FLUID COMPONENTS INTERNATIONAL LLC

FOUNDATION™ fieldbus Manual

ST100 Series
Thermal Mass Flow Meter

FOUNDATION

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Introduction

This manual describes the ST100 FOUNDATION™ fieldbus features, its operation and configuration. The ST100 can provide up to four different process variables. It provides Flow, Temperature, Flow Totalizer and Pressure as outputs. The flow output can be selected as volumetric, mass or velocity units. The basic ST100 can support up to two flow sensors providing the average flow of the two sensors in a single output.

FOUNDATION fieldbus is different from other communication protocols because it is designed to resolve process control applications instead of just transfer data in a digital mode.

This document is applicable to all members of the ST100 series product line configured with FOUNDATION fieldbus digital communication protocol.

FOUNDATION fieldbus is provided through an extension card that is fully integrated into the ST100 instrument.

Definition

AI Block: Analog Input Block. This block receives the ST100 process data variables from the Process Data Transducer Block and makes the process data available for the function blocks.

There are four AI blocks in the ST100. These are the Flow AI Block, Temperature AI Block, Totalizer AI Block and the Pressure AI block. Not all Process Variables are available in every member of the ST100 family.

TB Block: Transducer Block. This block makes the connection to the ST100 signal processing hardware, presents the process variables and eases instrument setup through FOUNDATION fieldbus.

PID Block: The Proportional, Integral, Derivative, control function block offers a lot of control algorithms that use the Proportional, Integral, and Derivative Terms. The algorithm of the ST100 PID is the non-iterative, ISA version.

RS Block: The Resource block contains basic FOUNDATION fieldbus information about the ST100 and some configuration data.

FF Configurator: A software tool used to access data and configure FOUNDATION fieldbus devices.

DD Files: The Device Description Files are used by configuration software, like the NI configurator or handheld configurators like the Emerson 475, or other FOUNDATION fieldbus hosts. The DD files describe the FOUNDATION fieldbus device. They also allow for custom manufacturer-specific features to be added to a FOUNDATION fieldbus device, and provide the means for the host to access the instrument's custom features.

FCI Configurator: A software application for accessing ST100 functions and features. The application is typically used for basic instrument setup and configuration, as well as provide access to advance functions. The FCI configurator interfaces through the ST100 USB service port or the Ethernet service port.

Installation

General

For details on the general mounting, placement of sensor head, and mounting options see the Basic User Manual.

Electrical Wiring

Access the wiring terminal block by removing the rear Electrical Connection Cover. This cover can be locked closed by the cover locking screw. Release the cover locking screw and remove the cover.

Cable access to wiring connections is obtained through one of the conduit ports.

FCI recommends the use of FOUNDATION fieldbus H1 cable compliant with the "H1 Cable Test Specification FF-844".

The FOUNDATION fieldbus connections for the ST100 are located on the interface circuit board under the solid cover. The J46 FOUNDATION fieldbus connector has pins labeled "FIELD_BUS_+" and "FIELD_BUS_-". The ST100 FOUNDATION fieldbus connections are non-polarized, but polarity needs to be observed for other manufacturer's devices. Connect the FOUNDATION fieldbus cable as shown in Figure 1.

In addition to the FOUNDATION fieldbus connections on the back panel, the ST100 also has a series of jumpers used to select the digital communication protocol. Confirm that J3 and J4 have the shorting jumper installed, which selects the FOUNDATION fieldbus output.

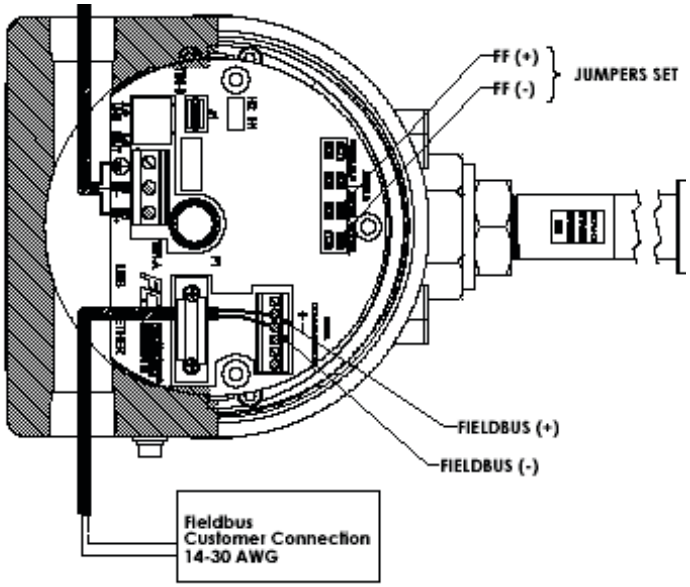


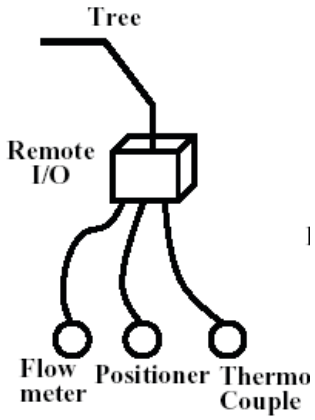
Figure 1

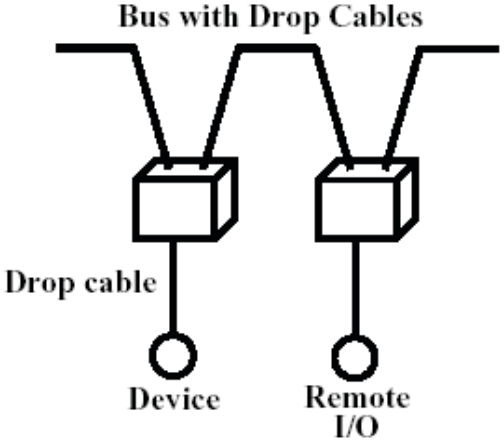
Topology and Network Configuration

The ST100 supports both Bus topology and Tree topology. Both types have a trunk cable with two terminations. The devices are connected to the trunk via spurs. The spurs may be integrated in the device giving zero spur length. A spur may connect more than one device, depending on the length. Active couplers may be used to extend spur lengths.

Active repeaters may be used to extend the trunk length.

The total cable length, including spurs, between any two devices in the FOUNDATION fieldbus network should not exceed 1900 m. The connection of couplers should be kept less than 15 per 250 m.





Operation

Functional Description

The ST100 is a flow meter with three flow classifications: volumetric flow, mass flow, and velocity flow. In addition, the ST100 family of instruments offers process temperature and process pressure.

The FOUNDATION fieldbus functionality is organized into two modes; an Instrument Process Data mode, and an Instrument Setup mode. To support these two modes, two transducer blocks were designed, one for process data and one for basic setup data.

The ST100 can support up to 2 flow sensors, the output is presented as an average of the two flow sensors. The ST100 has the capability of viewing the output of each sensor head.

Function Transducer Blocks

The ST100 provides the following FOUNDATION feldbus blocks to present its process data and setup features: Resource Block, Process data Transducer block, Service Transducer Block, Flow Analog Input Block, Temperature Analog Input, Totalizer Analog Input and Pressure Analog Input Block.

Data Types Definitions

DS-64 Data Type

E	Element Name	Data Type	Size
1	Block Tag	VisibleString	32
2	DD MemberId	Unsigned32	4
3	DD ItemId	Unsigned32	4
4	DD Revision	Unsigned16	2
5	Profile	Unsigned16	2
6	Profile Revision	Unsigned16	2
7	Execution Time	Unsigned32	4
8	Period of Execution	Unsigned32	4
9	Number of Parameters	Unsigned16	2
10	Next FB to Execute	Unsigned16	2
11	Starting Index of Views	Unsigned16	2
12	NumberofVIEW_3	Unsigned8	1
13	NumberofVIEW_4	Unsigned8	1

DS-65 Floating Point Value & Status

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

DS-69 Mode Structure

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

DS-72 Alarm Discrete Structure

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

DS-73 Event Update Structure

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

DS-74 Alarm Summary Structure

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

DS-85 Test Structure

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

Other Data Types used in the ST100

- Unsigned 16 and 32 bit integers
- Floating Point (Single Precision)

Resource Block

This block contains data that is specific to the ST100 hardware that is associated with the resource. All data is modeled as contained, so there are no links in the Block.

ITK_VER parameter

This parameter provides the ITK version to which the device is certified. The ST100 is certified to Version 5.

FD_VER parameter

This parameter provides the device Field Diagnostic Specification. The ST100 uses Version 1.

MANUFAC_ID parameter

This parameter provides the manufacturer identification number. An interface device to locate the DD file uses the MANUFAC_ ID parameter. The manufacturer ID for Fluid Component international is 0x01FC49.

DEV_TYPE parameter

This parameter provides the manufacturer's model number associated with the resource. The Fluid Components model number is FCI ST100.

DEV_REV parameter

This parameter provides the manufacturer's revision number associated with the resource. Fluid Components revision number is 1.

DD_REV parameter

This parameter provides the DD file revision of the associated resource. Fluid Components DD file revision number is 1.

ST100 Resource Block

Table 1 – ST100 Resource Block

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
0	BLOCK OBJECT	DS-64		
1	ST_REV	Unsigned16	0	
2	TAG_DESC	Octet String	spaces	
3	STRATEGY	Unsigned16	0	
4	ALERT_KEY	Unsigned8	0	
5	MODE_BLK	DS-69	O/S	
6	BLOCK_ERR	Bit String		
7	RS_STATE	Unsigned8		
8	TEST_RW	DS-85		
9	DD_RESOURCE	Visible String	null	
10	MANUFAC_ID	Unsigned32		
11	DEV_TYPE	Unsigned16		
12	DEV_REV	Unsigned8	0x01	
13	DD_REV	Unsigned8	0x01	
14	GRANT_DENY	DS-70		
15	HARD_TYPES	Bit String	0xC000	
16	RESTART	Unsigned8		
17	FEATURES	Bit String	0111.0100.0010.0000	
18	FEATURE_SEL	Bit String	0111.0100.0000.0000	
19	CYCLE_TYPE	Bit String		
20	CYCLE_SEL	Bit String	0	
21	MIN_CYCLE_T	Unsigned32		
22	MEMORY_SIZE	Unsigned16		
23	NV_CYCLE_T	Unsigned32		
24	FREE_SPACE	Float		
25	FREE_TIME	Float		
26	SHED_RCAS	Unsigned32	640000	
27	SHED_ROUT	Unsigned32	640000	
28	FAULT_STATE	Unsigned8		
29	SET_FSTATE	Unsigned8	1	
30	CLR_FSTATE	Unsigned8	1	
31	MAX_NOTIFY	Unsigned8		
32	LIM_NOTIFY	Unsigned8	MAX_NOTIFY	
33	CONFIRM_TIME	Unsigned32	640000	

Table 1 – ST100 Resource Block (continued)

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
34	WRITE_LOCK	Unsigned8	1	
35	UPDATE_EVT	DS-73		
36	BLOCK_ALM	DS-72		
37	ALARM_SUM	DS-74		
38	ACK_OPTION	Bit String	0	
39	WRITE_PRI	Unsigned8	0	
40	WRITE_ALM	DS-72		
41	ITK_VER	Unsigned16		
42	FD_VER	Unsigned16	1	
43	FD_FAIL_ACTIVE	Bit String	0	
44	FD_OFFSPEC_ACTIVE	Bit String	0	
45	FD_MAINT_ACTIVE	Bit String	0	
46	FD_CHECK_ACTIVE	Bit String	0	
47	FD_FAIL_MAP	Bit String		
48	FD_OFFSPEC_MAP	Bit String		
49	FD_MAINT_MAP	Bit String		
50	FD_CHECK_MAP	Bit String		
51	FD_FAIL_MASK	Bit String		
52	FD_OFFSPEC_MASK	Bit String		
53	FD_MAINT_MASK	Bit String		
54	FD_CHECK_MASK	Bit String		
55	FD_FAIL_ALM	DS-87	0;0;0,0;0;0;0;15;0;0	
56	FD_OFFSPEC_ALM	DS-87	0;0;0,0;0;0;0;16;0;0	
57	FD_MAINT_ALM	DS-87	0;0;0,0;0;0;0;17;0;0	
59	FD_FAIL_PRI	Unsigned8	0	
60	FD_OFFSPEC_PRI	Unsigned8	0	
61	FD_MAINT_PRI	Unsigned8	0	
62	FD_CHECK_PRI	Unsigned8	0	
63	FD_SIMULATE	SIMULATE_FD	0;0;1	
64	FD_RECOMMEN_ACT	Unsigned16	0	

Process Data Transducer Block

This block connects the ST100 sensor process variable values and engineering units to the blocks output channels. The ST100 process variables are Flow, Temperature, Totalizer, and Pressure. Not all of these variables are available in all members of the ST100 family of products.

PRIMARY_VALUE parameter

This parameter makes available to the AI block the flow value of the ST100. Flow is organized into three classes; volumetric, mass, and velocity. Each class has its associated valid engineering units. Confirm that units match the flow class.

SECONDARY_VALUE parameter

This parameter makes available to the AI block the temperature value of the ST100. There are two valid engineering units associated with this parameter, ºC and ºF

TERTIARY_VALUE parameter

This parameter makes available to the AI block the Totalizer value of the ST100. This is an optional parameter that can be turned ON or OFF. It is associated with the volumetric flow and the mass flow. The units are set by the flow units selected.

QUATERNARY_VALUE parameter

This parameter makes available to the AI block the pressure value of the ST100. This is an optional parameter that can be activated when a flow sensor is connected to the ST100. The engineering units associated with this variable are PSIG, in H2Og, bar (g), Kpa(g), cm H2O g, in Hg, KpaA, mm Hg.

Engineering units can be viewed through this block.

ST100 Process Data Transducer Block

The table below summarizes the ST100 Process Data Transducer Block.

Table 2 – ST100 Process Data Transducer Block

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
0	BLOCK OBJECT	DS-64		
1	ST_REV	Unsigned16	0	
2	TAG_DESC	Octet String	spaces	
3	STRATEGY	Unsigned16	0	
4	ALERT_KEY	Unsigned8	0	
5	MODE_BLK	DS-69	0	
6	BLOCK_ERR	Bit String	0	
7	UPDATE_EVT	DS-73		
8	BLOCK_ALM	DS-72		
9	TRANSDUCER_DIRECTORY	Unsigned16	0	
10	TRANSDUCER_TYPE	Unsigned16	65534	
11	XD_ERROR	Unsigned8	0	
12	COLLECTION_DIRECTORY	Unsigned32		
13	PRIMARY_VALUE	DS-65	0; 0.0	ST100 Flow Variable
14	PRIMARY_VALUE_UNIT	Unsigned16	0	ST 100 Flow Units
15	SECONDARY_VALUE	DS-65	0; 0.0	ST 100 Temperature Variable
16	SECONDARY_VALUE_UNIT	Unsigned16	0	ST100 Temperature Variable
17	TERTIARY_VALUE	DS-65	0; 0.0	ST 100 Totalizer Variable
18	TERTIARY_VALUE_UNIT	Unsigned16	0	ST100 Totalizer Units
19	QUATERNARY_VALUE	DS-65	0; 0.0	ST100 Pressure Variable
20	QUATERNARY_VALUE_UNIT	Unsigned16	0	ST 100 Pressure Units

Service Transducer Block

This block is primarily used to setup, configure and diagnose the ST100 from a remote location via a FOUNDATION fieldbus configurator, or a system monitor. Variables set or changed by this block affect all sensors when rights are authorized. Write access is authorized through the "PC Configurator" application from a computer connected to the ST100 through its USB or Ethernet service ports.

This block provides access to the ST100 basic setup parameters; some are read and write others are read only. This block can be used to review factory set calibration limits and settings of other process variables, like the plenum size, and to read and write the engineering units of the process variables. In addition, this block can be used to view process data from individual sensor elements in a multi-point system.

This block does not have an output, and it does not make any data available to other blocks.

Factory Calibration Limits

MAX_CAL_FLOW parameter

This parameter provides the value of the maximum calibrated flow limit that was set by the factory, for the active flow classification, and cal group.

MIN_CAL_FLOW parameter

This parameter provides the value of the minimum calibrated flow limit that was set by the factory, for the active flow classification, and cal group.

MAX_CAL_TEMP parameter

This parameter provides the value of the maximum calibrated temperature limit that was set by the factory during the factory calibration process.

MIN_CAL_TEMP parameter

This parameter provides the value of the minimum calibrated temperature limit that was set by the factory during the calibration process.

MAX_CAL_PRES parameter

This parameter provides the value of the maximum calibrated pressure limit that was set by the factory during the factory calibration process. This parameter applies to instruments that have a pressure sensor.

MIN_CAL_PRES parameter

This parameter provides the value of the minimum calibrated pressure limit that was set by the factory. This parameter applies to instruments that have a pressure sensor.

Process Engineering Units

FLOW_ENG_UNITS parameter

This parameter provides the engineering units associated with the process flow variable.

TOTALIZER_ENG_UNITS parameter

This parameter provides the engineering units associated with the process Totalizer variable. The Totalizer applies only to flow units that are volumetric or mass, and it is a parameter that can be turned off.

PLENUM_SIZE_VALUE_DIAMETER parameter

This parameter provides the engineering units associated with the pipe size diameter parameter, or the width parameter of the duct in which the ST100 Flowmeter is installed.

PLENUM_SIZE_VALUE_HEIGHT parameter

This parameter provides the engineering units associated with the duct in which the ST100 flow meter is installed.

PRESSURE_ENG_UNITS parameter

This parameter provides the engineering units associated with the process Pressure variable. This parameter applies to instruments that have a pressure sensor, and may not be active in all instruments.

Factory Restore Command

FACTORY_RESTORE parameter

This parameter is a write only command that restores the instrument calibration to the calibration parameters that were set by the factory, for the presently active calibration group.

Individual Sensors Data View

This section of the Service Transducer Block is a read only section. It shows a snapshot of the process data that each individual sensor head is detecting. This section provides information for up to 16 sensors of a multi-point ST100 instrument.

Listed below are typical parameters for a sensor head (Sensor 1 shown).

FLOW_VALUE_SENSOR_1 parameter

This parameter provides the flow value of flow sensor 1 in SFPS.

TEMPERATURE_VALUE_SENSOR_1 parameter

This parameter provides the temperature value associated with flow sensor 1 in °F.

PRESSURE_VALUE_SENSOR_1 parameter

This parameter provides the pressure value associated with flow sensor 1 in PSIA.

ST100 Service Transducer Block

The table below summarizes the ST100 Service Transducer Block.

Table 3 – ST100 Service Transducer Block

BLOCK INFO				
INDEX	**PARAMETER**	**DATA TYPE (LENGTH)**	**INITIAL VALUE**	**DESCRIPTION**
0	BLOCK OBJECT	DS-64		
1	ST_REV	Unsigned16	0	
2	TAG_DESC	Octet String	spaces	
3	STRATEGY	Unsigned16	0	
4	ALERT_KEY	Unsigned8	0	
5	MODE_BLK	DS-69	0	
6	BLOCK_ERR	Bit String	0	
7	UPDATE_EVT	DS-73		
8	BLOCK_ALM	DS-72		
9	TRANSDUCER_DIRECTORY	Unsigned16	0	
10	TRANSDUCER_TYPE	Unsigned16	65534	
11	XD_ERROR	Unsigned8	0	
12	COLLECTION_DIRECTORY	Unsigned32		

Table 3 – ST100 Service Transducer Block (continued)

INDIVIDUAL SENSOR RD				
INDEX	**PARAMETER**	**DATA TYPE (LENGTH)**	**INITIAL VALUE**	**DESCRIPTION**
Fluid Components Specific Service Parameters				
13	FLOW VALUE SENSOR #1	Floating Point	0	
14	TEMPERATURE VALUE SENSOR #1	Floating Point	0	
15	PRESSURE VALUE SENSOR #1	Floating Point	0	
16	FLOW VALUE SENSOR #2	Floating Point	0	
17	TEMPERATURE VALUE SENSOR #2	Floating Point	0	
18	PRESSURE VALUE SENSOR #2	Floating Point	0	
19	FLOW VALUE SENSOR #3	Floating Point	0	
20	TEMPERATURE VALUE SENSOR #3	Floating Point	0	
21	PRESSURE VALUE SENSOR #3	Floating Point	0	
22	FLOW VALUE SENSOR #4	Floating Point	0	
23	TEMPERATURE VALUE SENSOR #4	Floating Point	0	
24	PRESSURE VALUE SENSOR #4	Floating Point	0	
25	FLOW VALUE SENSOR #5	Floating Point	0	
26	TEMPERATURE VALUE SENSOR #5	Floating Point	0	
27	PRESSURE VALUE SENSOR #5	Floating Point	0	
28	FLOW VALUE SENSOR #6	Floating Point	0	
29	TEMPERATURE VALUE SENSOR #6	Floating Point	0	
30	PRESSURE VALUE SENSOR #6	Floating Point	0	
31	FLOW VALUE SENSOR #7	Floating Point	0	
32	TEMPERATURE VALUE SENSOR #7	Floating Point	0	
33	PRESSURE VALUE SENSOR #7	Floating Point	0	
34	FLOW VALUE SENSOR #8	Floating Point	0	
35	TEMPERATURE VALUE SENSOR #8	Floating Point	0	
36	PRESSURE VALUE SENSOR #8	Floating Point	0	
37	FLOW VALUE SENSOR #9	Floating Point	0	
38	TEMPERATURE VALUE SENSOR #9	Floating Point	0	
39	PRESSURE VALUE SENSOR #9	Floating Point	0	
40	FLOW VALUE SENSOR #10	Floating Point	0	
41	TEMPERATURE VALUE SENSOR #10	Floating Point	0	
42	PRESSURE VALUE SENSOR #10	Floating Point	0	
43	FLOW VALUE SENSOR #11	Floating Point	0	
44	TEMPERATURE VALUE SENSOR #11	Floating Point	0	
45	PRESSURE VALUE SENSOR #11	Floating Point	0	
46	FLOW VALUE SENSOR #12	Floating Point	0	
47	TEMPERATURE VALUE SENSOR #12	Floating Point	0	
48	PRESSURE VALUE SENSOR #12	Floating Point	0	
49	FLOW VALUE SENSOR #13	Floating Point	0	
50	TEMPERATURE VALUE SENSOR #13	Floating Point	0	

Table 3 – ST100 Service Transducer Block (continued)

FACTORY SETTINGS				
INDEX	**PARAMETER**	**DATA TYPE (LENGTH)**	**INITIAL VALUE**	**DESCRIPTION**
51	PRESSURE VALUE SENSOR #13	Floating Point	0	
52	FLOW VALUE SENSOR #14	Floating Point	0	
53	TEMPERATURE VALUE SENSOR #14	Floating Point	0	
54	PRESSURE VALUE SENSOR #14	Floating Point	0	
55	FLOW VALUE SENSOR #15	Floating Point	0	
56	TEMPERATURE VALUE SENSOR #15	Floating Point	0	
57	PRESSURE VALUE SENSOR #15	Floating Point	0	
58	FLOW VALUE SENSOR #16	Floating Point	0	
59	TEMPERATURE VALUE SENSOR #16	Floating Point	0	
60	PRESSURE VALUE SENSOR #16	Floating Point	0	
61	MAX CAL FLOW	Floating Point	0	
62	MIN CAL FLOW	Floating Point	0	
63	MAX CAL TEMP	Floating Point	0	
64	MIN CAL TEMP	Floating Point	0	
65	MAX CAL PRESS	Floating Point	0	
66	MIN CAL PRESS	Floating Point	0	
67	FLOW_ENG_UNITS	Unsigned16	0	
68	PLENUM_ENG_UNITS	Unsigned16	0	
69	TEMP_ENG_UNITS	Unsigned16	0	
70	PRESSURE_ENG_UNITS	Unsigned16	0	
71	TOTALIZER_ENG_UNITS	Unsigned16	0	
72	PLENUM_SIZE_VALUE_DIAMETER	Floating Point	0	
73	PLENUM_SIZE_UNITS_HEIGHT	Floating Point	0	
74	FACTORY RESTORE	Unsigned8	0	

Flow Analog Input Block

This block takes the input data from the Process Data Transducer Block, selected by the "Flow Average Channel" and makes it available to other function blocks at its output.

L_TYPE parameter

This parameter determines how the values passed by the Process Transducer Block will be used in the block. There are two options; direct or indirect.

Direct The Process Data Transducer flow value is passed directly to the PV of this AI block, and the XD_SCALE information is not used.
Indirect The Process Data Transducer flow value is converted to the OUT_SCALE and the information of XD_SCALE is applied.

CHANNEL parameter

This parameter selects the process variable to be used. The CHANNEL parameter, in the ST100 for the Flow Analog Input Block MUST be set to "Flow Average".

XD_SCALE parameter

This parameter sets the high and low scale values, the units index, and the number of digits after the decimal point, for display purposes.

ST100 Flow Analog Input Block

The table below summarizes the ST100 Flow Analog Input Block.

Table 4 – ST100 Flow Analog Input Block

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
1	ST_REV	Unsigned 16	0	
2	TAG_DESC	OctString(32)	Spaces	
3	STRATEGY	Unsigned 16	0	
4	ALERT_KEY	Unsigned 8	0	
5	MODE_BLK	DS-69	O/S	
6	BLOCK_ERR	Bitstring(2)		
7	PV	DS-65		ST100 FLOW value from the transducer block
8	OUT	DS-65		ST100 FLOW value available to other function blocks
9	SIMULATE	DS-82	Disable	
10	XD_SCALE	DS-68	0 - 100%	
11	OUT_SCALE	DS-68	0 - 100%	
12	GRANT_DENY	DS-70	0	
13	IO_OPTS	Bitstring(2)	0	
15	CHANNEL	Unsigned16	0	The channel needs to be set to "Flow Average"
16	L_TYPE	Unsigned 8	0	
17	LOW_CUT	Float	0	
18	PV_FTIME	Float	0	
19	FIELD_VAL	DS-65		
20	UPDATE_EVT	DS-73		
21	BLOCK_ALM	DS-72		
22	ALARM_SUM	DS-74		
23	ACK_OPTION	Bitstring(2)		
24	ALARM_HYS	Float		
25	HI_HI_PRI	Unsigned 8		
26	H_HI_LIM	Float		
27	HI_PRI	Unsigned 8		
28	HI_LIM	Float		
29	LO_PRI	Unsigned 8		
30	LO_LIM	Float		
31	LO_LO_PRI	Unsigned 8		
32	LO_LO_LIM	Float		
33	HI_HI_ALM	DS-71		
34	HI_ALM	DS-71		
35	LO_ALM	DS-71		
36	LO_LO_ALM	DS-71		

Temperature Analog Input Block

This block takes the input data from the Process Data Transducer Block, selected by the "Temperature Average Channel" and makes it available to other function blocks at its output.

L_TYPE parameter

This parameter determines how the values passed by the Process Transducer Block will be used in the block. There are two options; direct or indirect.

Direct The Process Data Transducer temperature value is passed directly to the PV of this AI block, and the XD_SCALE information is not used.

Indirect The Process Data Transducer flow value is converted to the OUT_SCALE and the information of XD_SCALE is applied.

CHANNEL parameter

This parameter selects the process variable to be used. The CHANNEL parameter, in the ST100 for the Temperature Analog Input Block MUST be set to "Temperature Average".

XD_SCALE parameter

This parameter sets the high and low scale values, the units index, and the number of digits after the decimal point, for display purposes.

ST100 Temperature Analog Input Block

The table below summarizes the ST100 Temperature Analog Input Block.

Table 5 – ST100 Temperature Analog Input Block

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
1	ST_REV	Unsigned 16	0	
2	TAG_DESC	OctString(32)	Spaces	
3	STRATEGY	Unsigned 16	0	
4	ALERT_KEY	Unsigned 8	0	
5	MODE_BLK	DS-69	O/S	
6	BLOCK_ERR	Bitstring(2)		
7	PV	DS-65		ST100 TEMPERATURE value from the transducer block
8	OUT	DS-65		ST100 TEMPERATURE value available to other function blocks
9	SIMULATE	DS-82	Disable	
10	XD_SCALE	DS-68	0 - 100%	
11	OUT_SCALE	DS-68	0 - 100%	
12	GRANT_DENY	DS-70	0	
13	IO_OPTS	Bitstring(2)	0	
15	CHANNEL	Unsigned16	0	The channel needs to be set to "Temperature Average"
16	L_TYPE	Unsigned 8	0	
17	LOW_CUT	Float	0	
18	PV_FTIME	Float	0	
19	FIELD_VAL	DS-65		
20	UPDATE_EVT	DS-73		
21	BLOCK_ALM	DS-72		
22	ALARM_SUM	DS-74		

Table 5 – ST100 Temperature Analog Input Block (continued)

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
23	ACK_OPTION	Bitstring(2)		
24	ALARM_HYS	Float		
25	HI_HI_PRI	Unsigned 8		
26	H_HI_LIM	Float		
27	HI_PRI	Unsigned 8		
28	HI_LIM	Float		
29	LO_PRI	Unsigned 8		
30	LO_LIM	Float		
31	LO_LO_PRI	Unsigned 8		
32	LO_LO_LIM	Float		
33	HI_HI_ALM	DS-71		
34	HI_ALM	DS-71		
35	LO_ALM	DS-71		
36	LO_LO_ALM	DS-71		

Totalizer Analog Input Block

This block takes the input data from the Process Data Transducer Block, selected by the "Totalizer Average Channel" and makes it available to other function blocks at its output.

L_TYPE parameter

This parameter determines how the values passed by the Process Transducer Block will be used in the block. There are two options; direct or indirect.

Direct The Process Data Transducer Totalizer value is passed directly to the PV of this AI block, and the XD_SCALE information is not used.

Indirect The Process Data Transducer Totalizer value is converted to the OUT_SCALE and the information of XD_SCALE is applied.

CHANNEL parameter

This parameter selects the process variable to be used. The CHANNEL parameter, in the ST100 for the Totalizer Analog Input Block MUST be set to "Totalizer Average".

XD_SCALE parameter

This parameter sets the high and low scale values, the units index, and the number of digits after the decimal point, for display purposes.

ST100 Totalizer Analog Inupt Block

The table below summarizes the ST100 Totalizer Analog Input Block.

Table 6 – ST100 Totalizer Analog Input Block

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
1	ST_REV	Unsigned 16	0	
2	TAG_DESC	OctString(32)	Spaces	
3	STRATEGY	Unsigned 16	0	
4	ALERT_KEY	Unsigned 8	0	
5	MODE_BLK	DS-69	O/S	
6	BLOCK_ERR	Bitstring(2)		
7	PV	DS-65		ST100 Totalizer value from the transducer block

Table 6 – ST100 Totalizer Analog Input Block (continued)

8	OUT	DS-65		ST100 Totalizer value available to other function blocks
9	SIMULATE	DS-82	Disable	
10	XD_SCALE	DS-68	0 - 100%	
11	OUT_SCALE	DS-68	0 - 100%	
12	GRANT_DENY	DS-70	0	
13	IO_OPTS	Bitstring(2)	0	
15	CHANNEL	Unsigned16	0	The channel needs to be set to "Totalizer Average"
16	L_TYPE	Unsigned 8	0	
17	LOW_CUT	Float	0	
18	PV_FTIME	Float	0	
19	FIELD_VAL	DS-65		
20	UPDATE_EVT	DS-73		
21	BLOCK_ALM	DS-72		
22	ALARM_SUM	DS-74		
23	ACK_OPTION	Bitstring(2)		
24	ALARM_HYS	Float		
25	HI_HI_PRI	Unsigned 8		
26	H_HI_LIM	Float		
27	HI_PRI	Unsigned 8		
28	HI_LIM	Float		
29	LO_PRI	Unsigned 8		
30	LO_LIM	Float		
31	LO_LO_PRI	Unsigned 8		
32	LO_LO_LIM	Float		
33	HI_HI_ALM	DS-71		
34	HI_ALM	DS-71		
35	LO_ALM	DS-71		
36	LO_LO_ALM	DS-71		

Pressure Analog Input Block

This block takes the input data from the Process Data Transducer Block, selected by the "Totalizer Average Channel" and makes it available to other function blocks at its output.

L_TYPE parameter

This parameter determines how the values passed by the Process Transducer Block will be used in the block. There are two options; direct or indirect.

Direct The Process Data Transducer Pressure value is passed directly to the PV of this AI block, and the XD_SCALE information is not used.

Indirect The Process Data Transducer Pressure value is converted to the OUT_SCALE and the information of XD_SCALE is applied.

CHANNEL parameter

This parameter selects the process variable to be used. The CHANNEL parameter, in the ST100 for the Totalizer Analog Input Block MUST be set to "Pressure Average".

XD_SCALE parameter

This parameter sets the high and low scale values, the units index, and the number of digits after the decimal point, for display purposes.

ST100 Pressure Analog Input Block

The table below summarizes the ST100 Pressure Analog Input Block.

Table 7 – ST100 Pressure Analog Input Block

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
1	ST_REV	Unsigned 16	0	
2	TAG_DESC	OctString(32)	Spaces	
3	STRATEGY	Unsigned 16	0	
4	ALERT_KEY	Unsigned 8	0	
5	MODE_BLK	DS-69	O/S	
6	BLOCK_ERR	Bitstring(2)		
7	PV	DS-65		ST100 PRESSURE value from the transducer block
8	OUT	DS-65		ST100 PRESSURE value available to other function blocks
9	SIMULATE	DS-82	Disable	
10	XD_SCALE	DS-68	0 - 100%	
11	OUT_SCALE	DS-68	0 - 100%	
12	GRANT_DENY	DS-70	0	
13	IO_OPTS	Bitstring(2)	0	
15	CHANNEL	Unsigned16	0	The channel needs to be set to "Pressure Average"
16	L_TYPE	Unsigned 8	0	
17	LOW_CUT	Float	0	
18	PV_FTIME	Float	0	
19	FIELD_VAL	DS-65		
20	UPDATE_EVT	DS-73		
21	BLOCK_ALM	DS-72		
22	ALARM_SUM	DS-74		
23	ACK_OPTION	Bitstring(2)		
24	ALARM_HYS	Float		
25	HI_HI_PRI	Unsigned 8		
26	H_HI_LIM	Float		
27	HI_PRI	Unsigned 8		
28	HI_LIM	Float		
29	LO_PRI	Unsigned 8		
30	LO_LIM	Float		
31	LO_LO_PRI	Unsigned 8		
32	LO_LO_LIM	Float		
33	HI_HI_ALM	DS-71		
34	HI_ALM	DS-71		
35	LO_ALM	DS-71		
36	LO_LO_ALM	DS-71		

PID Block

This block offers control algorithms that use the Proportional, Integral and Derivative terms. The algorithm is non-iterative or ISA. In this algorithm the GAIN is applied to all terms of the PID, and the proportional and the integral actuate over the error, and the derivative actuates over the PV value.

ST100 PID Block

The table below summarizes the ST100 PID Block.

Table 8 – ST100 PID Block

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
1	ST_REV	Unsigned16	0	
2	TAG_DESC	OctString(32)	Blanks	
3	STRATEGY	Unsigned16	0	
4	ALERT_KEY	Unsigned8	0	
5	MODE_BLK	DS-69	OOS	
6	BLOCK_ERR	Bitstring(2)		
7	PV	DS-65	Bad ns 0	ns = non specific
8	SP	DS-65	G C/0	G C/0 = GOOD_CAS/0
9	OUT	DS-65	BOS	BOS = BAD_Out of service 0
10	PV_SCALE	DS-68	0-100%	
11	OUT_SCALE	DS-68	0-100%	
12	GRANT_DENY	DS-70	0,0	
13	CONTROL_OPTS	Bitstring(2)	0	
14	STATUS_OPTS	Bitstring(2)	0	
15	IN	DS-65	BNc	BNc= Bad-Not connected 0
16	PV_FTIME	Float	0	
17	BYPASS	Unsigned8	Unititialized	
18	CAS_IN	DS-65	BNc	BNc= Bad-Not connected 0
19	SP_RATE_DN	Float	+INF	
20	SP_RATE_UP	Float	+INF	
21	SP_HI_LIM	Float	100	
22	SP_LO_LIM	Float	0	
23	GAIN	Float	0	
24	RESET	Float	+INF	
25	BAL_TIME	Float	0	
26	RATE	Float	0	
27	BKCAL_IN	DS-65	BNc	BNc = Bad_Not connected /0
28	OUT_HI_LIM	Float	100	
29	OUT_LO_LIM	Float	0	
30	BKCAL_HYS	Float	0.5%	
31	BKCAL_OUT	DS-65	BNs0	BNs0 = Bad-Non Specific 0
32	RCAS_IN	DS-65	Bos0	Bos0=Bad-Out of Service/0
33	ROUT_IN	DS-65	Bos0	Bos0=Bad-Out of Service/0
34	SHED_OPT	Unsigned8	Uninitialized	
35	RCAS_OUT	DS-65	BNs0	BNs0 = Bad-Non Specific 0
36	ROUT_OUT	DS-65	BNs0	BNs0 = Bad-Non Specific 0

Table 8 – ST100 PID Block (continued)

INDEX	PARAMETER	DATA TYPE (LENGTH)	INITIAL VALUE	DESCRIPTION
37	TRK_SCALE	DS-68	0-100%	
38	TRK_IN_D	DS-66	BNcO	BncO=Bad-Not connected/ off
39	TRK_VAL	DS-65	BNc	BNc = Bad_Not connected /0.0
40	FF_VAL	DS-65	BNc	BNc = Bad_Not connected /0.0
41	FF_SCALE	DS-68	0-100%	
42	FF_GAIN	Float	0.0	
43	UPDATE_EVT	DS-73		
44	BLOCK_ALM	DS-72		
45	ALARM_SUM	DS-74	All alarms enabled	
46	ACK_OPTION	Bitstring(2)	Auto ACK disabled	
47	ALARM_HYS	Float	0.5%	
48	HI_HI_PRI	Unsigned8	0	
49	HI_HI_LIM	Float	+INF	
50	HI_PRI	Unsigned8	0	
51	HI_LIM	Float	+INF	
52	LO_PRI	Unsigned8	0	
53	LO_LIM	Float	-INF	
54	LO_LO_PRI	Unsigned8	0	
55	LO_LO_LIM	Float	-INF	
56	DV_HI_PRI	Unsigned8	0	
57	DV_HI_LIM	Float	+INF	
58	DV_LO_PRI	Unsigned8	0	
59	DV_LO_LIM	Float	-INF	
60	HI_HI_ALM	DS-71		
61	HI_ALM	DS-71		
62	LO_ALM	DS-71		
63	LO_LO_ALM	DS-71		
64	DV_HI_ALM	DS-71		
65	DV_LO_ALM	DS-71		

Link Master Function

The ST100 with FOUNDATION fieldbus protocol supports the Link Master function, and it is capable of becoming a Link Active Scheduler (LAS).

A Link Master (LM) is any device containing Link Active Scheduler (LAS) functionality that can control communications on an H1 fieldbus link. There must be at least one LM on an H1 Link; one of those LM devices will be elected to serve as LAS.

A Link Active Scheduler (LAS) is a deterministic, centralized bus scheduler that maintains a list of transmission times for all data buffers in all devices that need to be cyclically transmitted. Only one Link Master (LM) device on an H1 fieldbus link can be functioning as that link's LAS.

Operation

The Link Active Scheduler (LAS) has a list of transmit times for all data buffers in all devices that need to be cyclically transmitted.

When it is time for a device to send a buffer, the LAS issues a Compel Data (CD) message to the device.

Upon receipt of the CD, the device broadcasts or "publishes" the data in the buffer to all devices on the fieldbus. Any device configured to receive the data is called a "subscriber".

Scheduled data transfers are typically used for the regular, cyclic transfer of control loop data between devices on the fieldbus.

Configuration

For details on the general mounting, placement of sensor head, and mounting options see the *Installation, Operation & Maintenance Manual* for the ST100 Series Thermal Mass Flow Meter, document number 06EN003400.

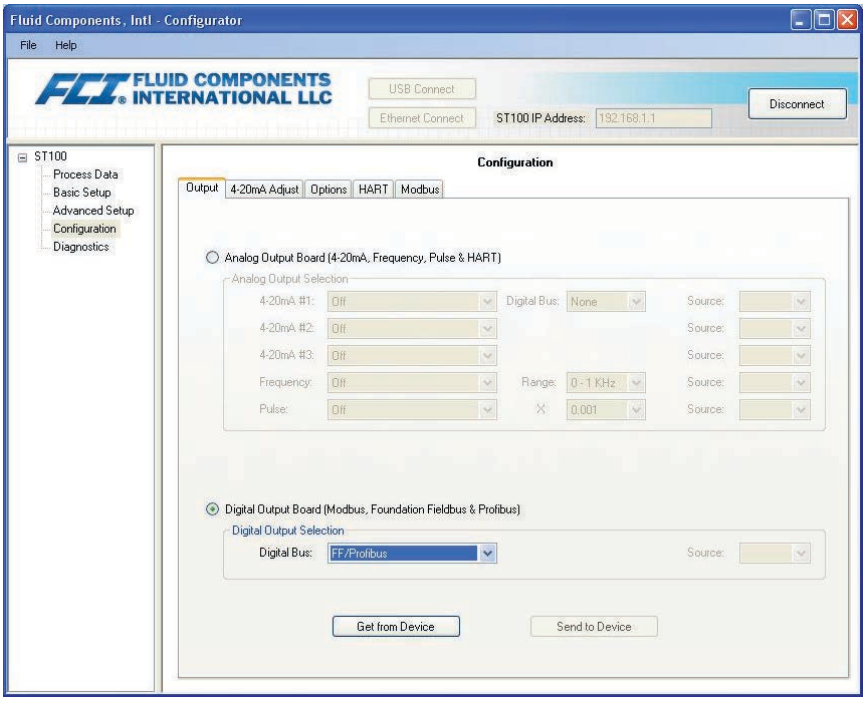
Setting the ST100 for FOUNDATION fieldbus Operation

Note: If the ST100 was ordered from the factory as a FOUNDATION fieldbus device, the factory will have configured the instrument accordingly with no further instrument configuration required.

The ST100 PC configurator is use to select the communication protocol.

Connect the PC with the configurator software to the ST100 USB port using FCI's cable USB cable (P/N 022646).

To configure the ST100 for FOUNDATION fieldbus invoke the ST100 Configurator, then from the tree menu, on the left side, select "Configuration", then select the "Output" tab. In the Output Tab select "Digital Output Board" and then from the pull down menu select "FF/Profibus".



Configuring the ST100 FOUNDATION fieldbus AI Blocks

All activities described below are done with the use of the National Instruments FOUNDATION fieldbus Configurator. These steps represent the minimum steps to put an AI block into AUTO mode.

ST100 Flow Analog Input Block (AI)

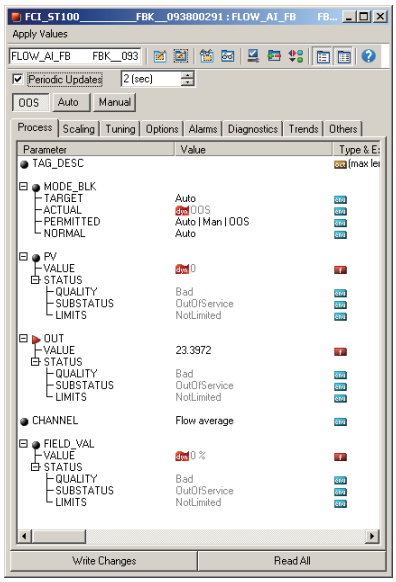
Import the DD files for use with the NI configurator by using the NI utility "Interface Configurator", if the DD files have not been loaded.

Start up the NI configurator and allow it find the ST100 Instrument in the FF segment.

Open up the "Function Block Application" in the NI configurator, and drag the desired AI block into it, in this case the Flow AI block. If there are other AI blocks to be loaded drag those in the Function Block Application area.

In the NI configurator under the "Configure" pull down menu select "Download Configuration". Then in the "Download Configuration" pop-up screen check the "Clear Device" check box, and proceed to press the "Download" button.

Configuring the Flow AI block

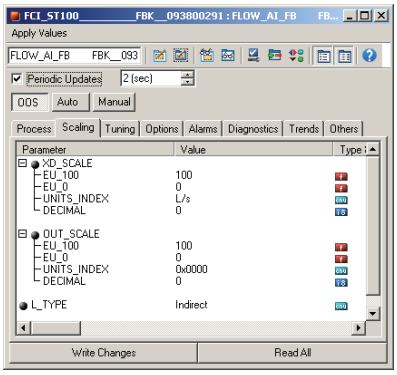


Double click on the "Flow" AI block.

If the MODE_BLK.TARGET of the AI block is not set to 'OOS', set it to 'OOS'.

Note: Some parameters can be written only if the MODE_BLK. ACTUAL is set to 'OOS'.

- Set the CHANNEL parameter to "Flow average".
- Set the UNITS_INDEX parameter to the desired flow units i.e. "L/s".
- Set the L_TYPE parameter to "Indirect" It can also be "Direct" if XD_SCALE and OUT_SCALE parameters have the same values.

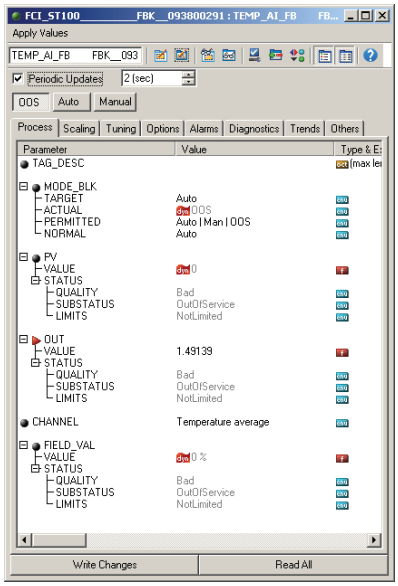


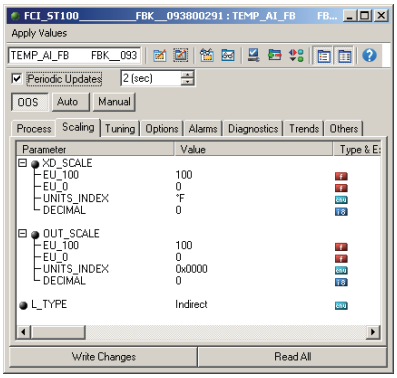
Confirm that the BLOCK_ERR parameter indicating "Out of Service". Once all of the above have been confirmed, set the block Mode into AUTO, and confirm that the bock is providing updated flow process data in the OUT parameter. If all conditions are met then the MODE_BLK.ACTUAL parameter of AI block goes into 'Auto'.

Configuring the Temperature AI Block

The configuration process is similar to the Flow AI block except for the parameter setting below.

- Set the CHANNEL parameter to "Temperature Average".
- Set the UNITS_INDEX parameter to the desired temperature units i.e. "°C".

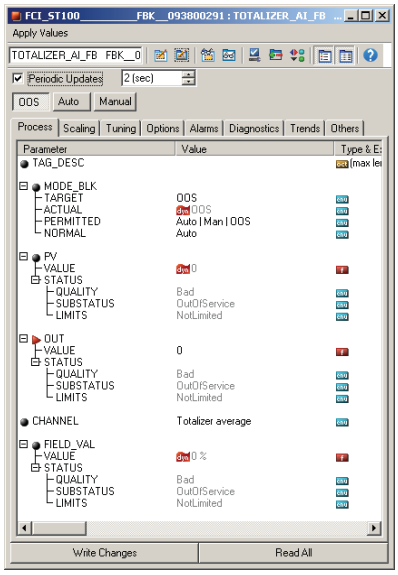


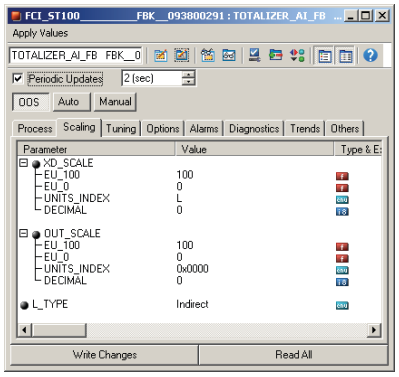


Configuring the Totalizer AI Block

The configuration process is similar to the Flow AI block except for the parameter setting below.

- Set the CHANNEL parameter to “Totalizer Average”.
- Set the UNITS_INDEX parameter to the Totalizer units that match the Flow units. If the flow units are ‘L/s’ that the Totalizer units must be ‘L’.

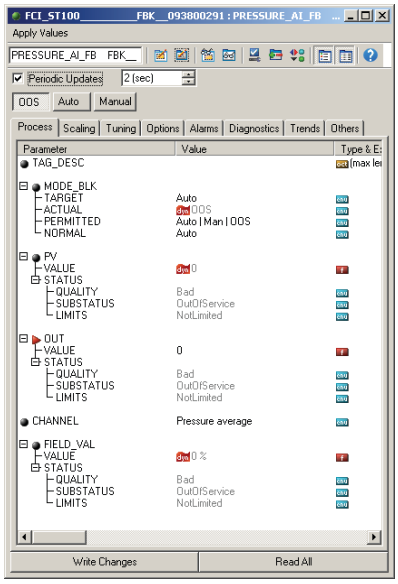


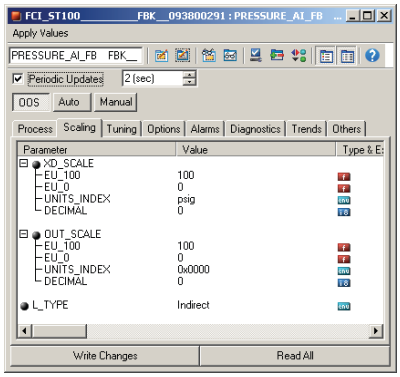


Configuring the Pressure AI Block

The configuration process is similar to the Flow AI block except for the parameter setting below.

- Set the CHANNEL parameter to “Pressure Average”.
- Set the UNITS_INDEX parameter to the desired pressure units i.e. “PSIG”.





Using the ST100 FOUNDATION fieldbus Service Transducer Block

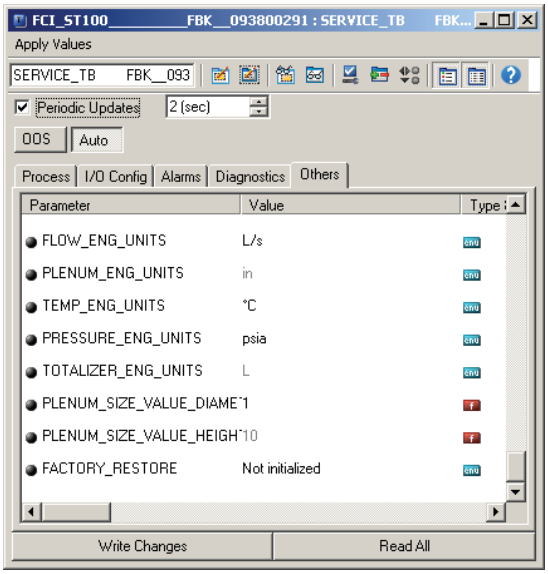
Introduction to the Service Transducer Block

The ST100 Service Transducer Block provides viewing access to a number of parameters and the ability to read and write a number of other instrument parameters through the FOUNDATION fieldbus Configurator tool.

This section is organized into three parts. The first part covers the instruments basic setup functions, the second part allows viewing of the instrument Min and Max setting for the process variables, and the third part allows viewing of individual sensor head process parameters in a multi-point system.

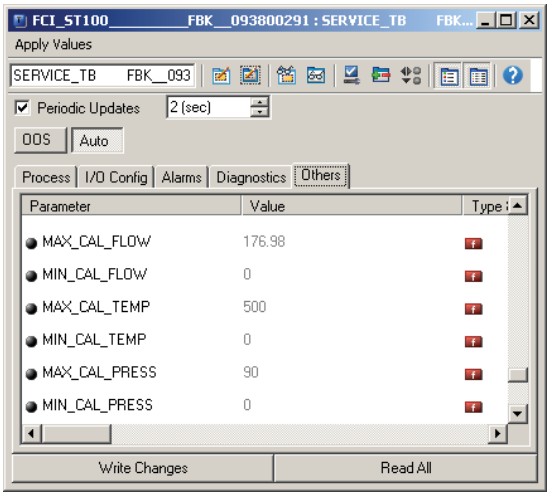
Basic Instrument Setup Functions

The basic setup functions include the ability to change and read engineering units for the process variable and the plenum. It also includes the ability to read and change the value of the plenum dimensions, and the ability to restore the factory calibration and setup values for the current Calibration Group.



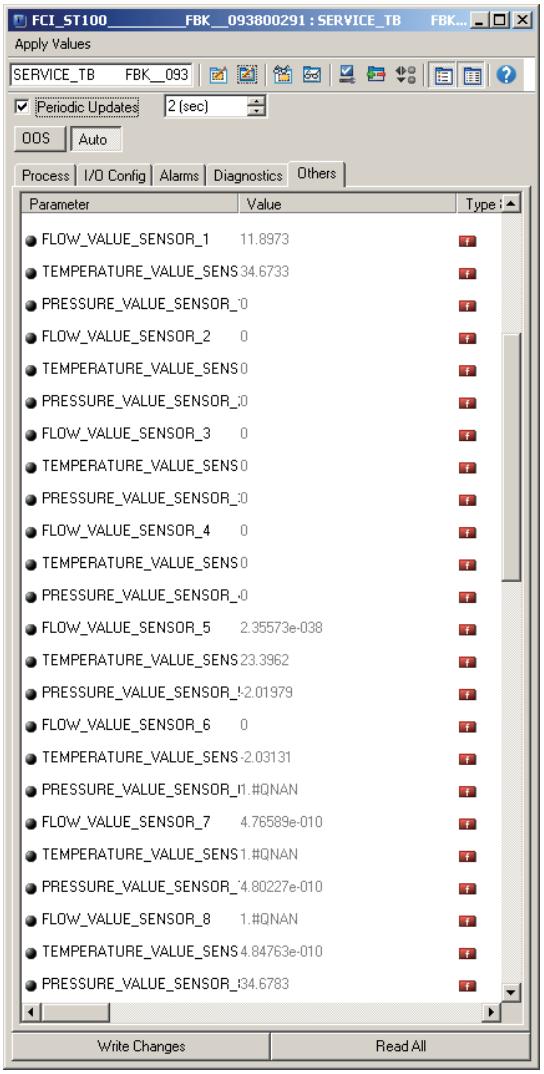
Review of Instrument Min/Max Settings

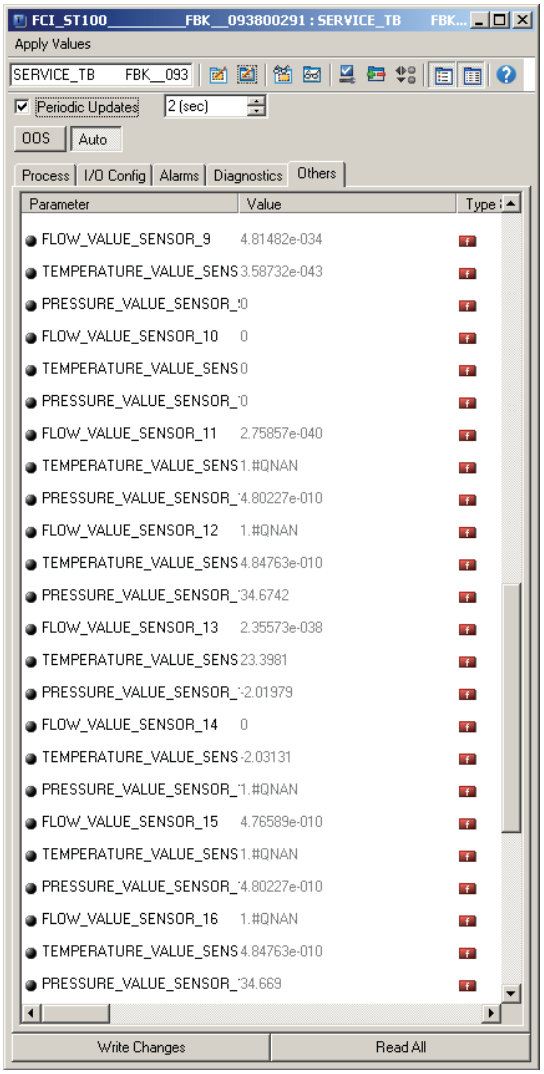
The Min/Max Setting Review lets you read the instrument's Flow Calibration maximum and minimum limits, the instrument's Temperature Calibration maximum and minimum limits and the Pressure Calibration minimum and maximum limits.



Advance Instrument Functions

The Advance Instrument Functions consist of the ability to review the process variable data of each sensor element channel, in a multi-point instrument. The data is not a continuous read but a one shot read when the block is open. To update the values of the channels the read button needs to be pressed. The instrument has the ability to show data for up to 16 sensor elements.





Device Description Files

General DD FILES

The DD files are device support files that include two device description files, and one capability files. DDs are platform and operating system independent.

The DD provides an extended description of each object in the Virtual Field Device (VFD).

The DD provides information needed for a control system or host to understand the meaning of the data in the VFD including the human interface for functions such as calibration and diagnostics. Thus, the DD can be thought of as a "driver" for the device.

The ST100 DD files are found under a file folder labeled "01FC49", and subfolder 0001:

0101.ffo

0101.sym

010101.cff

Emerson 475 Field Communicator

The Emerson Communicator uses the FOUNDATION fieldbus DDP files to interface with the FOUNDATION fieldbus device. These files must be loaded into the Emerson Fieldbus Communicator.

The ST100 FOUNDATION fieldbus DDP files are found under a file folder labeled "EMERSON_475_FILES", and subfolder 01FC49\0001 :

01FC49000101.fdd

01FFC9000101.fhd

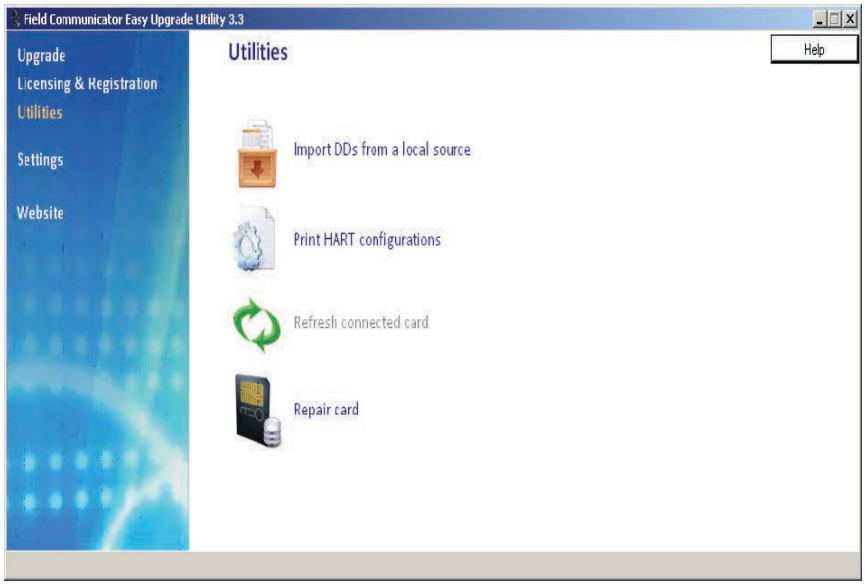
0101.ffo

0101.sym

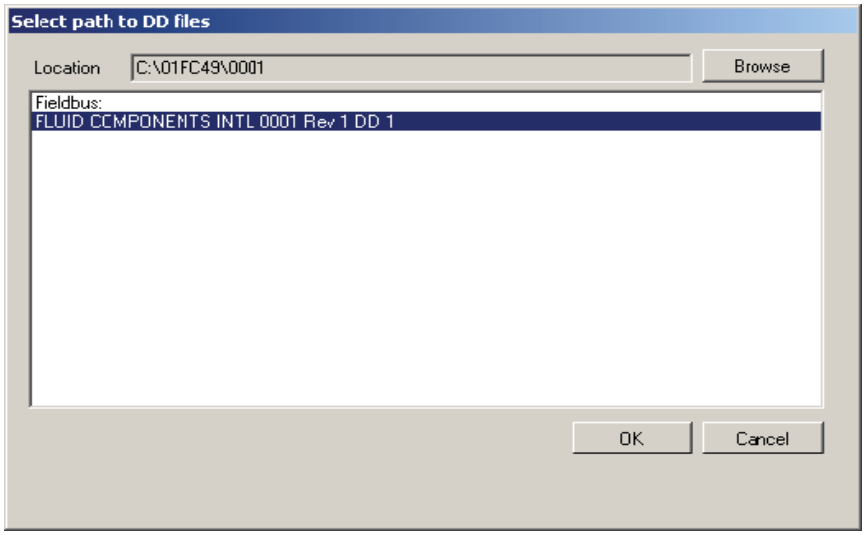
010101.cff

Load these files in the C:\01FC49\0001 directory.

To load the DDPs into the Field Communicator use the *Easy Upgrade Utility* from Emerson. First import the DDs by selecting "Utilities" and "Import DDs from a local source".



Select the FCI files and press "OK".



Technical Characteristics

Manufacturer ID:	01FC49
Output Signal:	H1 compliant to IEC 61158-2, bus powered. Integral reverse polarity protection.
Data transmission rate:	31.25 kBit/s, voltage mode
Signal coding:	Manchester II
LAS function:	LAS function supported.
Supported communication:	Publisher, Subscriber
H1 Profile Class:	31PS, 32L
H1 Device Class:	Link Master
Function Blocks:	Process Data TB Service Data TB Flow AI Temperature AI Totalizer AI Pressure AI PID
Certification:	Register Instrument (Test Campaign # IT071900)
Register Features:	Alarms and Events Function Blocks (1-RB2(e), 4-AI(s), 1-PID(s), 2-TB(s)) Linking Trending Muti-bit Alert Reporting Field Diagnostics

Customer Service/Technical Support

FCI provides full in-house technical support. Additional technical representation is also provided by FCI field representatives. Before contacting a field or in-house representative, please perform the troubleshooting techniques outlined in this document.

By Mail

Fluid Components International LLC
1755 La Costa Meadows Dr.
San Marcos, CA 92078-5115 USA
Attn: Customer Service Department

By Phone

Contact the area FCI regional representative. If a field representative is unable to be contacted or if a situation is unable to be resolved, contact the FCI Customer Service Department toll free at 1 (800) 854-1993.

By Fax

To describe problems in a graphical or pictorial manner, send a fax including a phone or fax number to the regional representative. Again, FCI is available by facsimile if all possibilities have been exhausted with the authorized factory representative. Our fax number is 1 (760) 736-6250; it is available 7 days a week, 24 hours a day.

By Email

FCI Customer Service can be contacted by email at: techsupport@fluidcomponents.com.

Describe the problem in detail making sure a telephone number and best time to be contacted is stated in the email.

International Support

For product information or product support outside the contiguous United States, Alaska, or Hawaii, contact your country's FCI International Representative or the one nearest to you.

After Hours Support

For product information visit FCI at www.fluidcomponents.com. For product support call 1 (800) 854-1993 and follow the prerecorded instructions.

Point of Contact

The point of contact for service, or return of equipment to FCI is your authorized FCI sales/service office. To locate the office nearest you, please go to www.fluidcomponents.com.

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Appendix A – ST100 FOUNDATION fieldbus Engineering Units/Codes

Unit		CLI	FOUNDATION Fieldbus
Temperature			
Fahrenheit		70	1002
Celsius		67	1001
Flow			
Standard Feet (vel)	SFPS	70	1067
	SFPM	83	1070
	SFPH	84	1073
	SFPD	85	32768
Normal Meters (vel)	NMPS	86	1061
	NMPM	87	32769
	NMPH	88	1063
	NMPD	89	32770
Standard Cubic Feet (vol)	SCFS	90	32771
	SCFM	67	1360
	SCFH	72	1361
	SCFD	91	32772
Pounds (mass)	LBPS	80	1330
	LBPM	65	1331
	LBPH	76	1332
	LBPD	92	1333
Kilograms (mass)	KGPS	73	1322
	KGPM	74	1323
	KGPH	75	1324
	KGPD	93	1325
Normal Cubic Meters (vol)	NCMS	94	1522
	NCMM	79	1523
	NCMH	78	1524
	NCMD	95	1525
Normal Liters (vol)	NLPS	68	1351
	NLPM	96	1352
	NLPH	97	1353
	NLPD	98	1354
Tonnes (mass)	TNPS	99	1326
	TNPM	100	1327
	TNPH	101	1328
	TNPD	102	1329
Totalizer			
Standard Cubic Feet		90	1053
Pounds		80	1094
Kilograms		73	1088
Normal Cubic meters		94	1521
Normal Liters		68	1038
Tonnes		99	1092
Pressure			
psi A		1	1142
psi G		2	1143
inches H_2O G		3	1560
inches Hg		4	1155
bar A		5	1597
bar G		6	1590
kPa A		7	1547
kPa G		8	1548
cm H_2O G		9	32773
mm Hg		10	1157
torr A		11	1139
Plenum			
inches		0	1019
millimeters		1	1013

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