in 'OOS' mode and the block error will indicate "Configuration Error".

4.1.3. AI – Temperature

The AI – Temperature represents the current flow sensor temperature detected by the device sensor. This AI is valid only for MFC and MFM devices. Querying the AI – Temperature on a PC will return a Bad status. This information is valid only if the transducer block and the AI – Temperature function block are in Auto mode.

Sensor temperature is available only in Celsius. This information may be used use for diagnostics, alarms, or trending. The value returned by the device represents the internal temperature of the flow sensor, not the processed gas temperature.

4.1.4. AI – Valve position

The AI – Valve Position represents the current valve position in percent of drive. This AI is valid only for controller (MFC and PC) devices. Querying the AI – Valve Position on a MFM will return a Bad status. This information is valid only if the transducer block and the AI – Temperature function block are in Auto mode.

The valve position varies from 0 to 100% of drive. Normal range of operation is indicated by the VALVE_SPAN and VALVE_OFFSET (refer to "Brooks Instrument Custom Valve Controller Transducer Block" on page 38). This value may be use to indicate for diagnostics, alarms, and trending. Change in process and device failure will drastically change the valve drive during normal operation. The user may use an alarm on those values to preemptively detect process failure.

Example:

A device will operate from 27.3% of drive (VALVE_OFFSET) to 54.7% (VALVE_SPAN) during normal operation, controlling from 0 to 100% of full scale at the calibrated range of pressure. If the valve position reports a value outside this range (+ or – a reasonable amount of uncertainty of 10%), it could conclude that either:

- The process gas property has changed. Change in density or pressure will affect the amount of opening of the valve.
- The device is having trouble to properly control the process due to valve or sensor clogging. Trending the valve position versus the setpoint over a long period of time can generate enough historical data to indicate that a device is on the verge of failure.

These values are specific per device and process; alarms values need to be adjusted accordingly by the user.

4.1.5. AO – Setpoint

The AO – Setpoint represents the requested value of control. This value is device specific; setpoint is in flow units for MFCs and pressure units for PCs. AO – Setpoint is not valid for MFM and will return a bad status.

AO – Setpoint is controlling the internal PID. In order to satisfy the PID loop (output equals the requested input) XD_SCALE must match the corresponding AI (flow for MFCs and pressure for PCs) XD_SCALE. If the XD_SCALE unit is different from the corresponding AI or the requested value is out of range, the block will switch mode to IMAN and a Bad status will be returned.

AO – Setpoint is used only if the Valve override DO is set to ‘Normal’ (State 0).

AO – Setpoint allows the device to use its internal PID controller. The internal controller is running at a much faster rate that the FOUNDATION Fieldbus PID. The controller device can match only specification by using the internal PID. Although available, disabling the internal PID controller is not recommended, as the FOUNDATION Fieldbus PID controller will have to run at the macro cycle rate.

4.1.6. AO – Valve Control

The AO – Valve Control represents the requested value of valve position. AO – Valve Control is not valid for MFM and will return a Bad status.

The AO – Valve Control varies from 0 to 100% of drive.

AO – Valve control is used only if the Valve override DO is set to ‘Open Loop’ (State 1).

Controlling the valve directly allows device calibration and process specific operation such as venting or cascade control.

Although not recommended, AO – Valve control also allows using the predefined FOUNDATION Fieldbus PID control of the valve. Valve control timing will be linked to the macro cycle. At the point, the device cannot guaranty that overshoot and response time are within specifications.

4.1.7. DO – Valve Override

DO – Valve Override controls the valve behavior according to a preset number of cases. DO – Valve Override is not valid for MFM and will return a Bad status.

DO – Valve Override offers the following states.

Table 4-3 Function Blocks – Channel Number

DO State	VOR State	Description
State 0	Normal	The valve is controlled by the internal PID and is responding to AO – Setpoint changes.
State 1	Open loop	The valve is controlled by the AO – Valve Control.
State 2	Valve closed	The valve is internally commanded to fully close.
State 3	Valve open	The valve is internally commanded to fully open.
State 4	Valve Off	Remove all power to the valve; valve position depends on the device configuration (normally open or normally closed).
State 5	Valve Hold	Valve power stays constant to the last applied value.
State 6	Valve On	Apply maximum power to the valve; valve position depends on the device configuration (normally open or normally closed).

4.1.8. PID – Cascade PID

This function block is not linked to any internal data within the device. It can be used to the discretion of the user. It is recommended to use this function block as a cascade PID controlling the setpoint. Please refer to the host manual on how to setup this function block. Note that the PID function block executes in 8 ms and can be connected from and to other devices' function blocks, reducing macro cycle timing.

4.2. Function Blocks Implementation for Mass Flow Controllers (MFCs)

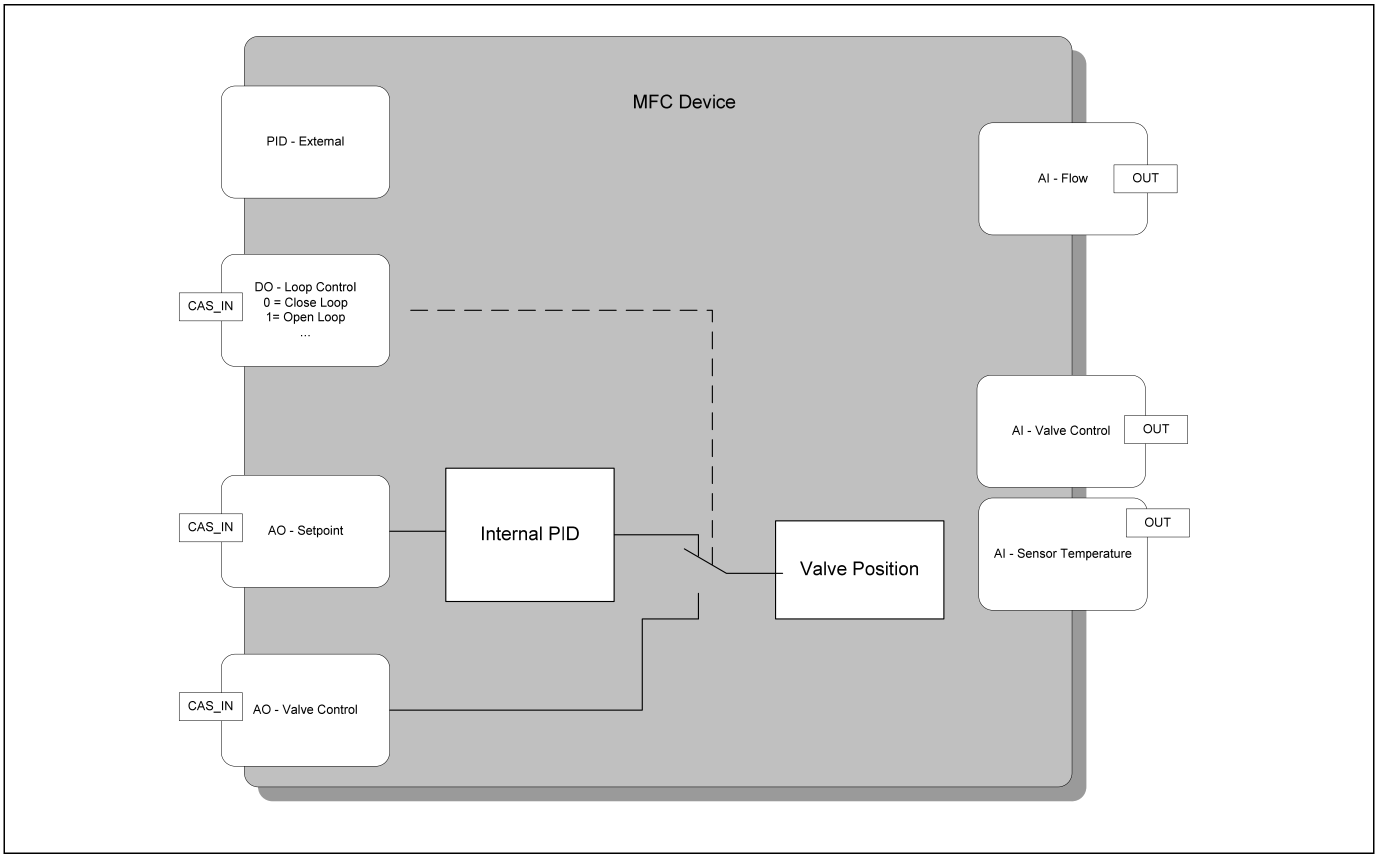

Figure 4-1 MFC Function Blocks Implementation

4.2.1. MFC Available Channels

Table 4-4 MFC – Available Channels

Device Data Type	Type	Channel
Setpoint (Flow)	AO	1
Valve Control	AO	2
Flow	AI	3
Valve Position	AI	5
Flow sensor Temperature	AI	6
Valve Override	DO	7
Cascade PID	PID	N/A

4.2.2. Function Block Units for MFC

- AO – Setpoint and AI – Flow

Table 4-5 MFC – Volumetric and Flow Unit

Value	Description (Host dependent)
Flow Rate	
1342	Percent (%)
1684	Standard Cubic Centimeter per Minute
1537	Standard Liter per Second
1538	Standard Liter per Minute
1539	Standard Liter per Hour
1347	Cubic Meter per Second
1348	Cubic Meter per Minute
1349	Cubic Meter per Hour
1356	Cubic Feet per Second
1357	Cubic Feet per Minute
1358	Cubic Feet per Hour
1362	Gallon Per Second
1363	Gallon Per Minute

Value	Description (Host dependent)
1364	Gallon Per Hour
1367	Imperial Gallon per Second
1368	Imperial Gallon per Minute
1369	Imperial Gallon per Hour
1371	Barrel per seconds
1372	Barrel per minutes
1373	Barrel per hours
Mass Rate	
1342	Percent (%)
1318	Gram per Second
1319	Gram per Minutes
1320	Gram per Hours
1322	Kilogram per Second
1323	Kilogram per Minute
1324	Kilogram per Hour
1326	Metric Ton per Second
1327	Metric Ton per Minute
1328	Metric Ton per Hour
1330	Pound per Second
1331	Pound per Minute
1332	Pound per Hour
1334	Tons per Second
1335	Tons per Minute
1336	Tons per Hour

- AI – Sensor Temperature

Table 4-6 MFC – Temperature Unit

Value	Description (Host dependent)
Temperature	
1001	Degree Celsius

- AO – Valve Control and AI – Valve position

Table 4-7 MFC – Valve position Unit

Value	**Description (Host dependent)**
Valve position	
1342	Percent (%)

Valve position and control are always expressed in % and controlled from 0 to 100.

4.3. Function Blocks Implementation for Mass Flow Meters (MFMs)

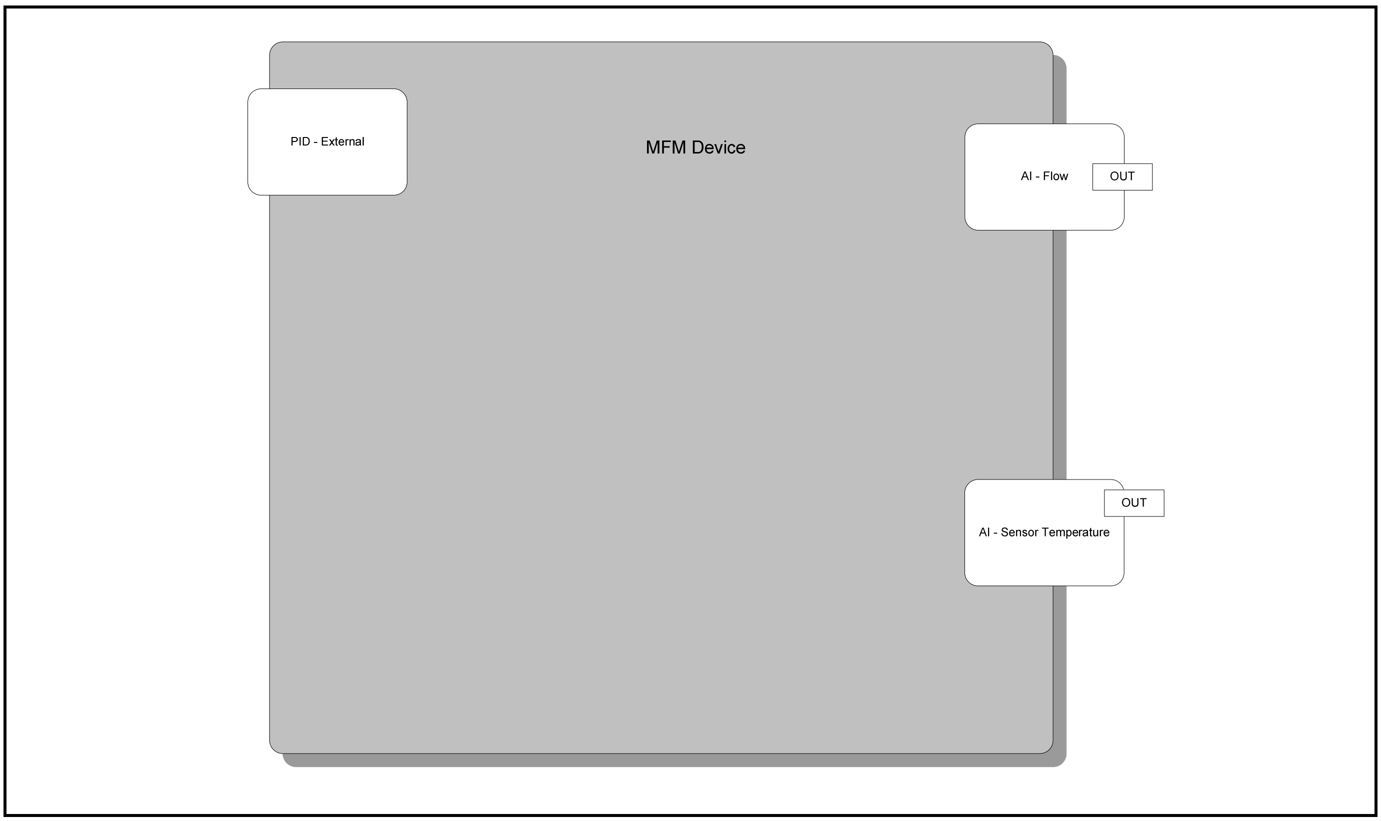

Figure 4-2 MFM Function Blocks Implementation

4.3.1. MFM Available Channels

Table 4-8 MFM – Available Channels

Device Data Type	**Type**	**Channel**
Flow	AI	3
Flow sensor Temperature	AI	6
Cascade PID	PID	N/A

4.3.2. Function Blocks Units for MFM

- AI – Flow

Table 4-9 MFM – Volumetric and Flow Unit

Value	**Description (Host dependent)**
Flow Rate	
1342	Percent (%)
1684	Standard Cubic Centimeter per Minute
1537	Standard Liter per Second
1538	Standard Liter per Minute
1539	Standard Liter per Hour
1347	Cubic Meter per Second
1348	Cubic Meter per Minute
1349	Cubic Meter per Hour
1356	Cubic Feet per Second
1357	Cubic Feet per Minute
1358	Cubic Feet per Hour
1362	Gallon Per Second
1363	Gallon Per Minute
1364	Gallon Per Hour
1367	Imperial Gallon per Second
1368	Imperial Gallon per Minute
1369	Imperial Gallon per Hour
1371	Barrel per seconds
1372	Barrel per minutes
1373	Barrel per hours
Mass Rate	
1342	Percent (%)
1318	Gram per Second
1319	Gram per Minutes
1320	Gram per Hours

Value	Description (Host dependent)
1322	Kilogram per Second
1323	Kilogram per Minute
1324	Kilogram per Hour
1326	Metric Ton per Second
1327	Metric Ton per Minute
1328	Metric Ton per Hour
1330	Pound per Second
1331	Pound per Minute
1332	Pound per Hour
1334	Tons per Second
1335	Tons per Minute
1336	Tons per Hour

- AI – Sensor Temperature

Table 4-10 MFC – Temperature Unit

Value	Description (Host dependent)
Temperature	
1001	Degree Celsius

4.4. Function Blocks Implementation for Pressure Controllers (PCs)

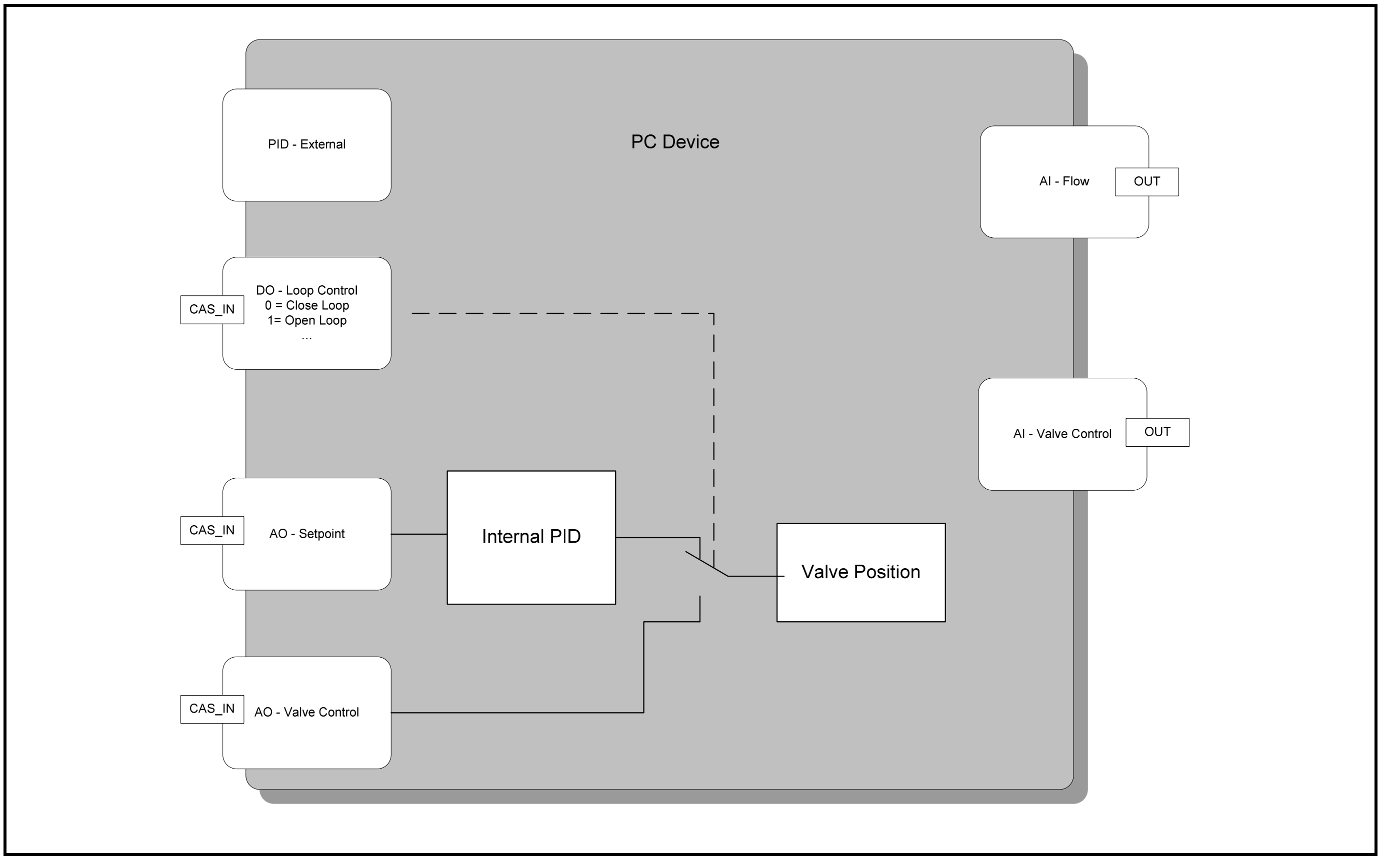

Figure 4-3 PC Function Blocks Implementation

4.4.1. PC Available Channels

Table 4-11 PC – Available Channels

Device Data Type	**Type**	**Channel**
Setpoint (Pressure)	AO	1
Valve Control	AO	2
Pressure	AI	4
Valve Position	AI	5
Valve Override	DO	7
Cascade PID	PID	N/A

4.4.2. Function Blocks Units for PC

- AO – Setpoint and AI - Pressure

Table 4-12 MFC – Pressure Unit

Value	Description (Host dependent)
Pressure	
1342	Percent (%)
1141	Pound per Square Inch
1139	Torr
1685	milliTorr
1158	Millimeters of Mercury (mmHg)
1156	Inches of Mercury (inHg)
1149	Millimeters of Water (mmH2O)
1146	Inches of Water (inH2O)
1137	Bar
1138	Millibar
1130	Pascal
1133	Kilopascal
1140	Atmosphere
1144	Grams per Square centimeter
1145	Kilograms per Square centimeter

Setpoint and pressure units (XD_SCALE) must match; failure to do so will result on the function block will return a “Bad” status and the BlockErr will show an output failure.

Range of XD_SCALE varies according to the device calibration.

- AO – Valve Control and AI – Valve position

Table 4-13 MFC – Valve Position Unit

Value	**Description (Host dependent)**
Valve Position	
1342	Percent (%)

Valve position and control are always expressed in % and controlled from 0 to 100.

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5. FOUNDATION Fieldbus Function Blocks

This section introduces fieldbus systems that are common to all fieldbus devices, including AI, AO, DO, and PID function blocks. The transducer function blocks present in the SLA Series transmitter are documented in Section 6.

5.1. Introduction

A fieldbus system is a distributed system composed of field devices and control and monitoring equipment integrated into the physical environment of a plant or factory. Fieldbus devices work together to provide I/O and control for automated processes and operations. The Fieldbus FOUNDATION provides a framework for describing these systems as a collection of physical devices interconnected by a fieldbus network. One of the ways the physical devices are used is to perform their portion of the total system operation by implementing one or more function blocks.

5.1.1. Function Blocks

Function blocks within the fieldbus device perform the various functions required for process control. Because each system is different, the mix and configuration of functions are different. Therefore, the Fieldbus FOUNDATION has designed a range of function blocks, each addressing a different need.

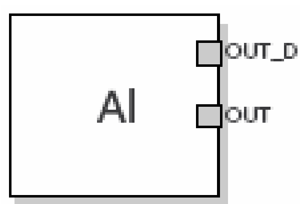
The Fieldbus FOUNDATION has established the function blocks by defining a small set of parameters used in all function blocks called universal parameters. They have also published definitions for transducer blocks commonly used with standard function blocks. Examples include temperature, pressure, level, and flow transducer blocks.

A block is a tagged logical processing unit. The tag is the name of the block. System management services locate a block by its tag. Thus the service personnel need only know the tag of the block to access or change the appropriate block parameters. Function blocks are also capable of performing short-term data collection and storage for reviewing blocks and their parameters.

5.1.2. Block Operation

In addition to function blocks, fieldbus devices contain two other block types to support the function blocks. These are the resource block and the transducer block. The resource block contains the hardware specific characteristics associated with a device. Transducer blocks couple the function blocks to local I/O functions.

5.2. Analog Input Function Block



OUT = The block output value and status
OUT_D = Discrete output that signals a selected alarm condition

Figure 5-1 Analog Input Function Block

The analog input (AI) function block processes field device measurements and makes them available to other function blocks. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement. The measuring device may have several measurements or derived values available in different channels. Use the channel number to define the variable that the AI block processes.

The AI block supports alarming, signal scaling, signal filtering, signal status calculation, mode control, and simulation. In Automatic mode, the block's output parameter (OUT) reflects the process variable (PV) value and status. In Manual mode, OUT may be set manually. The Manual mode is reflected on the output status. A discrete output (OUT_D) is provided to indicate whether a selected alarm condition is active. Alarm detection is based on the OUT value and user specified alarm limits. Table 5-1 on page 35 lists the AI block parameters and their units of measure, descriptions, and index numbers. AI block timing is illustrated in Figure 5-2 on page 38.

Table 5-1 Definitions of Analog Input Function Block System Parameters

Parameter	**Index Number**	**Units**	**Description**
ACK_OPTION	23	None	Used to set auto acknowledgment of alarm
ALARM_HYS	24	%	The amount the alarm value must return within the alarm limit before the associated active alarm condition clears
ALARM_SEL	38	None	Used to select the process alarm conditions that will cause the OUT_D parameter to be set
ALARM_SUM	22	None	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 will set 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.
ALERT_KEY	04	None	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
BLOCK_ALM	21	None	The block alarm is used for all configuration, hardware and connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status 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.
BLOCK_ERR	06	None	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.
CHANNEL	15	None	The CHANNEL value is used to select the measurement value. Refer to the appropriate device manual for information about the specific channels available in each device. You must configure the CHANNEL parameter before you can configure the XD_SCALE parameter.
FIELD_VAL	19	%	The value and status from the transducer block
GRANT_DENY	12	None	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. Not used by device.

Parameter	Index Number	Units	Description
HI_ALM	34	None	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
HI_HI_ALM	33	None	The HI HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
HI_HI_LIM	26	EU of PV_SCALE	The setting for the alarm limit used to detect the HI HI alarm condition
HI_HI_PRI	25	None	The priority of the HI HI alarm
HI_LIM	28	EU of PV_SCALE	The setting for the alarm limit used to detect the HI alarm condition
HI_PRI	27	None	The priority of the HI alarm
IO_OPTS	13	None	Allows the selection of I/O options used to alter the PV. Low cutoff enabled is the only selectable option.
L_TYPE	16	None	Linearization type. Determines whether the field value is used directly (Direct), is converted linearly (Indirect), or is converted with the square root (Indirect Square Root).
LO_ALM	35	None	The LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
LO_LIM	30	EU of PV_SCALE	The setting for the alarm limit used to detect the LO alarm condition
LO_LO_ALM	36	None	The LO LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
LO_LO_LIM	32	EU of PV_SCALE	The setting for the alarm limit used to detect the LO LO alarm condition
LO_LO_PRI	31	None	The priority of the LO LO alarm
LO_PRI	29	None	The priority of the LO alarm
LOW_CUT	17	%	If percentage value of transducer input fails below this, PV = 0.
MODE_BLK	05	None	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
OUT	08	EU of OUT_SCALE	The block output value and status
OUT_D	37	None	Discrete output to indicate a selected alarm condition

Parameter	Index Number	Units	Description
OUT_SCALE	11	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT
PV	07	EU of XD_SCALE	The process variable used in block execution
PV_FTIME	18	Seconds	The time constant of the first-order PV filter. It is the time required for a 63% change in the IN value.
STRATEGY	03	None	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ST_REV	01	None	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
TAG_DESC	02	None	The user description of the intended application of the block
UPDATE_EVT	20	None	This alert is generated by any change to the static data.
VAR_INDEX	39	% of OUT Range	The average absolute error between the PV and its previous mean value over that evaluation time defined by VAR_SCAN
VAR_SCAN	40	Seconds	The time over which the VAR_INDEX is evaluated
XD_SCALE	10	None	The high and low scale values, engineering unit code, and number of digits to the right of the decimal point associated with the channel input value. The XD_SCALE unit code must match the unit code of the measurement channel in the transducer block. If the units do not match, the block will not transition to MAN or AUTO.

5.2.1. Simulation

To support testing, you can either, change the mode of the block to manual and adjust the output value, or you can enable simulation through the configuration tool and manually enter a value for the measurement value and its status. In both cases, you must first set the ENABLE jumper on the field device.

Note: All fieldbus instruments have a simulation jumper. As a safety measure, the jumper has to be reset every time there is a power interruption. This measure is to prevent devices that went through simulation in the staging process from being installed with simulation enabled.

With simulation enabled, the actual measurement value has no impact on the OUT value or the status.

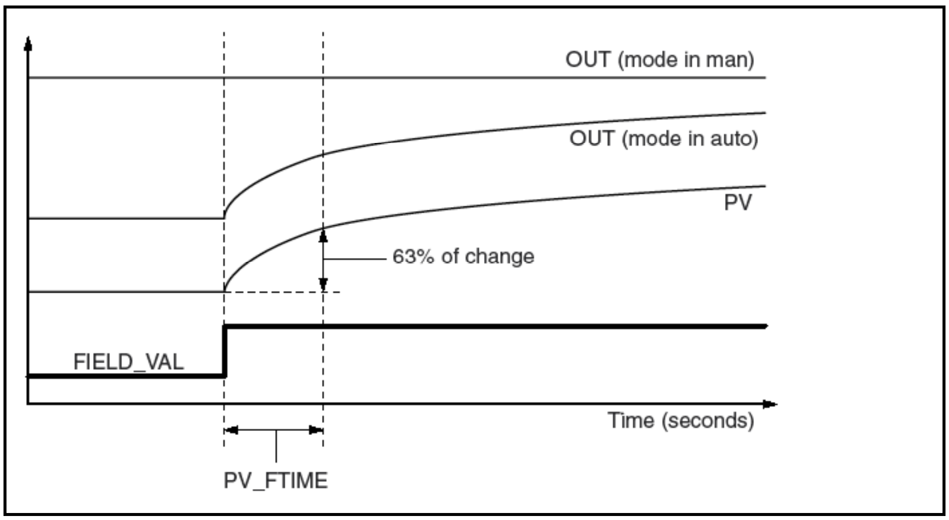


Figure 5-2 Analog Input Function Block Timing

5.2.2. Filtering

The filtering feature changes the response time of the device to smooth variations in output readings caused by rapid changes in input. You can adjust the filter time constant (in seconds) using the PV_FTIME parameter. Set the filter time constant to zero to disable the filter feature.

5.2.3. Signal Conversion

You can set the signal conversion type with the Linearization Type (L_TYPE) parameter. You can view the converted signal (in percent of XD_SCALE) through the FIELD_VAL parameter.

$$\text{FIELDVAL} = \frac{100 \times (\text{ChannelValue} - \text{EU}^* @ 0\%)}{\text{EU}^* @ 100\% - \text{EU} @ 0\%}$$

*XD_SCALE values

You can choose from direct, indirect, or indirect square root signal conversion with the L_TYPE parameter.

5.2.3.1. Direct

Direct signal conversion allows the signal to pass through the accessed channel input value.

5.2.3.2. Indirect

Indirect signal conversion converts the signal linearly to the accessed channel input value from its specified range (XD_SCALE) to the range and units of the PV and OUT parameters (OUT_SCALE).

$$\text{PV} = \left(\frac{\text{FIELD\_VAL}}{100}\right) \times (\text{EU}^{**} @ 100\% - \text{EU}^{**} @ 0\%) + \text{EU}^{**} @ 0\%$$

**OUT_SCALE values

5.2.3.3. Indirect Square Root

Indirect square root signal conversion takes the square root of the value computed with the indirect signal conversion and scales it to the range and units of the PV and OUT parameters.

$$\text{PV} = \sqrt{\frac{\text{FIELD\_VAL}}{100}} \times (\text{EU}^{**} @ 100\% - \text{EU}^{**} @ 0\%) + \text{EU}^{**} @ 0\%$$

**OUT_SCALE values

When the converted input value is below the limit specified by the LOW_CUT parameter, and the low cutoff I/O option (IO_OPTS) is enabled (True), a value of zero is used for the converted value (PV). This option is useful to eliminate false readings when the differential pressure measurement is close to zero, and it may also be useful with zero-based measurement devices such as flowmeters.

Note: Low cutoff is the only I/O option supported by the AI block. You can set the I/O option in manual or out of service mode only.

5.2.4. Block Errors

The following table lists conditions reported in the BLOCK_ERR parameter. Conditions in italics are inactive for the AI block and are given here only for your reference.

Table 5-2 BLOCK_ERR Conditions

Condition Number	Condition Name and Description
0	Other
1	Block Configuration Error: The selected channel carries a measurement that is incompatible with the engineering units selected in XD_SCALE, the L_TYPE parameter is not configured, or CHANNEL = zero.
2	Link Configuration Error
4	Local Override
5	Device Fault State Set
6	Device Needs Maintenance Soon
7	Input Failure/Process Variable has Bad Status: The hardware is bad, or a bad status is being generated.
8	Output Failure: The output is bad based primarily upon a bad input.
9	Memory Failure
10	Lost Static Data
11	Lost NV Data
12	Readback Check Failed
13	Device Needs Maintenance Now
14	Power Up
15	Out of Service: The actual mode is out of service.

5.2.5. Modes

The AI function Block supports three modes of operation as defined by the MODE_BLK parameter:

- **Manual (Man).** The block output (OUT) may be set manually.
- **Automatic (Auto).** OUT reflects the analog input.
- **Out of Service (O/S).** The block is not processed. FIELD_VAL and PV are not updated and the OUT status is set to Bad: Out of Service. The BLOCK_ERR parameter shows Out of Service. In this mode, you can make changes to all configured parameters. The target mode of a block may be restricted to one or more of the supported modes.

5.2.6. Alarm Detection

A block alarm will be generated whenever the BLOCK_ERR has an error bit set. The types of block error for the AI block are defined in Table 5-2.

Process alarm detection is based on the OUT value. You can configure the alarm limits of the following standard alarms:

- High (HI_LIM)
- High high (HI_HI_LIM)
- Low (LO_LIM)
- Low low (LO_LO_LIM)

In order to avoid alarm chattering when the variable is oscillating around the alarm limit, an alarm hysteresis in percent of the PV span can be set using the ALARM_HYS parameter. The priority of each alarm is set in the following parameters:

- HI_PRI
- HI_HI_PRI
- LO_PRI
- LO_LO_PRI

The following table shows the five alarm priority levels.

Table 5-3 Alarm Priority Levels

Priority Number	Priority Description
0	The priority of an alarm condition changes to 0 after the condition that caused the alarm is corrected.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator, but does not require operator attention. Examples include diagnostics and system alerts.
3–7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8–15	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

5.2.7. Status Handling

Normally, the status of the PV reflects the status of the measurement value, the operating condition of the I/O card, and any active alarm condition. In Auto mode, OUT reflects the value and status quality of the PV. In Man mode, the OUT status constant limit is set to indicate that the value is a constant and the OUT status is *Good*.

- **The Uncertain.** EU range violation status is always set, and the PV status is set high-or low-limited if the sensor limits for conversion are exceeded

  In the STATUS_OPTS parameter, you can select from the following options to control the status handling:

- **BAD if Limited.** Sets the OUT status quality of Bad when the value is higher or lower than the sensor limits
- **Uncertain if Limited.** Sets the OUT status quality to Uncertain when the value is higher or lower than the sensor limits
- **Uncertain if in Manual mode.** The status of the Output is set to Uncertain when the mode is set to Manual

Note: The instrument must be in Manual or Out of Service mode to set the status option.

Note: The AI block only supports the 'BAD if Limited' option. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

5.2.8. Advanced Features

The AI function block provided with Fisher-Rosemount fieldbus devices provides added capability through the addition of the following parameters:

- **ALARM_TYPE.** Allows one or more of the process alarm conditions detected by the AI function block to be used in setting its OUT_D parameter.
- **OUT_D.** Discrete output of the AI function block based on the detection of process alarm condition(s). This parameter may be linked to other function blocks that require a discrete input based on the detected alarm condition.
- **VAR_SCAN.** Time period in seconds over which the variability index (VAR_INDEX) is computed.
- **VAR_INDEX.** Process variability index measured as the integral of average absolute error between PV and its mean value over the previous evaluation period. This index is calculated as a percent of OUT span and is updated at the end of the time period defined by VAR_SCAN.

5.2.9. Troubleshooting

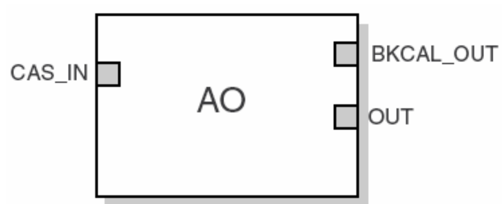
Refer to the following table to troubleshoot any problems that you encounter with the AI function block.

Table 5-4 Troubleshooting the AI Function Block

Symptom	**Possible Causes**	**Corrective Action**
Mode will not leave OOS	Target mode not set	Set target mode to something other than OOS.
	Configuration error	BLOCK_ERR will show the configuration error bit set. The following are parameters that must be set before the block is allowed out of OOS: • CHANNEL must be set to a valid value and cannot be left at initial value of 0. • XD_SCALE.UNITS_INDX must match the units in the transducer block channel value. • L_TYPE must be set to Direct, Indirect, or Indirect Square Root and cannot be left at initial value of 0.
	Resource Block	The actual mode of the Resource block is OOS.
	Schedule	Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.

Symptom	Possible Causes	Corrective Action
Process and/or block alarms will not work	Features	FEATURES_SEL does not have Alerts enabled. Enable the Alerts bit.
	Notification	LIM_NOTIFY is not high enough. Set equal to MAX_NOTIFY.
	Status Options	STATUS_OPTS has Propagate Fault Forward bit set. This should be cleared to cause an alarm to occur.
Cannot set HI_LIMIT, HI_HI_LIMIT, LO_LIMIT, LO_LO_LIMIT Values	Scaling	Limit values are outside the OUT_SCALE.EUO and OUT_SCALE.EU100 values. Change OUT_SCALE or set values within range.

5.3. Analog Output Function Block



CAS_IN = The remote setpoint value from another function block

BKCAL_OUT = The value and status required by the BKCAL_IN input of another block to prevent reset windup and to provide bumpless transfer to closed loop control

OUT = The block output and status

Figure 5-3 Analog Output Function Block

The analog Output (AO) function block assigns an output value to a field device through a specified I/O channel. The block supports mode control, signal status calculation, and simulation. The following table lists the definitions of the system parameters. AO block timing is illustrated in Figure 5-4 on page 46.

Table 5-5 Analog Output Function Block System Parameters

Parameters	Units	Description
BKCAL_OUT	EU of PV_SCALE	The value and status required by the BKCAL_IN input of another block to prevent reset windup and to provide bumpless transfer to closed loop control
BLOCK_ERR	None	The summary of active error conditions associated with the block. The block errors for the AO block are Input Failure/Process Variable has Bad Status, Output Failure, Read back Failed, and Out of Service.

Parameters	Units	Description
CAS_IN	EU of PV_SCALE	The remote setpoint value from another function block
IO_OPTS	None	Allows you to select how the I/O signals are processed. The supported I/O options for the AO function block are SP_PV Track in Man, Increase to Close, and Use PV for BKCAL_OUT.
CHANNEL	None	Defines the output that drives the field device
MODE	None	Enumerated attribute used to request and show the source of the setpoint and/or output used by the block
OUT	EU of XD_SCALE	The primary value and status calculated by the block in Auto mode. OUT may be set manually in Man mode
PV	EU of PV_SCALE	The process variable used in block execution. This value is converted from READBACK to show the actuator position in the same units as the setpoint value.
PV_SCALE	None	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
READBACK	EU of XD_SCALE	The measured or implied actuator position associated with the OUT value
SIMULATE	EU of XD_SCALE	Enables simulation and allows you to enter an input value and status.
SP	EU of PV_SCALE	The target block output value (setpoint)
SP_HI_LIM	EU of PV_SCALE	The highest setpoint value allowed
SP_LO_LIM	EU of PV_SCALE	The lowest setpoint value allowed
SP_RATE_DN	EU of PV_SCALE per second	Ramp rate for downward setpoint changes. When the ramp rate is set to 0, the setpoint is used immediately.
SP_RATE_UP	EU of PV_SCALE per second	Ramp rate for upward setpoint changes. When the ramp rate is set to zero, the setpoint is used immediately.
SP_WRK	EU of PV_SCALE	The working setpoint of the block. It is the result of setpoint rate-of-change limiting. The value is converted to percent to obtain the block’s OUT value.

5.3.1. Setting the Output

To set the output for the AO block, you must first set the mode to define the manner in which the block determines its setpoint. In Manual mode the value of the output attribute (OUT) must be set manually by the user, and is independent of the setpoint. In Automatic mode, OUT is set automatically based on the value specified by the setpoint (SP) in engineering units and the I/O options attribute (IO_OPTS). In addition, you can limit the SP value and the rate at which a change in the SP is passed to OUT.

In Cascade mode, the cascade input connection (CAS_IN) is used to update the SP. The back calculation output (BKCAL_OUT) is wired to the back calculation input (BKCAL_IN) of the upstream block that provides CAS_IN. This provides bumpless transfer on mode changes and windup protection in the upstream block. The OUT attribute or an analog readback value, such as valve position, is shown by the process value (PV) attribute in engineering units.

To support testing, you can enable simulation, which allows you to manually set the channel feedback. There is no alarm detection in the AO function block. To select the manner of processing the SP and the channel output value, configure the setpoint limiting options, the tracking options, and the conversion and status calculations.

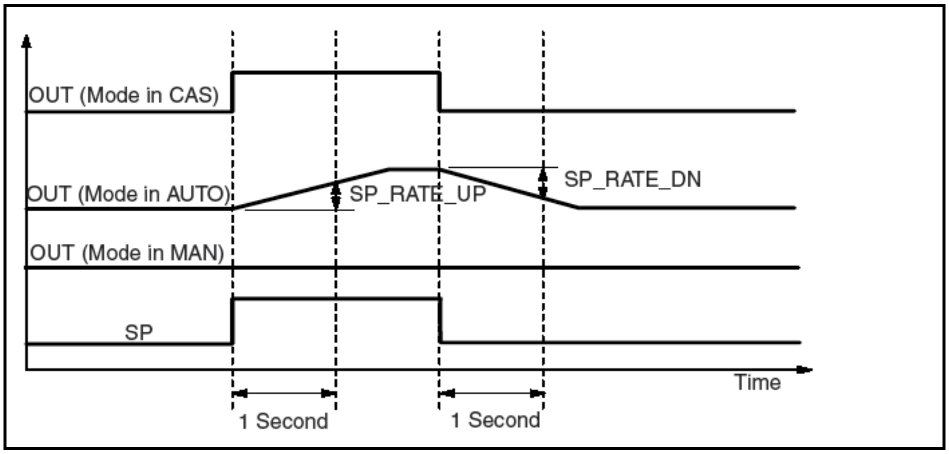


Figure 5-4 Analog Output Function Block Timing

5.3.2. Setpoint Selection and Limiting

To select the source of the SP value uses the MODE attribute. In Auto mode, the local, manually-entered SP is used. In Cascade (Cas) mode, the SP comes from another block through the CAS_IN input connector. In Remote Cascade (RCas) mode, the SP comes from a host computer that writes to RCAS_IN. The range and units of the SP are defined by the PV_SCALE attribute.

In Man mode the SP automatically tracks the PV value when you select the SP_PV Track in Man I/O option. The SP value is set equal to the PV value when the block is in manual mode, and is enabled (True) as a default. You can disable this option in Man or O/S mode only.

The SP value is limited to the range defined by the setpoint high limit attribute (SP_HI_LIM) and the setpoint low limit attribute (SP_LO_LIM) In Auto mode, the rate at which a change in the SP is passed to OUT is limited by the values of the setpoint upward rate limit attribute (SP_RATE_UP) and the setpoint downward rate limit attribute (SP_RATE_DN). A limit of zero prevents rate limiting, even in Auto mode.

5.3.3. Conversion and Status Calculation

The working setpoint (SP_WRK) is the setpoint value after limiting. You can choose to reverse the conversion range, which will reverse the range of PV_SCALE to calculate the OUT attribute, by selecting the Increase to Close I/O option. This will invert the OUT value with respect to the setpoint based on the PV_SCALE and XD_SCALE.

In Auto mode, the converted SP value is stored in the OUT attribute. In Man mode, the OUT attribute is set manually, and is used to set the analog output defined by the CHANNEL parameter. You can access the actuator position associated with the output channel through the READBACK parameter (in OUT units) and in the PV attribute (in engineering units). If the actuator does not support position feedback, the PV and READBACK values are based on the OUT attribute.

The working setpoint (SP_WRK) is the value normally used for the BKCAL_OUT attribute. However, for those cases where the READBACK signal directly (linearly) reflects the OUT channel, you can choose to allow the PV to be used for BKCAL_OUT by selecting the Use PV for BKCAL_OUT I/O option.

Note: SP_PV Track in Man, Increase to Close, and Use PV for BKCAL_OUT are the only I/O options that the AO block supports. You can set I/O options in Manual or Out of service mode only.

5.3.4. Action on Fault Detection

To define the state to which you wish the valve to enter when the CAS_IN input detects a bad status and the block is in CAS mode, configure the following parameters:

- **FSTATE_TIME.** The length of time that the AO block will wait to position the OUT value to the FSTATE_VAL value upon the detection of a fault condition. When the block has a target mode of CAS, a fault condition will be detected if the CAS_IN has a BAD status or an Initiate Fault State substatus is received from the upstream block.

- **FSTATE_VAL.** The value to which the OUT value transitions after FSTATE_TIME elapses and the fault condition has not cleared. You can configure the channel to hold the value at the start of the failure action condition or to go to the failure action value (FAIL_ACTION_VAL).

5.3.5. Block Errors

The following conditions are reported in the BLOCK_ERR attribute:

- **Input failure/process variable has *Bad* status.** The hardware is bad; the Device Signal Tag (DST) does not exist.
- **O/S.** The block is in Out of Service mode.
- **Output failure.** The output hardware is bad.
- **Readback failed.** The readback failed.

5.3.6. Modes

The analog output function block supports the following modes:

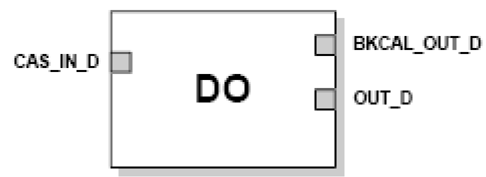
- **Man.** You can manually set the output to the I/O channel through the OUT attribute. This mode is used primarily for maintenance and troubleshooting.
- **Auto.** The block output (OUT) reflects the target operating pint specified by the setpoint (SP) attribute.
- **Cas.** The SP attribute is set by another function block through a connection to CAS_IN. The SP value is used to set the OUT attribute automatically.
- **RCas.** The SP is set by a host computer by writing to the RCAS_IN parameter. The SP value is used to set the OUT attribute automatically.
- **O/S.** The block is not processed. The output channel is maintained at the last value and the status of OUT is set to *Bad: Out of Service*. The BLOCK_ERR attribute shows *Out of Service*.
- **Initialization Manual (Iman).** The path to the output hardware is broken and the output will remain at the last position.
- **Local Override (LO).** The output of the block is not responding to OUT because the resource block has been placed into LO mode or fault state action is active. The target mode of the block may be restricted to one or more of the following modes: Man, Auto, Cas, RCas, or O/S.

5.3.7. Status Handling

Output or readback fault detection are reflected in the status of PV, OUT, and BKCAL_OUT. A limited SP condition is reflected in the BKCAL_OUT status. When simulation is enabled through the SIMULATE attribute, you can set the value and status for PV and READBACK.

When the block is in Cas mode and the CAS_IN input goes bad, the block sheds mode to the next permitted mode.

5.4. Digital Output Function Block



CAS_IN_D = The remote setpoint value from another function block.
BKCAL_OUT_D = The output value and status required by BKCAL_IN_D input of another block for output tracking.
OUT_D = The discrete output value and status

Figure 5-5 Digital Output Function Block

The Discrete Output (DO) function block processes a discrete setpoint and saves it to a specified channel to produce an output signal. The block supports mode control, output tracking, and simulation. There is no process alarm detection in the block. In operation, the DO function block determines its setpoint, sets the output, and, as an option, checks a feedback signal from the field device to confirm the physical output operation. Figure 5-6 on page 51 illustrates the internal components of the DO function block, and the following table lists the system parameters.

Table 5-6 Discrete Output Function Block System Parameters

Parameters	**Units**	**Description**
BKCAL_OUT_D	None	The value and status required by the BKCAL_IN_D input of another block for output tracking.
BLOCK_ERR	None	The summary of active error conditions associated with the block. The supported block errors in the Discrete Output function block are Input failure/process variable has Bad status, Output failure, read back failed, and Out of service. See System Support
CAS_IN_D	None	The remote set point value from another block.
IO_OPTS	None	Allows you to select how the I/O signals are processed. The supported I/O options for the Discrete Output function block are SP_PV Track in Man, Invert, and Use PV for BKCAL_OUT.
CHANNEL	None	Defines the output that drives the field device.
MODE	None	The mode record of the block. Contains the actual, target, permitted, and normal modes.
OUT_D	None	The discrete output value and status.

Parameters	Units	Description
PV_D	None	The discrete process variable calculated from READBACK_D.
READBACK_D	None	The discrete feedback from the output.
SIMULATE_D	None	Enables simulation.
SP_D	None	The discrete target block output value (setpoint).

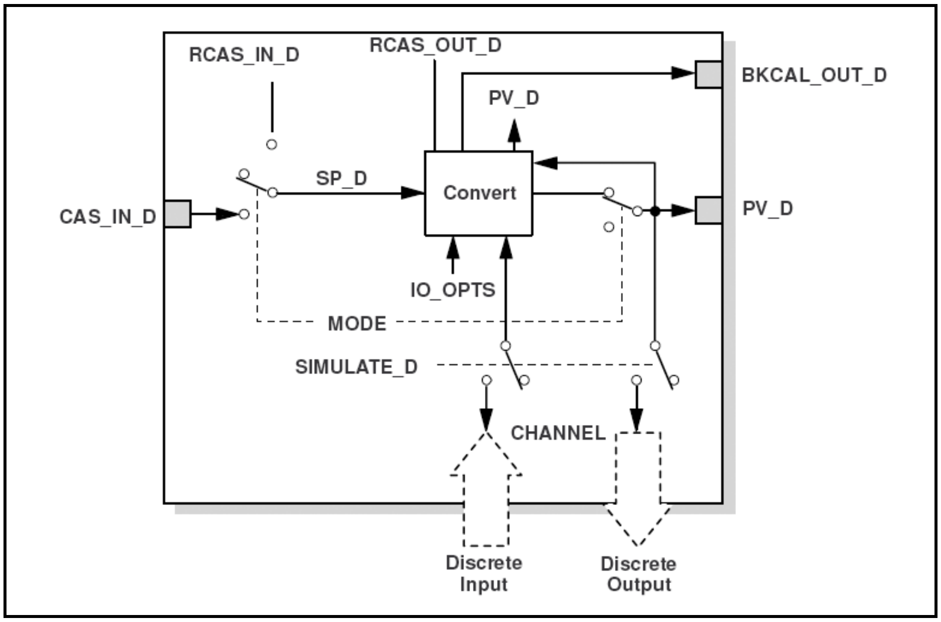


Figure 5-6 Discrete Input Function Block Schematic

5.4.1. Setting the Output

To set the output for the DO block, you must first set the mode to define the manner in which the block determines its setpoint. In Cascade mode, the setpoint equals the input value (CAS_IN_D). In Automatic or Manual mode, the setpoint must be entered manually by the user. In Remote Cascade mode, the setpoint is determined by a host computer that is writing to the RCAS_IN_D parameter.

To further customize the output, configure the SP_PV Track in Man, Invert, and Use PV for BKCAL_OUT I/O options.

Note: SP_PV Track in Man, Invert, and Use PV for BKCAL_OUT are the only I/O options supported by the DO block. You can configure I/O options in Manual or Out of Service mode only.

The SP_PV Track in Man option permits the setpoint to track the process variable when the block is in Manual mode. With this option enabled, the setpoint (SP_D) becomes a copy of the process variable (PV_D), and a manually-entered SP_D value is overwritten on the block's next execution cycle. This option can prevent a state change when transitional from Manual to Automatic mode. You can disable this option in Manual or Out of Service mode only.

The Invert option inverts the setpoint (SP_D) before it is stored in OUT_D. With this option enabled, OUT_D becomes an inverted copy of SP_D. With this option disabled, OUT_D is a direct copy of SP_D. If discrete output feedback is not supported by the field device, a copy of OUT_D is used in its place (with a delay of one execution time) to become READBACK_D. The readback value is processed through the Invert option to become PV_D, which normally matches SP_D in Auto, Cas, or RCas mode.

The Use PV for BKCAL_OUT option specifies that BKCAL _OUT equal the value of the process variable (PV_D) instead of the setpoint (SP_D). If you do not enable this option, BKCAL_OUT will equal SP_D.

5.4.2. Simulation

With SIMULATE_D enabled, the specified value and status is reflected in READBACK_D. If SIMULATE_D is not enabled, and the mode is not Out of Service, the value of OUT_D is sent to the hardware.

5.4.3. Action on Fault Detection

To determine the state to which the output goes if the block is in CAS mode and the CAS_IN input has a BAD status, configure the following parameters:

FSTATE_TIME The length of time that the AO block delays before setting OUT equal to FSTATE_VAL upon the detection of a fault condition. If the block's target mode is Cascade, a fault condition will be detected if the CAS_IN has a BAD status, or an Initiate Fault State substatus is received from the upstream block.

FSTATE_VALD The value to which the OUT_D attribute transitions if the length of time specified in FSTATE_TIME passes and the fault condition has not cleared. You can configure the channel to hold the value at the start of the fault action condition or to go to the Fault Action Value (FAULT_ACTION_VAL).

5.4.4. Block Errors

The following conditions are reported in the BLOCK_ERR attribute:

Simulate active SIMULATE_D is enabled; therefore, PV_D is not real.

Input failure/process variable has Bad status The readback value is bad.

Output failure The output hardware or the configured channel is invalid.

Readback failed The hardware providing readback is bad.

Out of service The block is not being processed.

5.4.5. Modes

The DO block supports the following modes:

Manual (Man) The block output (OUT_D) may be entered manually.

Automatic (Auto) The block algorithm uses the local setpoint value (SP_D) to determine OUT_D.

Cascade (Cas) The block uses a setpoint supplied by another function block.

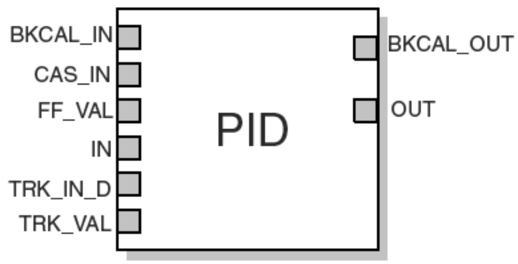
RemoteCascade (RCas) The block uses a setpoint supplied by a host computer.

Out of Service (O/S) The block is not processed and the output is not transferred to I/O. The BLOCK_ERR attribute shows Out of service.

5.4.6. Status Handling / Action on Failure

Under normal operating conditions, the output statuses (OUT_D and BKCAL_OUT_D) are Good: Cascade. If the output hardware fails, the status of BKCAL_OUT_D is set to Bad: DeviceFail, and the BLOCK_ERR attribute shows Output Failure. If the hardware used for output feedback fails, the status of READBACK_D and PV_D is set to Bad: DeviceFail, and the BLOCK_ERR attribute shows Bad PV and Readback Failed.

5.5. Proportional/Integral/Derivative Function Block



BKCAL_IN =The analog input value and status from another block's

BKCAL_OUT = Output that is used for backward output tracking for bumpless transfer and to pass limit status mode

CAS_IN = The remote setpoint value from another function block

FF_VAL = The feedforward control input value and status

IN = The connection for the process variable from another function block

TRK_IN_D = Initiates the external tracking function

TRK_VAL = The value after scaling applied to OUT in Local Override

BKCAL_OUT = The value and status required by the BKCAL_IN input of another function block to prevent reset windup and to provide bumpless transfer to closed loop control

OUT = The block output and status

Figure 5-7 Proportional/Integral/Derivative Function Block

The PID function block combines all of the necessary logic to perform proportional/integral/derivative (PID) control. The block supports mode control, signal scaling and limiting, feedforward control, override tracking, alarm limit detection, and signal status propagation.

The block supports two forms of the PID equation: Standard and Series. You can choose the appropriate equation using the FORM parameter. The Standard ISA PIK equation is the default selection.

$$\text{StandardOut} = \text{GAIN} \times e \times \left(1 + \frac{1}{\tau_r s + 1} + \frac{\tau_d s}{\alpha \times \tau_d s \times 1}\right) + F$$

$$\text{SeriesOut} = \text{GAIN} \times e \times \left[\left(1 + \frac{1}{\tau_r s}\right) + \left(\frac{\tau_d s + 1}{\alpha \times \tau_d s + 1}\right)\right] + F$$

Where

Gain: proportional gain value

τ_r : integral action time constant (RATE parameter) in seconds

s: laplace operator

τ_d: derivative action time constant (RATE parameter)

α: fixed smoothing factor of 0.1 applied to RATE

F: feedforward control contribution from the feedforward input (FF_VAL parameter)

e: error between setpoint and process variable

To further customize the block for use in your application, you can configure filtering, feedforward inputs, tracking inputs, setpoint and output limiting, PID equation structures, and block output action. The following table lists the PID block parameters and their descriptions, units of measure, and index numbers.

Table 5-7 PID Function Block System Parameters

Parameter	Number Index	Units	Description
ACK_OPTION	46	None	Used to set auto acknowledgment of alarms
ALARM_HYS	47	%	The amount the alarm value must return to within the alarm
			limit before the associated active alarm condition clears
ALARM_SUM	45	None	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 will set 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.
ALERT_KEY	04	None	The identification number of the plant unit. This information
			may be used in the host for sorting alarms, etc.
ALG_TYPE	74	None	Selects filtering algorithm as Backward or Bilinear
BAL_TIME	25	Seconds	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 will move to obtain balance when the output is limited and the mode is AUTO, CAS, or RCAS.
BIAS	66	EU of OUT_SCALE	The bias value used to calculate output for a PD type controller.
BKCAL_HYS	30	%	The amount that the output value must change away from its output limit before limit status is turned off, expressed as a percent of the span of the output
BKCAL_IN	27	EU of OUT_SCALE	The analog input value and status from another block's BKCAL_OUT output that is used for backward output tracking for bumpless transfer and to pass limit status
BKCAL_OUT	31	EU of PV_SCALE	The value and status required by the BKCAL_IN input of another block to prevent reset windup and to provide bumpless transfer of closed loop control

Parameter	Number Index	Units	Description
BLOCK_ALM	44	None	The block alarm is used for all configuration, hardware, connection failure, or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the active status in the status 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.
BLOCK_ERR	06	None	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.
BYPASS	17	None	Used to override the calculation of the block. When enabled, the SP is sent directly to the output.
CAS_IN	18	EU of PV_SCALE	The remote setpoint value from another block
CONTROL_OPTS	13	None	Allows you to 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 and Direct Acting.
DV_HI_ALM	64	None	The DV HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
DV_HI_LIM	57	EU of PV_SCALE	The setting for the alarm limit used to detect the deviation high alarm condition
DV_HI_PRI	56	None	The priority of the deviation high alarm
DV_LO_ALM	65	None	The DV LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
DV_LO_LIM	59	EU of PV_SCALE	The setting for the alarm limit used to detect the deviation low alarm condition
DV_LO_PRI	58	None	The priority of the deviation low alarm
ERROR	67	EU of PV_SCALE	The error (SP-PV) used to determine the control action
FF_ENABLE	70	None	Enables the use of feedforward calculations
FF_GAIN	42	None	The feedforward gain value. FF_VAL is multiplied by FF_GAIN before it is added to the calculated control output.
FF_SCALE	41	None	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_VAL	40	EU of FF_SCALE	The feedforward control input value and status
GAIN	23	None	The proportional gain value. This value cannot = 0.

Parameter	Number Index	Units	Description
GRANT_DENY	12	None	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.
HI_ALM	61	None	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
HI_HI_ALM	60	None	The HI HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
HI_HI_LIM	49	EU of PV_SCALE	The setting for the alarm limit used to detect the HI HI alarm condition
HI_HI_PRI	48	None	The priority of the HI HI alarm
HI_LIM	51	EU of PV_SCALE	The setting for the alarm limit used to detect the HI alarm condition
HI_PRI	50	None	The priority of the HI alarm
IN	15	EU of PV_SCALE	The connection for the PV input from another block
LO_ALM	62	None	The LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
LO_LIM	53	EU of PV_SCALE	The setting for the alarm limit used to detect the LO alarm condition
LO_LO_ALM	63	None	The LO LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm
LO_LO_LIM	55	EU of PV_SCALE	The setting for the alarm limit used to detect the LO LO alarm condition
LO_LO_PRI	54	None	The priority of the LO LO alarm
LO_PRI	52	None	The priority of the LO alarm
MATH_FORM	73	None	Selects equation form (series or standard)
MODE_BLK	05	None	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
OUT	09	EU of OUT_SCALE	The block input value and status
OUT_HI_LIM	28	EU of OUT_SCALE	The maximum output value allowed
OUT_LO_LIM	29	EU of OUT_SCALE	The minimum output value allowed

Parameter	Number Index	Units	Description
OUT_SCALE	11	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT
PV	07	EU of PV_SCALE	The process variable used in block execution
PV_FTIME	16	Seconds	The time constant of the first-order PV filter. It is the time required for a 63 percent change in the IN value.
PV_SCALE	10	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with PV
RATE	26	Seconds	The derivative action time constant
RCAS_IN	32	EU of PV_SCALE	Target setpoint and status that is provided by a supervisory host. Used when mode is RCAS.
RCAS_OUT	35	EU of PV_SCALE	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.
RESET	24	Seconds per repeat	The integral action time constant
ROUT_IN	33	EU of OUT_SCALE	Target output and status that is provided by a supervisory host. Used when mode is ROUT.
ROUT_OUT	36	EU of OUT_SCALE	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.
SHED_OPT	34	None	Defines action to be taken on remote control device timeout
SP	08	EU of PV_SCALE	The target block setpoint value. It is the result of setpoint limiting and setpoint rate of change limiting.
SP_FTIME	69	Seconds	The time constant of the first-order SP filter. It is the time required for a 63 percent change in the IN value.
SP_HI_LIM	21	EU of PV_SCALE	The highest SP value allowed
SP_LO_LIM	22	EU of PV_SCALE	The lowest SP value allowed
SP_RATE_DN	19	EU of PV_SCALE per second	Ramp rate for downward SP changes. When the ramp rate is set to zero, the SP is used immediately.
SP_RATE_UP	20	EU of PV_SCALE	Ramp rate for upward SP changes. When the ramp rate is set to zero, the SP is used immediately.

Parameter	Number Index	Units	Description
SP_WORK	68	EU of PV_SCALE	The working setpoint of the block after limiting and filtering is applied
STATUS_OPTS	14	None	Allows you to select options for status handling and processing. The supported status option for the PID block is Target to Manual is Bad IN.
STRATEGY	03	None	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ST_REV	01	None	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
STRUCTURE.CONFIG	75	None	Defines PID equation structure to apply controller action
TAG_DESC	02	None	The user description of the intended application of the block
TRK_IN_D	38	None	Discrete input that initiates external tracking
TRK_SCALE	37	None	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_VAL	39	EU of TRK_SCALE	The value (after scaling from TRK_SCALE) APPLIED to OUT in LO mode
UBETA	72	%	Used to set disturbance rejection vs. tracking response action for a 2.0 degree of freedom PID
UGAMMA	71	%	Used to set disturbance rejection vs. tracking response action for a 2.0 degree of freedom PID
UPDATE_EVT	43	None	This alert is generated by any changes to the static data.

5.5.1. Setpoint Selection and Limiting

The setpoint of the PID block is determined by the mode. You can configure the SP_HI_LIM and SP_LO_LIM parameters to limit the setpoint. In Cascade or RemoteCascade mode, the setpoint is adjusted by another function block or by a host computer, and the output is computed based on the setpoint.

In Automatic mode, the setpoint is entered manually by the operator, and the output is computed based on the setpoint. In Auto mode, you can also adjust the setpoint limit and the setpoint rate of change using the SP_RATE_UP and SP_RATE_DN parameters.

In Manual mode the output is entered manually by the operator, and is independent of the setpoint. In Remote Output mode, the output is entered by a host computer, and is independent of the setpoint. The following figure illustrates the method for setpoint selection.

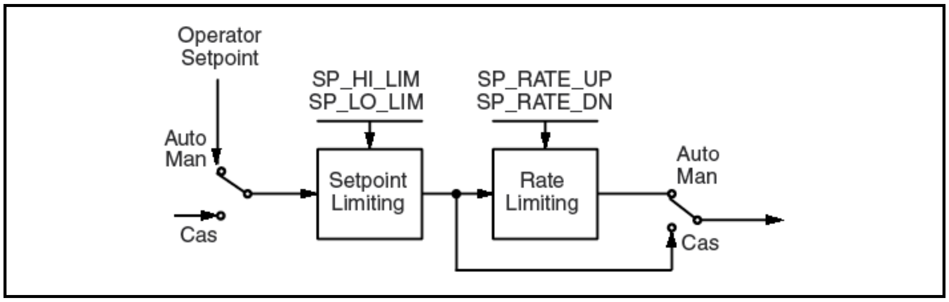


Figure 5-8 PID Function Block Setpoint

5.5.2. Filtering

The filtering feature changes the response time of the device to smooth variations in output reading caused by rapid changes in input. You can configure the filtering feature with the FILTER_TYPE parameter, and you can adjust the filter time constant (in seconds) using the PV_FTIME or SP_FTIME parameters. Set the filter time constant to zero to disable the filter feature.

5.5.3. Feedforward Calculation

The feedforward value (FF_VAL) is scaled (FF_SCALE) to a common range for compatibility with the output scale (OUT_SCALE). A gain value (FF_GAIN) is applied to achieve the total feedforward contribution.

5.5.4. Tracking

You enable the use of output tracking through the control options. You can set control options in Manual or Out of Service mode only. The Track Enable control option must be set to “True” for the track function to operate. When the Track in Manual control option is set to “True”, tracking can be activated and maintained only when the block is in Manual mode. When Track in Manual is False, the operator can override the tracking function when the block is in Manual mode. Activating the track function causes the block’s actual mode to revert to Local Override.

The TRK_VAL parameter specifies the value to be converted and tracked into the output when the track function is operating. The TRK_SCALE parameter specifies the range of TRK_VAL. When the TRK_IN_D parameter is “True” and the Track Enable control option is “True”, the TRK_VAL input is converted to the appropriate value and output in units of OUT_SCALE.

5.5.5. Output Selection and Limiting

Output selection is determined by the mode and the setpoint. In Automatic, Cascade, or Remote Cascade mode, the output is computed by the PID control equation. In Manual and RemoteOutput mode, the output may be entered manually. You can limit the output by configuring the OUT_HI_LIM and OUT_LO_LIM parameters.

5.5.6. Bumpless Transfer and Setpoint Tracking

You can configure the method for tracking the setpoint by configuring the following control options (CONTROL_OPTS):

- **SP-PV Track in Man.** Permits the SP to track the PV when the target mode of the block is Man.

- **SP-PV Track in Local Override (LO) or IMan.** Permits the SP to track the PV when the actual mode of the block is LO or IMan.

When one of these options is set, the SP value is set to the PV value while in the specified mode.

You can select the value that a master controller uses for tracking by configuring the Use PV for BKCAL_OUT control option. The BKCAL_OUT value tracks the PV value. BKCAL_IN on a master controller connected to BKCAL_OUT on the PID block in an open cascade strategy forces its OUT to match BKCAL_IN, thus tracking the PV from the slave PID block into its cascade input connection (CAS_IN). If the Use PV for BKCAL_OUT option is not selected, the working setpoint (SP_WRK) is used for BKCAL_OUT.

You can set control options in Manual or O/S mode only. When the mode is set to Auto, the SP will remain at the last value (it will no longer follow the PV).

5.5.7. PID Equation Structures

Configure the STRUCTURES parameter to select the PID equation structure. You can select one of the following choices:

- PI Action on Error, D Action on PV
- PID Action on Error
- Action on Error, PD Action on PV

Set RESET to zero to configure the PID block to perform integral only control regardless of the STRUCTURE parameter selection. When RESET equals zero, the equation reduces to an integrator equation with a gain value applied to the error:

$$\frac{GAIN \times e(s)}{s}$$

Where

Gain: proportional gain value
e: error
s: laplace operator

5.5.8. Reverse and Direct Action

To configure the block output action, enable the Direct Acting control option. This option defines the relationship between a change in PV and the corresponding change in output. With Direct Acting enabled (True), an increase in PV results in an increase in the output.

You can set control options in Manual or O/S mode only.

Note: Track Enable, Track in Manual, SP-PV Track in Man, SP-PV Track in LO or IMan, Use PV for BKCAK_OUT, and Direct Acting are the only control options supported by the PID function block. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

5.5.9. Reset Limiting

The PID function block provides a modified version of feedback reset limiting that prevents windup when output or input limits are encountered, and provides the proper behavior in selector applications.

5.5.10. Block Errors

Table 5-8 lists conditions reported in the BLOCK_ERR parameter. Conditions in *italics* are inactive for the PID block and are given here only for your reference.

Table 5-8 BLOCK_ERR Conditions

Condition Number	Condition Name and Description
0	*Other*
1	Block Configuration Error: The BY_PASS parameter is not configured and is set to 0, the SP_HI_LIM is less than the SP_LO_LIM, or the OUT_HI_LIM is less than the OUT_LO_LIM.
2	*Link Configuration Error*
3	*Simulate Active*
4	Local Override: The actual mode is LO.
5	*Device Fault State Set*
6	*Device Needs Maintenance Soon*
7	Input Failure/Process Variable has Bad Status: The parameter linked to IN is indicating a Bad status
8	*Output Failure*
9	*Memory Failure*
10	*Lost Static Data*
11	*Lost NV Data*
12	*Readback Check Failed*

Condition Number	Condition Name and Description
13	*Device Needs Maintenance Now*
14	*Power Up*
15	Out of Service: The actual mode is out of service

5.5.11. Modes

The PID function block supports the following modes:

- **Man.** The block output (OUT) may be set manually.
- **Auto.** The SP may be set manually and the block algorithm calculates OUT. Cas. The SP is calculated in another block and is provided to the PID block through the CAS_IN connection.
- **RCas.** The SP is provided by a host computer that writes to the RCAS_IN parameter.
- **Rout.** The OUT IS provided by a host computer that writes to the ROUT_IN parameter.
- **Local Override (LO).** The track function is active. OUT is set by TRK_VAL. The BLOCK_ERR parameter shows Local override.
- **IMan.** The output path is not complete (for example, the cascade-to-slave path might not be open). In IMan mode, OUT tracks BKCAL_IN.
- **O/S.** The block is not processed. The Out status is set to *Bad: Out of Service*. The BLOCK_ERR parameter shows Out of service. You can configure the Man, Auto, Cas and O/S modes as permitted modes for operator entry.

5.5.12. Alarm Detection

A block alarm will be generated whenever the BLOCK_ERR has an error bit set. The types of block error for the PID block are defined above. Process alarm detection is based on the PV value. You can configure the alarm limits of the following standard alarms:

- High (HI_LIM)
- High high (HI_HI_LIM)
- Low (LO_LIM)
- Low low (LO_LO_LIM)

Additional process alarm detection is based on the difference between SP and PV values and can be configured via the following parameters:

- HI_PRI
- HI_HO_PRI
- LO_PRI
- LO_LO_PRI
- DV_HI_PRI

The following table shows the five alarm priority levels.

Table 5-9 Alarm Priority Levels

Priority Number	Priority Description
0	The priority of an alarm condition changes to 0 after the condition that caused the alarm is corrected.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator, but does not require operator attention (such as diagnostics and system alerts).
3–7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8–17	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

5.5.13. Status Handling

If the input status on the PID block is Bad, the mode of the block reverts to Manual. In addition, you can select the Target to “Manually if Bad IN” status option to direct the target mode to revert to manual. You can set the status option in Manual or Out of Service mode only.

Note: Target to Manual if Bad IN is the only status option supported by the PID function block. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

5.5.14. Troubleshooting

Refer to the following table to troubleshoot any problems that you encounter with the PID function block.

Table 5-10 Troubleshooting the PID Function Block

Symptom	**Possible Causes**	**Corrective Action**
Mode will not leave OOS	Target mode not set	Set target mode to something other than OOS.
	Configuration error	BLOCK_ERR will show the configuration error bit set. The following are parameters that must be set before the block is allowed out of OOS: • BYPASS must be off or on and cannot be left at initial value of 0. • OUT_HI_LIM must be less than or equal to OUT_LO_LIM. • SP_HI_LIM must be less than or equal to SP_LO_LIM.
	Resource block	The actual mode of the Resource block is OOS.
	Schedule	Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
Mode will not leave IMAN	Back Calculation	BKCAL_IN • The link is not configured (the status would show “Not Connected”). Configure the BKCAL_IN link to the downstream block. • The downstream block is sending back a Quality of “Bad” or a Status of “Not Invited.”

Symptom	Possible Causes	Corrective Action
Mode will not change to CAS	Target mode not set	Set target mode to something other than OOS.
	Cascade	CAS_IN • The link is not configured (the status would show “Not Connected”). Configure the CAS_IN link to the block. • The upstream block is sending back a Quality of “Bad” or a Status of “Not Invited.” See the appropriate up stream block diagnostics for corrective action.
Mode sheds from RCAS to AUTO	Remote Cascade Value	Host system is not writing RCAS_IN with a quality and status of “good cascade” within shed time
	Shed Timer	The mode shed timer, SHED_RCAS in the resource block is set too low. Increase the value
Mode sheds from ROUT to MAN	Remote output value	Host system is not writing ROUT_IN with a quality and status of “good cascade” within shed time
	Shed timer	The mode shed timer, SHED_RCAS, in the resource block is set too low. Increase the value
Process and/or block alarms will not work.	Features	FEATURES_SEL does not have Alerts enabled. Enable the Alerts bit.
	Notification	LIM_NOTIFY is not high enough. Set equal to MAX_NOTIFY.
	Status Options	STATUS_OPTS has Propagate Fault Forward bit set. This should be cleared to cause an alarm to occur.

6. Resource Block Reference

6.1. Introduction

The Brooks devices have one resource block. The parameters and views are listed in this section.

6.2. Resource Block Overview

The resource block contains the hardware specific characteristics associated with a device; it has no input or output parameters. The resource block monitors and controls the general operation of other blocks within the device. For example, when the mode of the resource block is Out of Service, it impacts all function blocks.

6.3. Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
1		ST_REV	The revision level of the static data. Increments by one each time a static parameter changes. Static parameters are: 2, 3, 4, 5.3, 5.4, 9, 10, 11, 12, 13, 15, 17, 18, 19, 20, 21, 22, 23, 26, 27, 31, 32, 33, 34, 37.4, 38, 39	U16	0 to 65535	0	none	
2		TAG_DESC	The user description of the intended application of the block.	Octet String	7 bit ASCII	spaces	N/A	
3		STRATEGY	Used to help identify grouping of blocks. This data is not checked or processed by the block.	U16	0 to 65535	0	none	ALL

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
4		ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.	U8	1 to 255	0	none	ALL
5		MODE_BLK	"The target, actual, permitted, and normal modes of the block TARGET: Read / Write ACTUAL: Read Only PERMITTED: Read / Write NORMAL: Read / Write"	DS-69	**Valid Bits:** 7: O/S 6: IMAN actual mode only during initialization of device 3: AUTO **Valid Target** O/S AUTO **Permitted**: O/S + AUTO	O/S N/A 0x88 Auto	N/A	ALL
6		BLOCK_ERR	Error status associated with hardware or software for the Resource block. Lost Static Data bit is set until the next power up where static data is successfully read.	Bit String	0 = Inactive 1 = Active **Defined Bits** 3: Simulate Active 5: Device Fault State Set 6: Device needs Maintenance Soon 9: Memory Failure 10: Lost Static Data 12: Readback Check Failed 13: Device needs Maintenance Now. 14: Power-up 15: Out-of-Service (MSB)		N/A	N/A
7		RS_STATE	State of the function block application state machine	U8	**1 to 6** 1: Start/Restart **N/A** 2: Initialization, Actual mode = Iman 3: On-Line Linking **N/A** 4: On-line, Actual mode = Auto 5: Standby, Actual mode = O/S 6: Failure, Actual mode = O/S	5	Enum	N/A

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
8		TEST_RW	Read/Write Test Parameter This parameter may be used in interoperability testing to read and write all standard data types supported by the Fieldbus Foundation. The last value written will be maintained by the device until reset. Order is 1 – Boolean 2 – Integer8 3 – Interger16 4 – Interger326 5 – Unisigned8 6 – Unisigned16 7 – Unisigned32 8 – Floating point 9 – Visible String 10 – Octet String 11 – Date 12 – Time of Day 13 – Time Difference 14 – Bit String 15 – Time Value (DLL time)	DS-85	0 or " "	0	none	ALL
9		DD_RESOURCE	String identifying the VFD tag of the resource which contains the Device Description for this resource	Visible String		spaces		N/A
10		MANUFAC_ID	Manufacturer identification number, used by an interface device to locate the DD file for the resource	U32		0x0246		N/A
11		DEV_TYPE	Manufacturer's model number associated with the resource - used by an interface device to locate the DD for the resource	U16		SC=4601		N/A
12		DEV_REV	Manufacturer's revision number associated with the resource - used by an interface device to locate the DD file for the resource.	U8		0x01		N/A
13		DD_REV	Minimum compatible DD Revision of the DD associated with this device - used by an interface device to locate the DD file for the resource	U8		0x01		N/A
14		GRANT_DENY	Options for controlling access of host computer and local control panels to operating, tuning, and alarm parameters of the block. GRANT DENY	DS-70	**Valid Bits:** 0: Program 1: Tune 2: Alarm 3: Local	Grant = 0x00 Deny = 0x00		

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
15		HARD_TYPES	The types of hardware available as channel numbers on this resource	Bit String	**Valid Bits** 0 - Scalar Input (LSB) 1 - Scalar output 2 - Discrete input 3 - Discrete output	0x000A		N/A
16		RESTART	Allows a manual restart to be initiated. Several degrees of restart are possible. They are: 1: Run 2: Restart resource 3: Restart with defaults 4: Restart Processor	U8	**1 to 4** 1: Run 2: Restart resource 3: Restart with defaults 4: Restart Processor	1	Enumerated	ALL
17		FEATURES	Bit string that shows the supported resource block options	Bit String	**Valid Bits** 0 - Unicode strings, **N/A** 1 - Reports supported 2 - Fault State supported 3 - Soft Write lock supported 4 - Hard Write lock supported, **N/A** 5 - Output readback supported 6 - Direct write to output hardware, **N/A** 10 - Reannuciation Supported 11 - PW Alarms set PV Status 12 - DO Block Active	0x2E	N/A	N/A
18		FEATURE_SEL	Bit string that shows the selected resource block options. **Reports supported (bit 1)** clear to cause all alerts to be immediately confirmed even though the alarm is not sent. **Fault State supported (bit 2)** clear to disable Fault State behavior in the AO block. **Soft Write lock supported (bit 3)** clear to disable soft write lock behavior in parameter 34. **Output readback supported (bit 5)** clear to set AO READBACK parameter to track the AO OUT parameter, if set AO READBACK parameter tracks Transducer Final Position Value. Note: Readback and Final Position Value will not be identical due to calculation differences.	Bit String	**Valid Bits** 0 - Unicode strings **N/A** 1 - Reports supported 2 - Fault State supported 3 - Soft Write lock supported 4 - Hard Write lock supported **N/A** 5 - Output readback supported 6 - Direct write to output hardware **N/A** 10 - Reannuciation Supported 11 - PW Alarms set PV Status 12 - DO Block Active	0 per spec 0x2C FCS	N/A	ALL
19		CYCLE_TYPE	Bit string identifying the block execution routines available for this resource	Bit String	**Valid Bits** 0 - Scheduled (LSB) 1 - Completion of block execution **N/A** 2 - Manufacturer specific **N/A**	0x0001 FCS	N/A	N/A

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
20		CYCLE_SEL	Bit string identifying the block execution routine selected for this resource	Bit String	**Valid Bits** 0 - Scheduled (LSB) 1 - Completion of block execution **N/A** 2 - Manufacturer specific **N/A**	0x0000	N/A	ALL
21		MIN_CYCLE_T	Time duration of the shortest cycle interval of which the resource is capable	U32	Set by FCS	3200	1/32 millisec	N/A
22		MEMORY_SIZE	Available configuration memory in the empty resource. To be checked before attempting a download.	U16	Set by FCS	0	Kbytes	N/A
23		NV_CYCLE_T	Interval between writing copies of NV parameters to non-volatile memory. Zero means only on external writes.	U32	Positive	5760,0	1/32 millisec	N/A
24		FREE_SPACE	Percent of memory available for further configuration . Zero in a preconfigured resource	Float	0 to 100 %	0	%	N/A
25		FREE_TIME	Percent of the block processing time that is free to process additional blocks.	Float	0 to 100 %	0	%	N/A
26		SHED_RCAS	Time duration at which to give up on computer writes to function block RCAS locations.	U32	Positive	640000	1/32 millisec	ALL
27		SHED_ROUT	Time duration at which to give up on computer writes to function block ROUT locations.	U32	Positive	640000	1/32 millisec	ALL
28		FAULT_STATE	Forces output function blocks to the FAULT_STATE condition if **active** and the output function blocks will perform their FAULT_STATE action specified in the IO_OPS bit 6.	U8	**1: Clear** **2: Active**	1	Enumerated	N/A
29		SET_FSTATE	Writing a **set** to this parameter will cause the FAULT_STATE parameter to read **active** and the FAULT_STATE condition to be manually initiated. This parameter always reads **off**.	U8	**1: Off** **2: Set**	1	Enumerated	ALL

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
30		CLR_FSTATE	Writing a **clear** to this parameter will cause the FAULT_STATE parameter to read **clear** and will clear the output function blocks of the FAULT_STATE if the field condition, if any, has cleared. This parameter always reads **off**.	U8	**1: Off** **2: Clear**	1	Enumerated	ALL
31		MAX_NOTIFY	Maximum number of unconfirmed notify messages possible.	U8	Set by FCS	15	none	N/A
32		LIM_NOTIFY	Maximum number of unconfirmed alert notify messages allowed.	U8	0 to MAX_NOTIFY	MAX_NOTI FY	none	ALL
33		CONFIRM_TIME	Time between retries of alert reports	U32	greater than or equal to 32000 Set by FCS	640000	1/32 millisec	ALL
34		WRITE_LOCK	If set, no writes from anywhere are allowed, except to clear WRITE_LOCK. Inputs will continue to read. Can be disabled by FEATURE_SEL Setting to Locked clears WRITE_ALM Setting to Unlocked generates a WRITE_ALM at WRITE_PRI priority	U8	**1: Unlocked** **2: Locked**	1 FCS	Enumerated	ALL
35		UPDATE_EVT	Alert generated by change to static data composed of: UNACKNOWLEDGED (=unsigned8) Read / Write UPDATE STATE (=unsigned8) Read TIME STAMP (= Time Value DS-21 8 bytes) Read STATIC REVISION (=unsigned16) Read RELATIVE INDEX (=unsigned16) Read	DS-73	**Unacknowledged:** 0: Undefined 1: Acknowledged 2: Unacknowledged **Update State:** 0: Undefined 1: Update reported 2: Update not reported	0	N/A	N/A
36		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. UNACKNOWLEDGED (=unsigned8) Read / Write ALARM STATE (=unsigned8) Read TIME STAMP (= Time Value DS-21 8 bytes) Read SUBCODE (=unsigned16) =BLOCK_ERR bit Read VALUE (=unsigned8) = 0 Read	DS-72	**Unacknowledged:** 0: Undefined 1: Acknowledged 2: Unacknowledged **Alarm State:** 0: Undefined 1: Clear reported 2: Clear not reported 3: Active reported 4: Active not reported		N/A	N/A

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
37		ALARM_SUM	Current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block. CURRENT (=bitstring16) Read UNACKNOWLEDGED (=bitstring16) Read UNREPORTED (=bitstring16) Read DISABLED (=bitstring16) Read / Write	DS-74	**VALID BITS:** 0: Discrete alarm (LSB) Set when write lock is turned off. 1: High High Alarm **N/A** 2: High Alarm **N/A** 3: Low low alarm **N/A** 4: Low alarm **N/A** 5: Deviation High Alarm **N/A** 6: Deviation Low Alarm **N/A** 7: Block Alarm 8-15: Defined by Block Profile **N/A**		N/A	ALL
38		ACK_OPTION	Selection of whether alarms associated with the block will be automatically acknowledged.	Bit String	0: Discrete alarm (LSB) 7: Block Alarm 0 to Disable, 1 to Enable	0	N/A	ALL
39		WRITE_PRI	Priority of the alarm generated by clearing the write lock	U8	0 to 15	0	none	ALL
40		WRITE_ALM	This alert is generated if the write lock is cleared UNACKNOWLEDGED (=unsigned8) Read / Write ALARM STATE (=unsigned8) Read TIME STAMP (= Time Value DS-21 8 bytes) Read SUBCODE (=unsigned16) = 0 Read VALUE (=unsigned8) = 0 Read	DS-72	**Unacknowledged:** 0: Undefined 1: Acknowledged 2: Unacknowledged **Alarm State:** 0: Undefined 1: Clear reported 2: Clear not reported 3: Active reported 4: Active not reported	0	N/A	N/A
41		ITK_VER	Major version if ITK test this device has been tested to. Parameters below here are Emerson extensions.	U16	**Set by FF**	4		N/A
42		DISTRIBUTOR	Private label distributor	U32	settable by ValveLink	0x5100	E	N/A
43		DEV_STRING	This is used to load new licensing into the device. The value can be written but will always read back with a value of 0.	array of 8 U32		Random Number	N/A	OOS
44		XB_OPTIONS						

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
45		FB_OPTIONS	Indicates which function block licensing options are enabled. One bit for each block type that is supported. Bits: 0=AO 1 = DO 2 = AI 3 = DI 4 = PID 5 = IS 6 = OS	bit string	0x3F	0x3F	N/A	N/A
46		DIAG_OPTIONS	Indicates which diagnostics licensing options are enabled.	ENUM	1:FD Fieldbus Diagnostics 2:AD Advanced Diagnostics 3:PD Performance Diagnostics	1 - FD	N/A	N/A
47		MISC_OPTIONS	Indicates which miscellaneous licensing options are enabled.	bit string	Bit 31-11: NOT USED 10: Travel Control Capable 0: Software Download	0x501	N/A	N/A
48		RB_SFTWR_REV_MAJOR		U8				
49		RB_SFTWR_REV_MINOR		U8				
50		RB_SFTWR_REV_BUILD		U8				
51		RB_SFTWR_REV_ALL		octet string				
52		HARDWARE_REV	Single 8-bit integer indicating the hardware revision.	U8	Hardware revision number	Factory Set	N/A	N/A
53		OUTPUT_BOARD_SN	Set by factory.	U32		Factory Set		N/A
54		FINAL_ASSY_SN	Set by factory.	U32		N/A		N/A

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
55		DETAILED_STATUS	Additional status bit string (4 bytes) Byte 0: bit 0-7 - Rosemount Common Practice Byte 1: bit 0-7 - Rosemount Common Practice Byte 2: bit 0-7 - transmitter specific Comm Prac Rev: G.3	bit string			N/A	
56		SUMMARY_STATUS	Comm Prac Rev: G.3	U8				
57		MESSAGE_DATE	Comm Prac Rev: G.3	Time Of Day				
58		MESSAGE_TEXT	Comm Prac Rev: G.3	octet string				
59		SELF_TEST	Comm Prac Rev: G.3	U8				
60		DEFINE_WRITE_LOCK	Comm Prac Rev: G.3	U8				
61		SAVE_CONFIG_NOW	Comm Prac Rev: G.3	U8				
62		SAVE_CONFIG_BLOCKS	Comm Prac Rev: G.3	U16				
63		START_WITH_DEFAULTS	Comm Prac Rev: G.3	U8				
64		SIMULATE_IO	Comm Prac Rev: G.3	U8				
65		SECURITY_IO	Comm Prac Rev: G.3	U8				
66		SIMULATE_STATE	Comm Prac Rev: G.3	U8				
67		DOWNLOAD_MODE	Comm Prac Rev: G.3	U8				
68		RECOMMENDED_ACTION	Comm Prac Rev: G.3	U16				

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
69		FAILED_PRI	Comm Prac Rev: G.3	U8				
70		FAILED_ENABLE	Comm Prac Rev: G.3	Bit String				
71		FAILED_MASK	Comm Prac Rev: G.3	Bit String				
72		FAILED_ACTIVE	Comm Prac Rev: G.3	Bit String				
73		FAILED_ALM	Comm Prac Rev: G.3					
	1	UNACKNOWLEDGED	Comm Prac Rev: G.3	U8	0: Undefined 1: Acknowledged 2: Unacknowledged			
	2	ALARM STATE	Comm Prac Rev: G.3	U8	0: Undefined 1: Clear - reported 2: Clear - not reported 3: Active - reported 4: Active - not reported			
74		MAINT_PRI	Comm Prac Rev: G.3	U8				
75		MAINT_ENABLE	Comm Prac Rev: G.3	Bit String				
76		MAINT_MASK	Comm Prac Rev: G.3	Bit String				
77		MAINT_ACTIVE	Comm Prac Rev: G.3	Bit String				
78		MAINT_ALM	Comm Prac Rev: G.3					
	1	UNACKNOWLEDGED	Comm Prac Rev: G.3	U8	0: Undefined 1: Acknowledged 2: Unacknowledged			
	2	ALARM STATE	Comm Prac Rev: G.3	U8	0: Undefined 1: Clear - reported 2: Clear - not reported 3: Active - reported 4: Active - not reported			

OD Index	OD Subindex	Parameter Mnemonic	Description	Data Type	Valid Values	Default Value	Units	Read Only or Read/ Write
79		ADVISE_PRI	Comm Prac Rev: G.3	U8				
80		ADVISE_ENABLE	Comm Prac Rev: G.3	Bit String				
81		ADVISE_MASK	Comm Prac Rev: G.3	Bit String				
82		ADVISE_ACTIVE	Comm Prac Rev: G.3	Bit String				
83		ADVISE_ALM	Comm Prac Rev: G.3					
	1	UNACKNOWLEDGED	Comm Prac Rev: G.3	U8	0: Undefined 1: Acknowledged 2: Unacknowledged			
	2	ALARM STATE	Comm Prac Rev: G.3	U8	0: Undefined 1: Clear - reported 2: Clear - not reported 3: Active - reported 4: Active - not reported			
84		HEALTH_INDEX	Comm Prac Rev: G.3	U8				
85		PWA_SIMULATE	Comm Prac Rev: G.3	U8				

6.4. Block View

OD Index	OD Subindex	Parameter Mnemonic	Views						
			1	2	3	4	4.1	4.2	4.3
1		ST_REV	2	2	2	2	2	2	2
2		TAG_DESC							
3		STRATEGY					2		
4		ALERT_KEY					1		
5		MODE_BLK	4		4				
6		BLOCK_ERR	2		2				
7		RS_STATE	1		1				
8		TEST_RW							
9		DD_RESOURCE							
10		MANUFAC_ID					4		
11		DEV_TYPE					2		
12		DEV_REV					1		
13		DD_REV					1		
14		GRANT_DENY		2					
15		HARD_TYPES					2		
16		RESTART							
17		FEATURES					2		
18		FEATURE_SEL		2					
19		CYCLE_TYPE					2		
20		CYCLE_SEL		2					
21		MIN_CYCLE_T					4		
22		MEMORY_SIZE					2		
23		NV_CYCLE_T		4					
24		FREE_SPACE		4					
25		FREE_TIME	4		4				
26		SHED_RCAS		4					
27		SHED_ROUT		4					
28		FAULT_STATE	1		1				
29		SET_FSTATE							
30		CLR_FSTATE							
31		MAX_NOTIFY					1		

OD Index	OD Subindex	Parameter Mnemonic	Views						
			1	2	3	4	4.1	4.2	4.3
32		LIM_NOTIFY		1					
33		CONFIRM_TIME		4					
34		WRITE_LOCK		1					
35		UPDATE_EVT							
36		BLOCK_ALM							
37		ALARM_SUM	8		8				
38		ACK_OPTION					2		
39		WRITE_PRI					1		
40		WRITE_ALM							
41		ITK_VER					2		
42		DISTRIBUTOR						4	
43		DEV_STRING						32	
44		XB_OPTIONS						4	
45		FB_OPTIONS						4	
46		DIAG_OPTIONS						4	
47		MISC_OPTIONS						4	
48		RB_SFTWR_REV_MAJOR							
49		RB_SFTWR_REV_MINOR							
50		RB_SFTWR_REV_BUILD							
51		RB_SFTWR_REV_ALL						48	
52		HARDWARE_REV						1	
53		OUTPUT_BOARD_SN						4	
54		FINAL_ASSY_SN						4	
55		DETAILED_STATUS				4			
56		SUMMARY_STATUS				1			
57		MESSAGE_DATE						6	
58		MESSAGE_TEXT							48
59		SELF_TEST	1						
60		DEFINE_WRITE_LOCK							1
61		SAVE_CONFIG_NOW	1						
62		SAVE_CONFIG_BLOCKS	1			1			
63		START_WITH_DEFAULTS		1		1			
64		SIMULATE_IO				1			
65		SECURITY_IO				1			
66		SIMULATE_STATE				1			

OD Index	OD Subindex	Parameter Mnemonic	Views						
			1	2	3	4	4.1	4.2	4.3
67		DOWNLOAD_MODE							
68		RECOMMENDED_ACTION				2			
69		FAILED_PRI							1
70		FAILED_ENABLE							4
71		FAILED_MASK							4
72		FAILED_ACTIVE				4			
73		FAILED_ALM				13			
	1	UNACKNOWLEDGED							
	2	ALARM STATE							
74		MAINT_PRI							1
75		MAINT_ENABLE							4
76		MAINT_MASK							4
77		MAINT_ACTIVE				4			
78		MAINT_ALM				13			
	1	UNACKNOWLEDGED							
	2	ALARM STATE							
79		ADVISE_PRI							1
80		ADVISE_ENABLE							4
81		ADVISE_MASK							4
82		ADVISE_ACTIVE				4			
83		ADVISE_ALM				13			
	1	UNACKNOWLEDGED							
	2	ALARM STATE							
84		HEALTH_INDEX				1			
85		PWA_SIMULATE				1			
			25	31	22	67	31	117	78

6.5. PlantWeb Alarm Descriptions

PlantWeb alarms are available only if using an Emerson DeltaV system or compatible host. Please refer to the DeltaV manual for setup and usage.

6.5.1. Available PlantWeb Alerts

6.5.1.1. Temperature Sensor Connection Failure

The device has detected that a temperature sensor connection failure. This is an unrecoverable error and the device needs to be inspected for unplugged or damaged sensor connection. In rare occasions, the alert could also indicate the value read by the temperature sensor is outside the allowed range for the device (from -10˚C to 100˚C).

6.5.1.2. Firmware Checksum Failure

The device performs a background diagnostics of the firmware data. If this error occurs, the firmware within the device is corrupted either by loss of data or by component failure. Power cycle the device. If the problem persists, the device needs to be returned to Brooks Instrument.

6.5.1.3. NV – Memory Write Failure

When data is written to the non-volatile memory, a background diagnostics verifies if the data is stable and corresponds to the intended written value. If this error occurs, the non-volatile memory is corrupted and is not representing the expected saved value. Power cycle the device. If the problem persists, the device needs to be returned to Brooks Instrument.

6.5.1.4. RAM Write Failure

When data is written to the RAM, a background check verifies if the data is stable and corresponds to the intended written value. If this error occurs, the RAM is corrupted and is not representing the expected dynamic value. Power cycle the device. If the problem persists, the device needs to be returned to Brooks Instrument.

6.5.1.5. RB Electronics Failure

The FOUNDATION Fieldbus interface board has detected an electronic failure. This is an unrecoverable error; the FOUNDATION Fieldbus board needs to be replaced. Device TAG Name and ID will be changed; refer to your host manual on how to replace a device in your process. The device does not need to be recalibrated.

6.5.1.6. Zero Drift Alarm

This is an option on the MFC devices allowing detection of sensor zero drift or valve leak-by.

To detect true zero drift, the device needs to be placed in a specific environment. Please refer to the Zero Drift Alarm procedure to ensure proper re-zeroing of the device.

Leak by may be induced by a faulty valve, clogged valve, or over pressure downstream off the device. Any of these conditions will require troubleshooting and maintenance of the device.

6.5.1.7. Device Overhaul Due

This is a user settable preventive maintenance indicator. Device overhaul is due. A typical life span for a device is three years. The device will need to be cleaned and returned to the Brooks Instrument service center for an overhaul of the device. Please contact your service center for details.

6.5.1.8. Device Recalibration Due

This is a user settable preventive maintenance indicator. Device calibration is due. A typical recalibration is due after 2,000 hours of usage. Recalibration must be performed by a qualified calibration center. Please contact your service center for details.

6.5.1.9. Valve Spring Life

This is a user settable preventive maintenance indicator. The life of the valve spring has been exceeded. Please contact your service center for a replacement spring.

6.5.1.10. Valve Response

Valve response is out of specification. Either the device is control is too slow, the device control cannot match setpoint, or the device detects large overshoot. This indicates process error, improper usage of the device, or a faulty device. Troubleshooting is needed to determine what is the cause of the problem.

6.5.1.11. Valve Signature

A valve signature alert represents a slow shift in device response over a specific control position. Historical data needs to be accumulated before this alert can be generated. This alert indicates that the device may become unusable soon and preventive maintenance is required.

6.5.1.12. No Flow

This alert is triggered by the flow value staying below an adjustable threshold after an adjustable period of time. This may indicate process or device error. Investigate for possible clog, closed system valve, or fluid not present.

6.5.1.13. Reverse Flow

This alert is triggered by the flow value staying below an adjustable negative threshold after an adjustable period of time. This may indicate incorrect installation, process problem, or device error. Investigate pressure or temperature imbalance in the system, or re-zero the device if the error occurs when the device setpoint is zero.

6.5.1.14. Flow Totalizer Alarm

This alert is triggered by the user adjustable time de-counter value reaching zero (0). This is a process indicator and should be used for advanced device control.

6.5.1.15. Time Totalizer Alarm

This alert is triggered by the adjustable time de-counter value reaching zero (0). This is a process indicator and should be used for advanced device control.

6.5.1.16. PWA Simulate Active

The PlantWeb Alert simulation is activated. This is not a state for normal operation. Please disable PlantWeb simulation to properly continue with the device.

The following tables represent the PlantWeb alerts implementation detail and is provided for reference only.

Table 6-1 PlantWeb Alerts

	Fail	Maintenance	Advise	Transducer Block	Transducer Block	Resource Block	Resource Block	Resource Block	Resource Block
	Enable - Default	Enable - Default	Enable - Default	BLOCK_ERR	XD_ERROR_x	DETAILED_STATUS	SUMMARY_STATUS	BLOCK_ERR - changed based on user selection	Recommended Actions
bit 2: Temperature sensor connection	1	0	0	Sensor Failure	I/O Failure	Transducer Error	Call service center	Maintenance Now	Connection to the temperature sensor has been lost. Device need to be repaired.
Bit 3: Firmware Checksum	1	0	0	Memory Failure	Electronics Failure	Transducer Error	Call service center	Maintenance Now	Recycle device power. If problem persists, contact Brooks.
bit 4: Non Volatile Memory	1	0	0	Memory Failure	Electronics Failure	Transducer Error	Call service center	Maintenance Now	Recycle device power. If problem persists, contact Brooks.
bit 5: RAM	1	0	0	Memory Failure	Electronics Failure	Transducer Error	Call service center	Maintenance Now	Recycle device power. If problem persists, contact Brooks.
bit 6: RB-Electronics Failure	1	0	0	0	0	RB Electronics fail	Call service center	Maintenance Now	The device has detected an electronics component failure on the fieldbus board. Replace fieldbus board.
Bit 7: RB-NV Memory Failure	1	0	0	0	0	RB NV memory Fail	Call service center	Maintenance Now	The device has detected NV memory failure on the Fieldbus board.
bit 10: Zero Drift /Leak-by	0	1	0	Other	0	0	Repairable	Maintenance Soon	Investigate device zero per instruction manual. Then investigate valve leak-by.
bit 11: Device overhaul due	0	1	0	Other	0	0	Repairable	Maintenance Soon	Return device to Brooks for device overhaul.
bit 12: Calibration due	0	1	0	Other	0	0	Repairable	Maintenance Soon	Schedule device recalibration
Bit 13: Valve spring life	0	1	0	Other	0	0	Repairable	Maintenance Soon	Return device to Brooks for valve maintenance.
bit 14:Valve Signature	0	1	0	Other	0	0	Repairable	Maintenance Soon	Valve signature has changed, this indicates a change of condition or the valve is not responding as expected.
bit 15: Valve Response	0	1	0	Other	0	0	Repairable	Maintenance Soon	Valve response is greatly different than specifications, the device may not be able to handle the current process
bit 18: No Flow	0	0	1	Other	0	0	ok	0	Possible clog, closed system valve, or fluid not present.
bit 19: Reverse Flow	0	0	1	Other	0	0	ok	0	Investigate pressure or temperature imbalance in system or re-zero device.
bit 20: Flow totalizer	0	0	1	Other	0	0	ok	0	User alarm Flow totalizer has reached zero
bit 21: Time totalizer	0	0	1	Other	0	0	ok	0	User alarm Time totalizer has reached zero
bit 22: PWA Simulate Active	0	0	1	0	0	0	ok	Simulate Active	Plantweb Alerts are being overwritten by the user.

Table 6-2 XD_ERROR Values

Value	Description	Detail
16	Unspecified error	An error has occurred that was not identified.
17	General error	An error has occurred that could not be classified as one of the errors below.
18	Calibration error	An error occurred during calibration of the device or a calibration error has been detected during operation of the device.
19	Configuration error	An error occurred during configuration of the device or a configuration error has been detected during operation of the device.
20	Electronics Failure	An electronic component has failed.
21	Mechanical Failure	A mechanical component has failed.
22	I/O Failure	An I/O failure has occurred
23	Data Integrity Error	Indicates that data stored within the system may no longer be valid due to NVM checksum failure, Data verify after write failure, etc.
24	Software Error	The software has detected an error. This could be caused by an improper interrupt service routine, an arithmetic overflow, a watchdog timer, etc.
25	Algorithm Error	The algorithm used in the transducer block produced an error. This could be due to an overflow, data reasonableness failure, etc.

Table 6-3 BLOCK_ERR Values

Value	Description
0	Other (LSB)
1	Block Configuration Error
2	Link Configuration Error
3	Simulate Active
4	Local Override
5	Device Fault State Set
6	Device Needs Maintenance Soon
7	Sensor Failure detected by this block/process variable has a status of BAD, Sensor Failure
8	Output Failure detected by this block/back calculation input has a status of BAD, Device Failure
9	Memory Failure
10	Lost Static Data
11	Lost NV Data
12	Readback Check Failed
13	Device Needs Maintenance Now
14	Power-up
15	Out-of-Service (MSB)

Table 6-4. Summary Status

Value	Description
0	Uninitialized
1	No repair needed
2	Repairable
3	Call service center

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7. Transducer Blocks Reference

7.1. Introduction

The Brooks devices have one multi-variable transducer block. The parameters and views are listed in this section.

7.2. Transducer Block Overview

The purpose of a Transducer Block Definition is to describe base parameter collections and characteristics common to the specific aspects of a class of device. The same parameter collections can be applied to a device whose primary or only function is the specific aspect covered by a Transducer Block Definition, or the collection can be applied by other field devices that have the specific aspect as a secondary variable.

This Transducer Block Definition describes base parameter collections and characteristics common to the measurement of pressure.

7.3. Transducer block Methods

7.3.1. Sensor Zero Trim

Only available on the Mass Flow meter and Mass flow controllers, this method allows the user to reset the zero value of the flow sensor with the current read value.

Note: Before zeroing the instrument, zero pressure differential MUST be established across the device. If there is pressure across the instrument during the zero process, any detected flow through the sensor will be misinterpreted as the zero flow reading. This will result in calibration inaccuracy during normal operation. Once zero differential pressure is established and verified, execute Zero-Trim function. The zeroing process requires approximately 10 seconds.

7.4. Block Parameters Tables

7.4.1. Multi-Variable Common Transducer Block

The Brooks Instrument devices respect the FOUNDATION Fieldbus implementation of the multi-variable transducer block known as FF-902 of March 2004. Please refer to the FOUNDATION for more detail on this implementation.

The following information is for reference only. DD and CFF files are the preferred way for device installation.

Table 7-1 Device Information Transducer Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
1		ST_REV	Static data revision. Updated when static data is changed	x	2	UINT16	0 to 65535	N/A		N/A	RO
2		TAG_DESC	The user description of the intended application of the block.	S	3 2	STRING		N/A		ALL	RW
3		STRATEGY	Used to help identify grouping of blocks. This data is not checked or processed by the block.	S	2	UINT16	0 to 65535	0		ALL	RW
4		ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.	S	1	UNIT8	1 to 255	1 per FCS define		ALL	RW
5		MODE_BLK				DS-69					
	1	TARGET		N	1	Bit String	0x01: OOS 0x10: AUTO	0x01 (OOS)		ALL	RW
	2	ACTUAL	ACTUAL	D	1	Bit String	Same as TARGET	0x01 (OOS)		N/A	RO
	3	PERMITTED	PERMITTED	S	1	Bit String	Same as TARGET	0x11		ALL	RW
	4	NORMAL	NORMAL	S	1	Bit String	AUTO	0x10		ALL	RW
6		BLOCK_ERR	0 = Inactive, 1 = Active	D	2	Bit String		N/A		N/A	RO

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
7		UPDATE_EVT	Used to tell other devices (displays, historians) that a change has occurred in the static data of this block.			DS-73					
	1	UNACKNOWLEDGED		D	1	UINT8	0: Undefined 1: Acknowledged 2: Unacknowledged	N/A		ALL	RW
	2	UPDATE STATE		D	1	UINT8	0: Undefined 1: Update reported 2: Update not reported	N/A		N/A	RO
	3	TIME STAMP		D	8	DS-21		N/A		N/A	RO
	4	STATIC REVISION		D	2	UINT16		N/A		N/A	RO
	5	RELATIVE INDEX		D	2	UINT16		N/A		N/A	RO
8		BLOCK_ALM	Alarm generated by block_err.			DS-72					
	1	UNACKNOWLEDGED		D	1	UINT8	0: Undefined 1: Acknowledged 2: Unacknowledged	0		ALL	RW
	2	ALARM STATE		D	1	UINT8	0: Undefined 1: Clear - reported 2: Clear - not reported 3: Active - reported 4: Active - not reported	0		N/A	RO
	3	TIME STAMP		D	8	DS-21		0		N/A	RO
	4	SUBCODE		D	2	UINT16	Subcode: = TDC ALARM SUMMARY CURRENT	0		N/A	RO
	5	VALUE		D	1	UINT8	Value of parameter at alarm time for single alarm, 0 for multiple alarms	0		N/A	RO

7.4.2. Standard Flow with Calibration Transducer Block

The Brooks Instrument devices respect the early FOUNDATION Fieldbus implementation of the Standard Flow with Calibration Transducer Block known as FF-903 of April 1998 [Transducer Blocks (Part 2) Preliminary Specification FF-903 Rev PS 3.0]. Refer to the FOUNDATION for more detail on this implementation.

The following information is for reference only. DD and CFF files are the preferred way for device installation.

Table 7-2 Flow Sensor Transducer Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
10		TRANSDUCER_TYPE_1	Identifies the transducer that follows.	S	2	ENUM		65535		N/A	RO
11		XD_ERROR_1	Extensions to BLOCK_ERR indicated by the “OTHER” bit 0 being set.	D	1	ENUM	Valid Numbers: 0 = No Error	0		N/A	RO
12		COLLECTION_DIRECTORY_1	The directory that specifies the number, starting indices, and DD Item IDs of the data collections for this transducer block.	S	4	Array [1] of UINT32	0	0		N/A	RO
13		PRIMARY_VALUE_TYPE_1	Depends of Eng. Units	S	2	ENUM	100: Mass Flow 101: Volumetric Flow			OOS	RW
14		PRIMARY_VALUE_1	The measured value and status available to the function block								
	1	STATUS		D	1	UINT8	0 = Bad, 128 = Good			N/A	RO
	2	VALUE		D	4	FLOAT				N/A	RO
15		PRIMARY_VALUE_RANGE_1	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 Primary Value.								
	1	EU_100	EU_100	S	4	FLOAT		1000	UI	N/A	RO
	2	EU_0	EU_0	S	4	FLOAT		0	UI	N/A	RO
	3	UNITS_INDEX	UNITS_INDEX	S	2	UINT16	See Flow and Mass Eng. Units	SSCM		N/A	RO
	4	DECIMAL	DECIMAL	S	1	UINT8		4		N/A	RO
16		CAL_POINT_HI_1	The highest calibrated value for this block	S	4	FLOAT		1000	CU	OOS	RW
17		CAL_POINT_LO_1	The lowest calibrated value for this block.	S	4	FLOAT		0	CU	OOS	RW
18		CAL_MIN_SPAN_1	The minimum calibration span value allowed. This minimum span information is necessary to ensure that when calibration is done, the two calibrated points (high and low) are not too close together.	S	4	FLOAT		1000	CU	N/A	RO
19		CAL_UNIT_1	The Device Description engineering units code index for the calibration values.	S	2	UINT16	See Flow and Mass Eng. Units	SSCM		OOS	RW

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
20		SENSOR_TYPE_1	The type of sensor as defined in the Fieldbus Standard Tables Specification (FF-131).	S	2	ENUM	100: Flow Sensor Unknown	100		OOS	RW
21		SENSOR_RANGE_1	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.								
	1	EU_100	EU_100	S	4	FLOAT		1000	UI	N/A	RO
	2	EU_0	EU_0	S	4	FLOAT		0	UI	N/A	RO
	3	UNITS_INDEX	UNITS_INDEX	S	2	UINT16	See Flow and Mass Eng. Units	SSCM		N/A	RO
	4	DECIMAL	DECIMAL	S	1	UINT8		4		N/A	RO
22		SENSOR_SN_1	The sensor serial number.	S	3 2	Visible String		Spaces		N/A	RO
23		SENSOR_CAL_METHOD_1	The method of this sensor's last calibration. ISO defines several standard methods of calibration. This parameter is intended to record that method, or if some other method was used.	S	1	ENUM	105: factory trim special calibration	105		OOS	RW
24		SENSOR_CAL_LOC_1	The location of this sensor's last calibration. This describes the physical location at which the calibration was performed.	S	3 2	Visible String		Spaces		OOS	RW
25		SENSOR_CAL_DATE_1	The date of the sensor's last calibration. This is intended to reflect the calibration of that part of the sensor that is usually wetted by the process.	S	7	Date		0		OOS	RW
26		SENSOR_CAL_WHO_1	The name of the person responsible for the last sensor calibration.	S	3 2	VISIBLE STRING		Spaces		OOS	RW
27		LIN_TYPE_1	The linearization type used to describe the behavior of this sensor output as defined in the Fieldbus Standard Tables Specification (FF-131).	S	1	UINT8		2: Linear with output		OOS	RW
28		GAS_DENSITY	Gas density to be use with Mass Flow control	S	4	FLOAT			Eng Unit	ALL	RW

This transducer variable respects the early FF-903 specification. GAS_DENSITY has been added to allow the user to report values in Mass Flow instead of Volumetric Flow. Density must be calculated by the user if the gas flow is different from the gas used for calibration.

The following information is from the early FF-903 specifications.

7.4.2.1. Overview

This section describes the flow specific aspects of a device application process used in the transducer block application process. For the purpose of transducer specifications, *flow devices* are those measurement devices whose primary process sensors measure flow, including mass flow, volumetric flow, average mass flow, and average volumetric flow. The Standard Flow with Calibration Definition was constructed to provide the user with a flexible list of basic parameters that define transducer operating limits, sensor characteristics and parameters used for calibration. Refer to the Transducer Block Application Process – Part 1 (FF-902) for details of the characteristics that apply to all of the devices that are included in this definition.

Flow is one of the basic measurements, so a full transducer block will be defined with ordered parameters. The grouping of parameters into device description collections will also be defined, so that the flow parameters may be used as part of a more complex device. Any device whose primary purpose is to measure flow and includes calibration should use the defined transducer block for those aspects of the device, and add any additional parameters to the end of the definition.

Channel numbers will be defined for the flow with calibration basic device (i.e., a transducer block which only functions as a single flow with calibration transducer block), but not for a more complex device.

Physical data for the basic flow device will be defined as device description collections that are to be attached to the device resource block described in FF-890 and FF-891. Alternately, a physical collection could be added instead.

One flow transducer will be used for primary sensor data.

7.4.2.2. Schematic

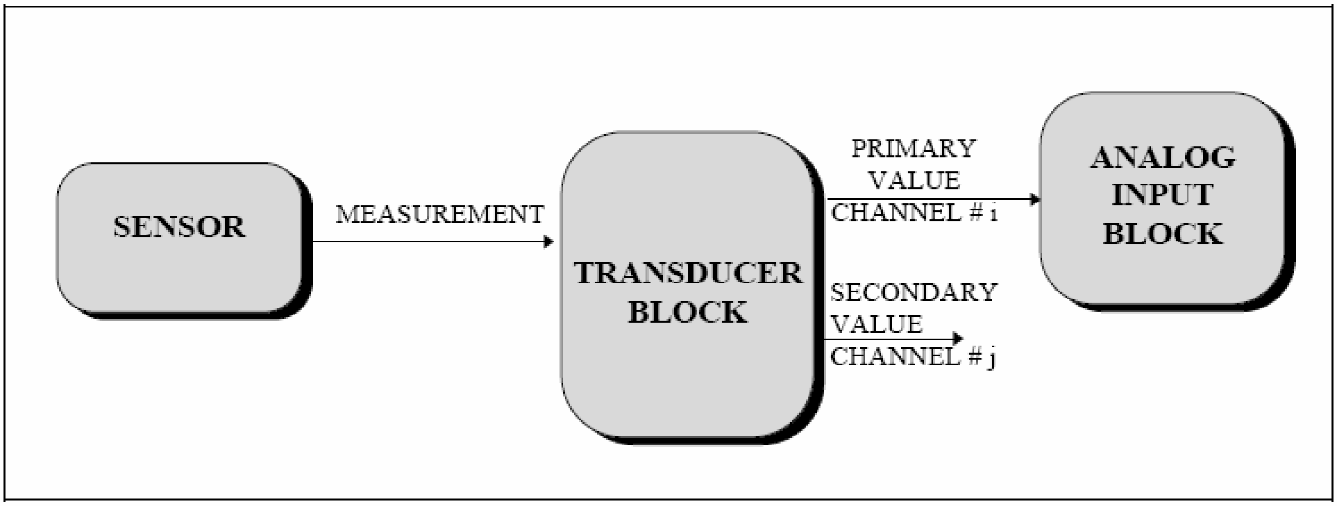

Figure 7-1 Flow Transducer Block Schematic

7.4.2.3. Description

The primary measurement will be mass flow, volumetric flow, average mass flow, or average volumetric flow. This will be identified by the PRIMARY_VALUE_TYPE parameter. Should the sensor provide more than one flow measurement type, such as mass flow and volumetric flow, the set of parameters for mass flow should be followed by the set of parameters for volumetric flow.

The flow technology transducer computes its output using primary sensor data and parameters. The calculation can be modeled as shown in the schematic above. The parameters configure the device application processes for their intended function. The parameters are organized into DD collections.

Note the addition of a parameter, linearization type (LIN_TYPE), that may require some clarification. Though Analog Input function blocks also have a linearization type (L_TYPE), it is limited to direct (no scaling), indirect (scaling), and indirect square root (scaling with a square root function). But, LIN_TYPE as used here provides many more options for the device developer.

The sensor with calibration calculation collection contains seven parameters that define the channel value and the means used to get that value from the sensor. For each channel of measurement, these parameters are repeated.

PRIMARY_VALUE_TYPE Defines the type of calculation, from the list in Section 4.1 Primary Value Types.

PRIMARY_VALUE The value and status that appears on channel 1.

PRIMARY_VALUE_RANGE Defines the ends of the PRIMARY_VALUE, the units of the PRIMARY_VALUE, 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.

CAL_POINT_HI Defines the upper calibrated value. Must be at least CAL_MIN_SPAN away from CAL_POINT_LO, and at or below the high range value of SENSOR_RANGE. Refer to the Appendix on page 129 for more information on calibration.

CAL_POINT_LO Defines the lower calibrated 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 Defines the absolute minimum span between CAL_POINT_HI and CAL_POINT_LO.

CAL_UNIT Defines the engineering units to be used when calibrating the device.

SENSOR_TYPE This parameter contains the index code for the sensor type descriptor.

SENSOR_RANGE Defines the absolute maximum ends 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 Last calibration method.

SENSOR_CAL_LOC Last calibration location.

SENSOR_CAL_DATE Last calibration date.

SENSOR_CAL_WHO Identifies the person that last calibrated the sensor.

LIN_TYPE Contains the linearization type used to describe the behavior of the sensor output.

The secondary value technology collection contains two parameters that pertain to the sensor. These parameters are repeated as necessary.

7.4.2.4. Supported Modes

O/S, Manual, and Auto.

7.4.2.5. User Selectable Modes

O/S and Auto.

7.4.2.6. Alarm Types

Standard block alarm.

7.4.2.7. Mode Handling

Standard transition in and out of O/S.

7.4.2.8. Initialization

Standard initialization.

7.4.2.9. Channel Assignments

1. Primary Value (flow)

7.4.3. Pressure Transducer Block

The Brooks Instrument devices respect the FOUNDATION Fieldbus implementation of the Pressure Transducer Block known as FF-903 of March 2004 (Pressure Transducer Block Specification FF-903 Rev FS 1.0). Please refer to the FOUNDATION for more detail on this implementation.

The following information is for reference only. DD and CFF files are the preferred way for device installation.

Table 7-3 Pressure Sensor Transducer Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
29		TRANSDUCER_TYPE_2		S	2	ENUM	100: Standard Pressure with Calibration	100		N/A	RO
30		XD_ERROR_2	Extensions to BLOCK_ERR indicated by the “OTHER” bit 0 being set.	D	1	ENUM	Valid Numbers: 0 = No Error	0		N/A	RO
31		COLLECTION_DIRECTORY_2		S	4	Array [1] of UINT32	0	0		N/A	RO
32		PRIMARY_VALUE_TYPE_2		S	2	ENUM	109: Absolute pressure			N/A	RO
33		PRIMARY_VALUE_2									
	1	STATUS		D	1	UINT8		IDLE		N/A	RO
	2	VALUE		D	4	FLOAT		Depends on Sensor Safe		N/A	RO
34		PRIMARY_VALUE_RANGE_2									
	1	EU_100	EU_100	S	4	FLOAT		1000	UI	N/A	RO
	2	EU_0	EU_0	S	4	FLOAT		0	UI	N/A	RO
	3	UNITS_INDEX	UNITS_INDEX	S	2	UINT16	See Pressure Eng. Units	Torr		N/A	RO
	4	DECIMAL	DECIMAL	S	1	UINT8		4		N/A	RO
35		CAL_POINT_HI_2		S	4	FLOAT		1000	CU	OOS	RW
36		CAL_POINT_LO_2		S	4	FLOAT		0	CU	OOS	RW
37		CAL_MIN_SPAN_2		S	4	FLOAT		1000	CU	N/A	RO
38		CAL_UNIT_2		S	2	UINT16	See Pressure Eng. Units	Torr		OOS	RW
39		SENSOR_TYPE_2		S	2	ENUM	125: Piezo resistive	125		OOS	RW
40		SENSOR_RANGE_2									
	1	EU_100	EU_100	S	4	FLOAT		1000	UI	N/A	RO
	2	EU_0	EU_0	S	4	FLOAT		0	UI	N/A	RO
	3	UNITS_INDEX	UNITS_INDEX	S	2	UINT16	See Pressure Eng. Units	Torr		N/A	RO
	4	DECIMAL	DECIMAL	S	1	UINT8		4		N/A	RO
41		SENSOR_SN_2		S	32	Visible String		Spaces		N/A	RO
42		SENSOR_CAL_METHOD_2		S	1	ENUM	105: factory trim special calibration	105		OOS	RW
43		SENSOR_CAL_LOC_2		S	32	Visible String		Spaces		OOS	RW

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
44		SENSOR_CAL_DATE_2		S	7	Date				OOS	RW
45		SENSOR_CAL_WHO_2		S	3 2	Visible String		Spaces		OOS	RW
46		SENSOR_ISOLATOR_MTL_2		S	2	ENUM	251: None			N/A	RO
47		SENSOR_FILL_FLUID_2		S	2	UENUM	251: None			N/A	RO

7.4.3.1. Overview

This section describes the pressure specific aspects of a device application process used in a transducer. For the purpose of transducer specifications, pressure devices are those measurement devices whose primary process sensors measure pressure, or differential pressure. The Standard Pressure with Calibration Definition was constructed to provide the user with a flexible list of basic parameters that define transducer operating limits, sensor characteristics and parameters used for calibration. See the Transducer Block Common Structures Specification (FF-902) for details of the characteristics that apply to all of the devices that are included in this definition.

Pressure is one of the basic measurements, so a full transducer block will be defined with ordered parameters. The grouping of parameters into device description collections will also be defined, so that the pressure parameters may be used as part of a more complex device. Any device whose primary purpose is to measure pressure and includes calibration should use the defined transducer block for those aspects of the device, and add any additional parameters to the end of the definition.

Channel numbers will be defined for the pressure with calibration simple device (i.e., a transducer block which only functions as a single pressure with calibration transducer block), but not for a more complex device.

A multi-measurement device is not a simple device. However, this transducer definition will include a secondary value that is often sensor temperature in the simple device. This is included since there is almost always a method for temperature compensation of the pressure sensor in a pressure device.

Physical data for the simple pressure device will be defined as device description collections that are to be attached to the device resource block described in FF-890 and FF-891. Alternately, a physical collection could be added instead.

One pressure transducer will be used for primary sensor data.

7.4.3.2. Schematic

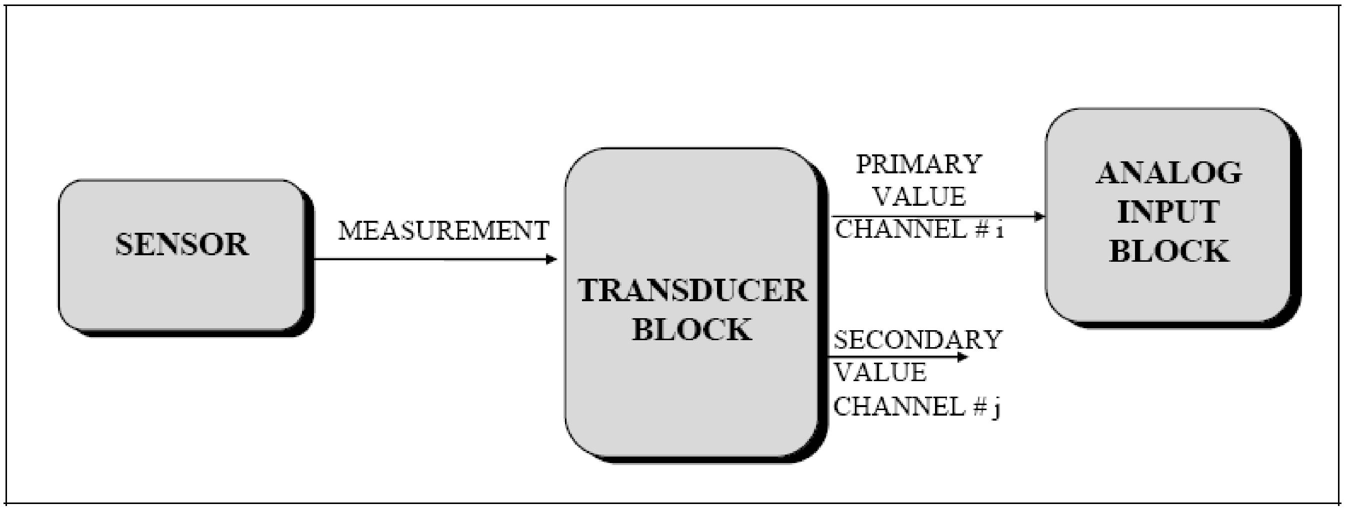

Figure 7-2 Pressure Transducer Block Schematic

7.4.3.3. Description

The primary measurement will be differential, absolute or gauge pressure. This will be identified by the PRIMARY_VALUE_TYPE parameter. Should the sensor provide more than one pressure measurement type, such as differential pressure and/or static pressure, the set of parameters for differential pressure should be followed by the set of parameters for static pressure.

The pressure technology transducer computes its output using primary sensor data and parameters. The calculation can be modeled as shown in Figure 7-2 above. The parameters configure the device application processes for their intended function. The parameters are organized into DD collections.

The sensor with calibration calculation collection contains seven parameters that define the channel value and the means used to get that value from the sensor. If there are multiple channels of measurement, each of these parameters will have the suffix *_x* where *x* starts at 1 and is incremented for each additional channel of measurement.

PRIMARY_VALUE_TYPE	Defines the type of calculation, from the list found in the Standard Table Specification (FF-131).
PRIMARY_VALUE	The value and status that appears on channel 1 as defined in this definition.
PRIMARY_VALUE_RANGE	Defines the ends of the PRIMARY_VALUE, the units of the PRIMARY_VALUE, 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.
CAL_POINT_HI	Defines the upper calibrated value. Must be at least CAL_MIN_SPAN away from CAL_POINT_LO, and at or below the high range value of SENSOR_RANGE. Refer to the Appendix on page 129 for more information on calibration.
CAL_POINT_LO	Defines the lower calibrated 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	Defines the absolute minimum span between CAL_POINT_HI and CAL_POINT_LO.
CAL_UNIT	Defines the engineering units to be used when calibrating the device.
SENSOR_TYPE	Defines the type of sensor, from the list the Standard Table Specification (FF-131).
SENSOR_RANGE	Defines the absolute maximum ends 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	Last calibration method.
SENSOR_CAL_LOC	Last calibration location.
SENSOR_CAL_DATE	Last calibration date.
SENSOR_CAL_WHO	Identifies the person that last calibrated the sensor.
SENSOR_ISOLATOR_MTL	Defines the material used in the sensor isolation diaphragms.
SENSOR_FILL_FLUID	Shows the type of fill fluid used in the sensor.

7.4.3.4. Supported Modes

O/S, Manual, and Auto.

7.4.3.5. User Selectable Modes

O/S and Auto.

7.4.3.6. Alarm Types

Standard block alarm.

7.4.3.7. Mode Handling

Standard transition in and out of O/S.

7.4.3.8. Initialization

Standard initialization.

7.4.3.9. Channel Assignments

1. Primary Value (pressure) sensor

7.4.4. Temperature Transducer Block

The Brooks Instrument devices respect the FOUNDATION Fieldbus implementation of the Temperature Transducer Block known as FF-904 of March 2004 (Pressure Transducer Block Specification FF-904 Rev DPS 1.0). Please refer to the FOUNDATION for more detail on this implementation.

The following information is for reference only. DD and CFF files are the preferred way for device installation.

Table 7-4 Temperature Sensor Transducer Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
48		TRANSDUCER_TYPE_3		S	2	ENUM	101: Standard Temperature With Calibration	101		N/A	RO
49		XD_ERROR_3	Extensions to BLOCK_ERR indicated by the “OTHER” bit 0 being set.	D	1	ENUM	Valid Numbers: 0 = No Error	0		N/A	RO
50		COLLECTION_DIRECTORY_3		S	4	Array [1] of UINT32	0	0		N/A	RO
51		PRIMARY_VALUE_TYPE_3		S	2	ENUM	104: Process Temperature 105: Non Process Temperature	105		N/A	RO
52		PRIMARY_VALUE_3									
	1	STATUS		D	1	UINT8				N/A	RO
	2	VALUE		D	4	FLOAT				N/A	RO
53		PRIMARY_VALUE_RANGE_3									
	1	EU_100	EU_100	S	4	FLOAT		65	UI	N/A	RO
	2	EU_0	EU_0	S	4	FLOAT		5	UI	N/A	RO
	3	UNITS_INDEX	UNITS_INDEX	S	2	UINT16	See Pressure Eng. Units	DegC		N/A	RO
	4	DECIMAL	DECIMAL	S	1	UINT8		4		N/A	RO
54		CAL_POINT_HI_3		S	4	FLOAT		65	CU	OOS	RW
55		CAL_POINT_LO_3		S	4	FLOAT		5	CU	OOS	RW
56		CAL_MIN_SPAN_3		S	4	FLOAT		60	CU	N/A	RO
57		CAL_UNIT_3		S	2	UINT16	See Pressure Eng. Units	DegC		OOS	RW
58		SENSOR_TYPE_3		S	2	ENUM	127:Unknown	127		OOS	RW
59		SENSOR_RANGE_3									
	1	EU_100	EU_100	S	4	FLOAT		65	UI	N/A	RO
	2	EU_0	EU_0	S	4	FLOAT		5	UI	N/A	RO
	3	UNITS_INDEX	UNITS_INDEX	S	2	UINT16	See Temperature Eng. Units	DegC		N/A	RO
	4	DECIMAL	DECIMAL	S	1	UINT8		4		N/A	RO
60		SENSOR_SN_3		S	3 2	Visible String				N/A	RO
61		SENSOR_CAL_METHOD_3		S	1	ENUM	105: factory trim special calibration			OOS	RW
62		SENSOR_CAL_LOC_3		S	3 2	Visible String		Spaces		OOS	RW

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
63		SENSOR_CAL_DATE_3		S	7	Date				OOS	RW
64		SENSOR_CAL_WHO_3		S	32	Visible String		Spaces		OOS	RW
65		SENSOR_CONNECTION_3		S	1	ENUM	4 - wire			N/A	RO

7.4.4.1. Overview

This subsection describes the temperature specific aspects of a device application process used in a transducer block. For the purpose of transducer specifications, *temperature devices* are those measurement devices whose primary process sensors measure temperature, or differential temperature. The Standard Temperature with Calibration definition was constructed to provide the user with a flexible list of basic parameters that define transducer operating limits, sensor characteristics and parameters used for calibration. See the Transducer Block Common Structures Specification (FF-902) for details of the characteristics that apply to all of the devices that are included in this area.

Temperature is one of the basic measurements, so a full transducer block will be defined with ordered parameters. The grouping of parameters into device description collections will also be defined, so that the temperature parameters may be used as part of a more complex device. Any device whose primary purpose is to measure temperature should use the defined transducer block for temperature, and add any additional parameters to the end of the definition.

Channel numbers will be defined for the temperature with calibration basic device (i.e., a transducer block which only functions as a single temperature with calibration transducer block), but not for a more complex device.

A multi-measurement device is not a basic device. However, this definition will include body temperature in the basic device, because it is almost universally used for temperature compensation and/or cold junction compensation of the temperature sensor.

Physical data for the basic temperature device will be defined as device description collections that are to be attached to the device resource block described in FF-890 and FF-891. Alternately, a physical collection could be added instead.

One temperature transducer will be used for primary sensor data.

7.4.4.2. Schematic

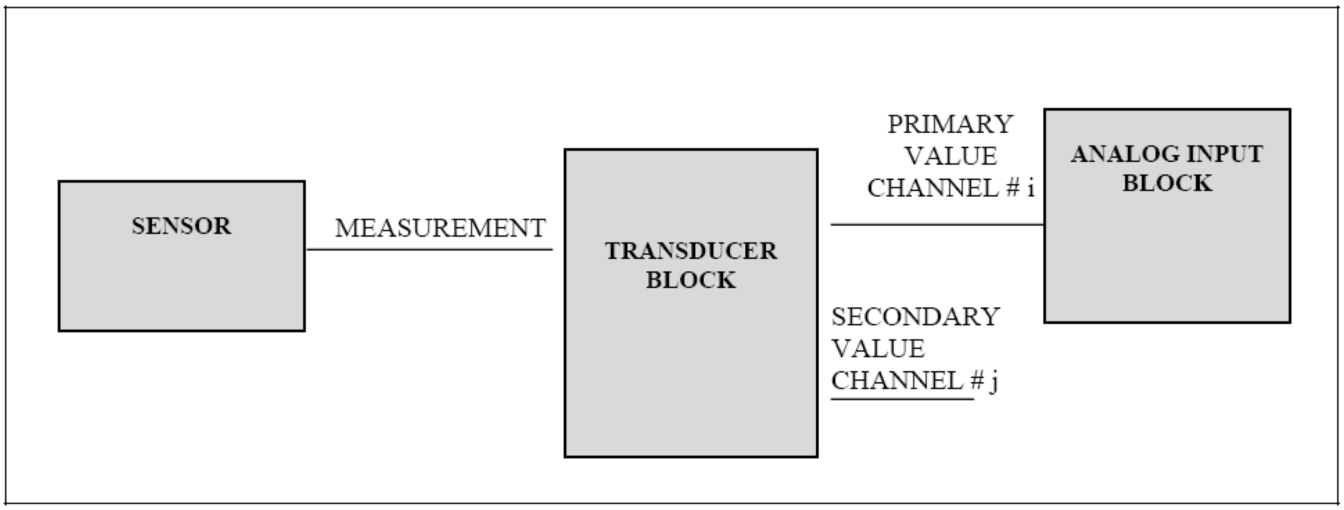

Figure 7-3 Temperature Transducer Block Schematic

7.4.4.3. Description

The primary measurement will be process, non-process or differential temperature. This will be identified by the PRIMARY_VALUE_TYPE parameter. Should the sensor provide more than one temperature measurement type, like differential temperature and process temperature, the set of parameters for process temperature should be followed by the set of parameters for differential temperature.

The temperature technology transducer computes its output using primary sensor data and parameters. The calculation can be modeled as shown in Figure 7-3 above. The parameters configure the device application processes for their intended function. The parameters are organized into DD collections.

The sensor with calibration calculation collection contains seven parameters that define the channel value and the means used to get that value from the sensor. For each channel of measurement, these parameters are repeated.

PRIMARY_VALUE_TYPE Defines the type of calculation, from the list found in the Standard Table Specification (FF-131).

PRIMARY_VALUE	The value and status that appears on channel 1 as defined in this definition.
PRIMARY_VALUE_RANGE	Defines the ends of the PRIMARY_VALUE, the units of the PRIMARY_VALUE, 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.
CAL_POINT_HI	Defines the upper calibrated value. Must be at least CAL_MIN_SPAN away from CAL_POINT_LO, and at or below the high range value of SENSOR_RANGE. Refer to the Appendix on page 129 for more information on calibration.
CAL_POINT_LO	Defines the lower calibrated 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	Defines the absolute minimum span between CAL_POINT_HI and CAL_POINT_LO.
CAL_UNIT	Defines the engineering units to be used when calibrating the device.
SENSOR_TYPE	Defines the type of sensor, from the list the Standard Table Specification (FF-131).
SENSOR_RANGE	Defines the absolute maximum ends 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	Last calibration method.
SENSOR_CAL_LOC	Last calibration location.
SENSOR_CAL_DATE	Last calibration date.
SENSOR_CAL_WHO	Identifies the person that last calibrated the sensor.
SENSOR_CONNECTION	Defines the connections used by the sensor.

7.4.4.4. Supported Modes

O/S, Manual, and Auto.

7.4.4.5. User Selectable Modes

O/S and Auto.

7.4.4.6. Alarm Types

Standard block alarm.

7.4.4.7. Mode Handling

Standard transition in and out of O/S.

7.4.4.8. Initialization

Standard initialization.

7.4.4.9. Channel Assignments

1. Primary Value (Temperature)

7.4.5. Brooks Instrument Custom Valve Controller Transducer Block

The following data describes the Brooks Instrument custom implementation of a valve controller on FOUNDATION Fieldbus.

Table 7-5 Valve Controller Transducer Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
66		TRANSDUCER_TYPE_4		S	2	ENUM		65535		N/A	RO
67		XD_ERROR_4	Extensions to BLOCK_ERR indicated by the “OTHER” bit 0 being set.	D	1	ENUM	Valid Numbers: 0 = No Error	0		N/A	RO
68		FINAL_VALUE_4	Targeted value for flow control								

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
	1	STATUS		D	1	UINT8				N/A	RO
	2	VALUE		D	4	FLOAT			FVR	N/A	RO
69		ACT_FAIL_ACTION_4		S	1	ENUM	1 - Self closing; 2 - Self opening; 3 - Hold last value	1 - Self closing		ALL	RW
70		CAL_VALVE_SPAN	Valve position to achieve full scale	S	4	FLOAT		*do not default	FVR	ALL	RW
71		CAL_VALVE_OFFSET	Minimum Valve position before flowing gas	S	4	FLOAT		*do not default	FVR	ALL	RW
72		CAL_VALVE_KP	Proportional Gain of internal PID	S	4	FLOAT		*do not default		ALL	RW
73		CAL_VALVE_KI	Integral Gain of internal PID	S	4	FLOAT		*do not default		ALL	RW
74		CAL_VALVE_KD	Derivative Gain of internal PID	S	4	FLOAT		*do not default		ALL	RW
75		VALVE_OVERRIDE	Valve Override (Service) allows manual control of the valve position (Open loop control)	S	1	ENUM	0:Normal 1:Open Loop 2:Valve Close 3:Valve Open 4:Valve Off 5:Valve Hold 6:Valve On	Normal		N/A	RO
76		SECONDARY_FINAL_VALUE_4	Target valve opening in percent								
	1	STATUS		D	1	UINT8				N/A	RO
	2	VALUE		D	4	FLOAT			FVR	N/A	RO
77		SECONDARY_FINAL_POSITION_ VALUE	Current Valve open value								
	1	STATUS		D	1	UINT8				N/A	RO
	2	VALUE		D	4	FLOAT			FVR	N/A	RO

7.4.5.1. Overview

This section describes the valve controller specific aspects of a device application process used in a transducer block. For the purpose of transducer specifications, *controller devices* are those devices whose primary process actuator controls a setpoint relative to the sensor already represented in the device. A secondary process actuator directly controls the valve position. Secondary Final valve position is provided. Control of the final element is selected through a Digital Output block.

Channel numbers will be defined for the valve controller.

7.4.5.2. Schematic

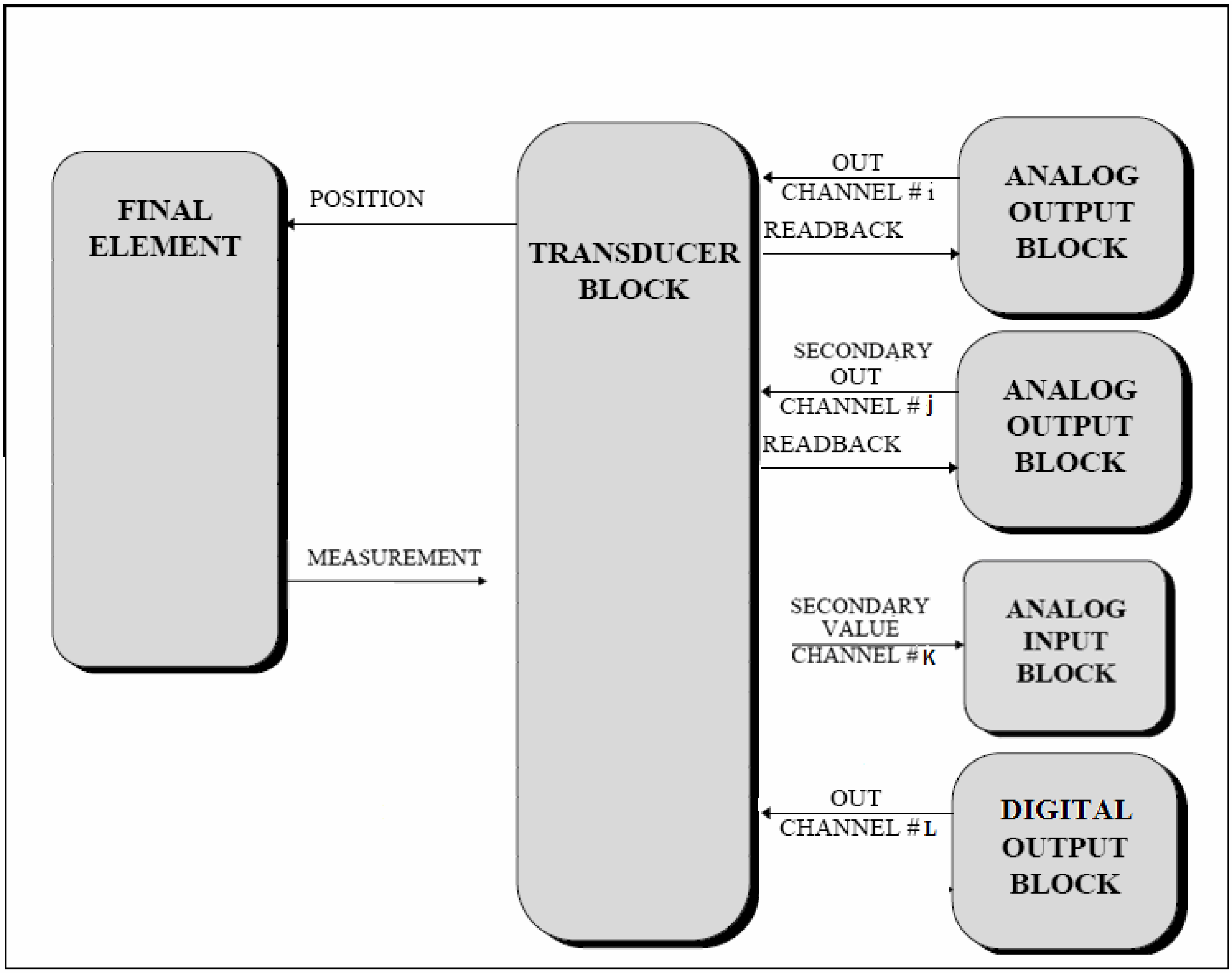

Figure 7-4 Custom Valve Controller Transducer Block Schematic

7.4.5.3. Description

The Custom valve controller transducer uses the output of two AO Blocks as a setpoint to position an automated valve with software configurable capability utilizing an Electric final element. The final element modifies the process in response to the OUT parameter sent from one of the AO Blocks. The OUT parameter provides the basis for determining the setpoint (desired controlled position) of the transducer.

Typically the final element is controlled within the device.

The Custom valve controller transducer will respond to remote changes in setpoint carried through Fieldbus. It will position the final element to satisfy the internal close loop using the available input (flow or pressure). The remote adjustments of KI, KP, and KD allow change in response of the close loop system.

The FINAL_VALUE AO Block OUT parameter is scaled by SENSOR_VALUE_RANGE of the available sensor input (flow or pressure), within the transducer block, to scale the range of FINAL_VALUE, which is carried via internal, manufacturer-specific means to the final element. Adjustment of CAL_VALVE_KI, CAL_VALVE_KP, and CAL_VALVE_KD modifies the value of the output signal according to the Brooks Instrument-specific algorithm.

The SECONDARY_FINAL_VALUE AO Block OUT is provided for direct control of the valve position, without using the Brooks Instrument-specific algorithm. The range of the secondary value is always in % of drive from 0 to 100.

The SECONDARY_FINAL_POSITION_VALUE represents the actual requested position either controlled by the internal Brooks Instrument PID algorithm or controlled by the SECONDARY_FINAL_VALUE. The range of the secondary final position value is always in % of drive from 0 to 100.

The DO Block out allows the selection between the AO blocks, FINAL_VALUE, and SECONDARY_FINAL_VALUE or internal control of the final element for specific actions such as Valve override.

FINAL_VALUE

The requested setpoint position and status written by the Function Block.

ACT_FAIL_ACTION

Specifies the action the actuator takes in case of failure:

1. Self-Closing
2. Self-Opening
3. Hold Last Value

CAL_VALVE_SPAN Valve position in % of drive to achieve full scale at calibration condition.

CAL_VALVE_OFFSET Minimum valve position in % of drive before flowing gas at calibration condition.

CAL_VALVE_KP Proportional gain of the Brooks Instrument-specific control algorithm.

CAL_VALVE_KI Integral gain of the Brooks Instrument-specific control algorithm.

CAL_VALVE_KD Derivative gain of the Brooks Instrument-specific control algorithm.

VALVE_OVERRIDE The requested valve control type written by the Function block.

1. Normal, valve position is controlled internally by the Brooks Instrument-specific algorithm. FINAL_VALUE or setpoint is in sensor unit. Value read by the sensor must be equal to the setpoint to satisfy the close loop.
2. Open Loop, valve position is controlled by the SECONDARY_FINAL_VALUE in % of drive.
3. Closed, final element is driven internal to satisfy a fully closed valve. Depending of the valve technology (normally closed or normally opened), this could be full or no power.
4. Open, final element is driven internal to satisfy a fully opened valve. Depending of the valve technology (normally closed or normally opened), this could be full or no power.
5. Drive Off, no power to the valve. Depending of the valve technology (normally closed or normally opened), the valve could be opened or closed.
6. Hold, the valve power is constant and equal to the last controlled value from any source.
7. Drive On, full power to the valve. Depending of the valve technology (normally closed or normally opened), the valve could be opened or closed.

SECONDARY_FINAL_VALUE The requested valve position and status written by the Function Block.

SECONDARY_FINAL_POSITION_VALUE The actual valve position and status, reported by the AI block.

7.4.5.4. Supported Modes

O/S, Manual, and Auto.

7.4.5.5. User Selectable Modes

O/S and Auto.

7.4.5.6. Alarm Types

Standard block alarm.

7.4.5.7. Mode Handling

Standard transition in and out of O/S.

7.4.5.8. Initialization

Standard initialization.

7.4.5.9. Channel Assignments

1. Final Value (AO Setpoint)
2. Secondary Value (AO Valve control)
3. Secondary Final Value (AI Valve position)
4. Valve override request (DO Valve override)

7.4.6. Brooks Specific custom data

Brooks Instrument devices provide access to some internal data. Those data are commonly available to allow the user a flexible usage of the device.

7.4.6.1. Flow Sensor Calibration information

Table 7-6 Flow Sensor Calibration Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
78		GAS_CALIBRATION									
	1	CAL_PRESSURE	Calibration Pressure in kPa	S	4	FLOAT		*do not default	Kpa	N/A	RO
	2	CAL_TEMP	Calibration Temp. in Deg C	S	4	FLOAT		*do not default	Deg C	N/A	RO
	3	CAL_GAS	Calibration Gas Number	S	1	UINT8		*do not default		N/A	RO
	4	CAL_ID	Selection among the 10 Flow Calibration ID	S	1	UINT8	1 to 10	*do not default		OOS	RW

Flow devices allow storage for 10 different gas calibrations. Those calibrations must be requested when ordering the device. These data allow selection and reading of calibration information. Gas calibration affects KP, KI, KD, Valve span, valve offset, and sensor calibration to reflect the gas properties.

GAS_CALIBRATION Structure representing the currently selected gas calibration.

CAL_PRESSURE Pressure in which the device was calibrated.

CAL_TEMP Temperature in which the device was calibrated.

CAL_GAS Standard gas number.

CAL_ID Number from 1 to 10 that selected the calibration database used by the device. If the selected value is out of range or does not exist, the request will be ignored and the currently selected calibration will be used.

7.4.6.2. Pressure Application Information

Table 7-7 Pressure Sensor Calibration Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
79		PRESS_APP_ID	Selection among the 10 Pressure Application ID	S	1	UINT8	1 to 10	*do not default		OOS	RW

Pressure devices allow storage for 10 different applications. Those applications must be requested when ordering the device. These data allow selection and reading of calibration information. Gas calibration affects KP, KI, KD, Valve span, and Valve offset.

PRESS_APP_ID

Number from 1 to 10 that selected the application database used by the device. If the selected value is out of range or does not exist, the request will be ignored and the currently selected application will be used.

7.4.6.3. Alarm Setup

Table 7-8 Alarm Information Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
82		ALARM_SETUP	Control the different alarm settings								
	1	TIME_TOTALIZER	Total time usage in seconds. Restable by user	D	4	UINT32			Seconds	ALL	RW
	2	FLOW_TOTALIZER	Total flow usage in amount of full scale. Resetable by user	D	4	FLOAT			Eng Unit	ALL	RW
	3	VALVE_SPRING_LIFE	Remaining valve spring life, in amount of full stroke	D	4	UINT32			% of Full Stroke	ALL	RW
	4	CALIBRATION_DUE	Remaining hours before device calibration is due	D	4	UINT32		2000	Hours	ALL	RW
	5	OVERHAUL_DUE	Remaining hours before device overhaul is due	D	4	UINT32		26280	Hours	ALL	RW

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
	6	REMAINING_FLOW_TOTALIZER	Remaining quantity before Flow alarm	D	4	FLOAT	0 to 262143 * full scale	0	Eng. Unit	ALL	RW
	7	REMAINING_TIME_TOTALIZER	Remaining seconds before Timer alarm	D	4	UINT32		0	Seconds	ALL	RW

Alarm setup will adjust behavior on some of the reported PlantWeb alerts.

TIME_TOTALIZER Represents the amount of time, in seconds, the device controlled gas.

FLOW_TOTALIZER Only available for MFM and MFC, represents the total amount of volume in % of full scale flown through the device. A value of 1 will indicate that 100% of full scale has been accumulated through the sensor. If full scale is 1 SL/m, 1 Standard Liter (SL) of calibrated gas has been provided.

VALVE_SPRING_LIFE Remaining number of stroke available before the internal spring may show fatigue.

CALIBRATION_DUE Remaining number of hours before the calibration of the device is due.

OVERHAUL_DUE Remaining number of hours before the device overhaul is due.

REMAINING_FLOW_TOTALIZER Amount of full scale of flow before the device generates the flow totalizer alert.

REMAINING_TIME_TOTALIZER Amount of seconds before the device generates the time totalizer alert.

7.4.6.4. Diagnostic Data

Table 7-9 Diagnostic Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
83		DIAGNOSTIC_DATA	Data from the device								
	1	NO_FLOW_DELAY	Delay in seconds before no flow alarm	S	4	FLOAT		30	Seconds	ALL	RW
	2	NO_FLOW_THRESHOLD	Flow threshold indicating No Flow	S	4	FLOAT	0 to 100	1.0	%	ALL	RW
	3	NEGATIVE_FLOW_THRESHOLD	Negative flow threshold value	S	4	FLOAT	-33 TO 0	-1.0	%	ALL	RW
	4	ZDD_ERROR_LIMIT	ZDD Error limit	S	4	FLOAT	0 to 100	1.0	%	ALL	RW
	5	ZDD_ADJUST_LIMIT	ZDD Adjust error limit for temperature	S	1	UINT8	0-1	1		ALL	RW
	6	ZDD_ALARM_DELAY	ZDD Alarm delay	S	4	FLOAT		1	Seconds	ALL	RW
	7	ZDD_INTERLOCK_DELAY	ZDD Interlock Delay	S	4	FLOAT		5	Minutes	ALL	RW
	8	ZDD_SAFE_STATE	ZDD Safe State Enabled	S	1	ENUM	1 - Self closing 2 - Self opening 3 - Hold last value	1 - Self closing		ALL	RW

Diagnostic data will adjust behavior on some of the reported PlantWeb alerts.

NO_FLOW_DELAY

Delay in seconds before the no flow alarm is generated. The No Flow alarm will be generated only if the flow stays below the NO_FLOW_THRESHOLD for at least this amount of time.

NO_FLOW_THRESHOLD

Threshold below which the no flow alarm will be generated.

NEGATIVE_FLOW_THRESHOLD

Flow below which the device will generate an alarm.

ZDD_*

Zero drift adjustment. Refer to the separate Zero Drift Diagnostic for adjustment. This option must be purchased to be activated.

7.4.6.5. Firmware Information

Table 7-10 Firmware Information Block Parameters

OD Index	OD Subindex	Parameter Mnemonic	Description	Store/Rate (Hz)	Size	Data Type	Valid Values	Default Value	Units	Mode for Writes	Read Only or Read/ Write
84		SENSOR_BRD_VERSION		S	12	Visible String			N/A	N/A	RO
85		MODULE_TYPE	Manufacturer's model number	S	2	ENUM	0x1000 = "58xx MFC"; 0x1001 = "58xx MFM"; 0x1002 = "58xx PC"; 0x1100 = "MF MFC"; 0x1101 = "MF MFM"; 0x1102 = "MF PC"	0x1000	N/A	N/A	RO

Main sensor board information.

SENSOR_BRD_VERSION

Version of firmware stored in the sensor board (or main board). Typically, AA, AB, etc.

MODULE_TYPE

Model number of the Fieldbus device

- 0x1000 = "58xx MFC";
- 0x1001 = "58xx MFM";
- 0x1002 = "58xx PC";
- 0x1100 = "MF MFC";
- 0x1101 = "MF MFM";
- 0x1102 = "MF PC”

7.4.7. Block View

Table 7-11 Flow Sensor Transducer Block Views

OD Index	OD Subindex	Parameter Mnemonic	Views							
			1	2	3	4	4.1	4.2	4.3	4.4
10		TRANSDUCER_TYPE_1	2	2	2	2				
11		XD_ERROR_1	1		1					
12		COLLECTION_DIRECTORY_1								
13		PRIMARY_VALUE_TYPE_1		2						
14		PRIMARY_VALUE_1	DS-65							
	1	STATUS	1		1					
	2	VALUE	4		4					
15		PRIMARY_VALUE_RANGE_1	DS-68							
	1	EU_100				4				
	2	EU_0				4				
	3	UNITS_INDEX				2				
	4	DECIMAL				1				
16		CAL_POINT_HI_1		4						
17		CAL_POINT_LO_1		4						
18		CAL_MIN_SPAN_1				4				
19		CAL_UNIT_1				2				
20		SENSOR_TYPE_1				2				
21		SENSOR_RANGE_1	DS-68							
	1	EU_100				4				
	2	EU_0				4				
	3	UNITS_INDEX				2				
	4	DECIMAL				1				
22		SENSOR_SN_1				32				
23		SENSOR_CAL_METHOD_1				1				
24		SENSOR_CAL_LOC_1				32				
25		SENSOR_CAL_DATE_1				7				
26		SENSOR_CAL_WHO_1					32			
27		LIN_TYPE_1				1				

OD Index	OD Subindex	Parameter Mnemonic	Views							
			1	2	3	4	4.1	4.2	4.3	4.4
28		GAS_DENSITY				4				
29		TRANSDUCER_TYPE_2	2	2	2		2			
30		XD_ERROR_2	1		1					
31		COLLECTION_DIRECTORY_2								
32		PRIMARY_VALUE_TYPE_2		2						
33		PRIMARY_VALUE_2	DS-65							
	1	STATUS	1		1					
	2	VALUE	4		4					
34		PRIMARY_VALUE_RANGE_2	DS-68							
	1	EU_100					4			
	2	EU_0					4			
	3	UNITS_INDEX					2			
	4	DECIMAL					1			
35		CAL_POINT_HI_2		4						
36		CAL_POINT_LO_2		4						
37		CAL_MIN_SPAN_2					4			
38		CAL_UNIT_2					2			
39		SENSOR_TYPE_2					2			
40		SENSOR_RANGE_2	DS-68							
	1	EU_100					4			
	2	EU_0					4			
	3	UNITS_INDEX					2			
	4	DECIMAL					1			
41		SENSOR_SN_2						32		
42		SENSOR_CAL_METHOD_2					1			
43		SENSOR_CAL_LOC_2					32			
44		SENSOR_CAL_DATE_2					7			
45		SENSOR_CAL_WHO_2						32		
46		SENSOR_ISOLATOR_MTL_2					2			
47		SENSOR_FILL_FLUID_2					2			
48		TRANSDUCER_TYPE_3	2	2	2			2		
49		XD_ERROR_3	1		1					
50		COLLECTION_DIRECTORY_3								

OD Index	OD Subindex	Parameter Mnemonic	Views							
			1	2	3	4	4.1	4.2	4.3	4.4
51		PRIMARY_VALUE_TYPE_3		2						
52		PRIMARY_VALUE_3	DS-65							
	1	STATUS	1		1					
	2	VALUE	4		4					
53		PRIMARY_VALUE_RANGE_3	DS-68							
	1	EU_100						4		
	2	EU_0						4		
	3	UNITS_INDEX						2		
	4	DECIMAL						1		
54		CAL_POINT_HI_3		4						
55		CAL_POINT_LO_3		4						
56		CAL_MIN_SPAN_3						4		
57		CAL_UNIT_3						2		
58		SENSOR_TYPE_3							2	
59		SENSOR_RANGE_3	DS-68							
	1	EU_100							4	
	2	EU_0							4	
	3	UNITS_INDEX							2	
	4	DECIMAL							1	
60		SENSOR_SN_3						32		
61		SENSOR_CAL_METHOD_3							1	
62		SENSOR_CAL_LOC_3							32	
63		SENSOR_CAL_DATE_3							7	
64		SENSOR_CAL_WHO_3							32	
65		SENSOR_CONNECTION_3							1	
66		TRANSDUCER_TYPE_4	2	2	2				2	
67		XD_ERROR_4	1		1					
68		FINAL_VALUE_4	DS-65							
	1	STATUS	1		1					
	2	VALUE	4		4					
69		ACT_FAIL_ACTION_4							1	
70		CAL_VALVE_SPAN							4	

OD Index	OD Subindex	Parameter Mnemonic	Views							
			1	2	3	4	4.1	4.2	4.3	4.4
71		CAL_VALVE_OFFSET							4	
72		CAL_VALVE_KP							4	
73		CAL_VALVE_KI							4	
74		CAL_VALVE_KD							4	
75		VALVE_OVERRIDE		1						
76		SECONDARY_FINAL_VALUE_4	DS-65							
	1	STATUS	1		1					
	2	VALUE	4		4					
77		SECONDARY_FINAL_POSITION_VALUE	DS-65							
	1	STATUS	1		1					
	2	VALUE	4		4					
78		GAS_CALIBRATION								
	1	CAL_PRESSURE								4
	2	CAL_TEMP								4
	3	CAL_GAS								1
	4	CAL_ID								1
79		PRESS_APP_ID		1						
82		ALARM_SETUP								
	1	TIME_TOTALIZER	4		4					
	2	FLOW_TOTALIZER	4		4					
	3	VALVE_SPRING_LIFE	4		4					
	4	CALIBRATION_DUE	4		4					
	5	OVERHAUL_DUE	4		4					
	6	REMAINING_FLOW_TOTALIZER	4		4					
	7	REMAINING_TIME_TOTALIZER	4		4					
83		DIAGNOSTIC_DATA								
	1	NO_FLOW_DELAY								4
	2	NO_FLOW_THRESHOLD								4
	3	NEGATIVE_FLOW_THRESHOLD								4
	4	ZDD_ERROR_LIMIT								4
	5	ZDD_ADJUST_LIMIT								1
	6	ZDD_ALARM_DELAY								4
	7	ZDD_INTERLOCK_DELAY								4

OD Index	OD Subindex	Parameter Mnemonic	Views							
			1	2	3	4	4.1	4.2	4.3	4.4
	8	ZDD_SAFE_STATE								1
84		SENSOR_BRD_VERSION								12
85		MODULE_TYPE								2
			72	42	78	114	110	117	111	52

8. Troubleshooting

Information in this troubleshooting guide must be used within context. Please report problems to Brooks Instrument in order to extend this manual.

The first step of troubleshooting is to make sure power and communication are adequate to the system.

Make sure the Transducer block is in Auto mode. The default mode for the transducer block is OOS; none of the function block will execute if the transducer block is OOS.

8.1. Data write NIF_ERR_EXCEED_LIMIT

The value being returned exceeds the valid range, please change the transducer block table for a complete list of range.

8.2. AI Function block stays in OOS or status is BAD

Check Channel, channel must match the type of data requested. Channel needs to be checked if the device is moved from one type of host controller to another.

Block Error indicates “InputFailure”:

- The transducer block may not be in Auto mode.
- Check the channel assignment (for more information, refer to “Function Block” on page 18).

Block Error indicates “BlockConfiguration|InputFailure”; the AI block may be referring to an invalid data such as pressure for on a MFC or MFM.

Block Error indicates “Configuration Error”, scaling may not be set properly:

- L_TYPE set to Direct, the Engineering unit must be part of the available unit for the sensor (for more information, refer to “Function Block Units for MFC” on page 23 or “Function Blocks Implementation for Pressure Controllers (PCs)” on page 29).

- L_TYPE set to Indirect, XD_SCALE and OUT_SCALE must be adjusted to report a value corresponding to the current process. When set to indirect, the usual unit for XD_SCALE is percent (%).

8.3. AO Function block stays in OOS or status is bad

Check Channel, channel must match the type of data requested. Channel needs to be checked if the device is moved from one type of host controller to another.

The setpoint XD_SCALE must match the controlled sensor (Flow for MFC, Pressure for PC) PRIMARY_VALUE_RANGE information. The setpoint XD_SCALE must be Identical to the corresponding AI block.

For example, if the device is a Mass Flow controller and the AI block XD_SACLE for flow is set as follow:

INDEX_UNIT = SL/min
EU_100 = 100
EU_0 = 0
L_TYPE = DIRECT

EU_100 and EU_0 are not ignored as the L_TYPE is direct, check the PRIMARY_VALUE_RANGE_1 in the transducer block in order to determinate the scale. In this example:

PRIMARY_VALUE_RANGE_1.EU_100 = 1
PRIMARY_VALUE_RANGE_1.EU_0 = 0

The AO block XD_SCALE must be set as followed:

INDEX_UNIT = SL/min
EU_100 = 1
EU_0 = 0

8.4. DO Function block stays in OOS or status is bad

Check Channel, channel must match the type of data requested. Channel needs to be checked if the device is moved from one type of host controller to another.

8.5. Transducer block stays in OOS

Make sure no alarms are present in the system, some alarms, such as Temperature sensor connection, will also indicated a complete device failure. The default device state is forced to OOS and the Dev. LED will be red.

Device memory may have been erased and no calibration record can be selected. Please return the device to a Brooks Instrument service center to restore the calibration database.

After a fieldbus or device firmware update, the device may need to be power cycle a second time.

8.6. Device does not appear on the network

Please verify all power connection and the LED status to determinate the problem. The device will only appear on the network if both LEDs are study green.

First time connection, the device information is not initialized and it may take some time for the device to acquire a permanent address (dependant of the host system).

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9. Appendix: (Informative) Calibration

This information is provided to recommend parameters for a common user measurement calibration procedure.

The calibration process is used to match the channel value reading with the applied input. The calibration of the sensor itself is not changed, because that is a factory procedure. Five parameters are defined to configure this process: CAL_POINT_HI, CAL_POINT_LO, CAL_MIN_SPAN, CAL_UNIT, and SENSOR_RANGE. The CAL_* parameters define the highest and lowest calibrated values for this sensor, and the minimum allowable span value for calibration (if necessary). CAL_UNIT allows the user to select different units for calibration purposes than the units defined by SENSOR_RANGE.

The SENSOR_RANGE parameter defines the maximum and minimum values the sensor is capable of indicating, the engineering units used, and the decimal position. The upper and lower sensor limits shown in the figure are part of the SENSOR_RANGE parameter.

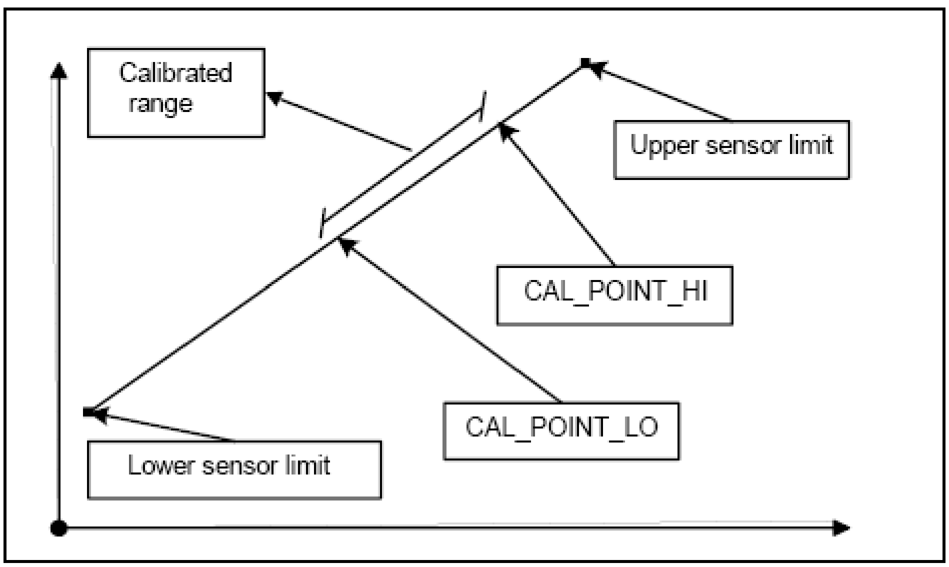

Figure 9-1 Upper and Lower Sensor Limits

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LIMITED WARRANTY
Seller warrants that the Goods manufactured by Seller will be free from defects in materials or workmanship under normal use and service and that the Software will execute the programming instructions provided by Seller until the expiration of the earlier of twelve (12) months from the June, 2008 of initial installation or eighteen (18) months from the June, 2008 of shipment by Seller.

Products purchased by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer.

All replacements or repairs necessitated by inadequate preventive maintenance, or by normal wear and usage, or by fault of Buyer, or by unsuitable power sources or by attack or deterioration under unsuitable environmental conditions, or by abuse, accident, alteration, misuse, improper installation, modification, repair, storage or handling, or any other cause not the fault of Seller are not covered by this limited warranty, and shall be at Buyer's expense.

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Our dedicated flow experts provide consultation and support, assuring successful applications of the Brooks flow measurement and control products.

Calibration facilities are available in local sales and service offices. The primary standard calibration equipment to calibrate our flow products is certified by our local Weights and Measures Authorities and traceable to the relevant international standard.

START-UP SERVICE AND IN-SITU CALIBRATION
Brooks Instrument can provide start-up service prior to operation when required.
For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this services can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standard.

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