244LD, 244LVP LevelStar Intelligent Buoyancy Transmitters

Communication with FF-FIELDBUS

The intelligent buoyancy transmitters 244LD and 244LVP are designed to perform measurements for liquid level, interface and density of liquids based on the Archimedes buoyancy principle and are accessible via fieldbus communication according Foundation Fieldbus (FF) specifications under the common device type LevelStar FF.

FEATURES

- Power supply DC 12...30V
- Power Consumption 10.5 mA
- Process temperature –196°C to +500°C
- Multilingual full text graphic LCD
- Communication FIELDBUS according FF Specifications
- Connection according IEC 1158-2
- H1 ITK Profile 6
- Field Diagnostics (NE 107)
- Block Instantiation/Destantiation
- Function Blocks:
  - AI Analog Input
  - PID Proportional Integral Derivative
  - AR Arithmetic
  - IS Input Selector
  - OS Output Splitter

CONTENTS

1 CONFIGURATION VIA FIELDBUS

The intelligent transmitter LevelStar FF performs function block (FB) application of measurements according the Foundation Fieldbus (FF) specifications. Physically the LevelStar FF interfaces to external devices via one two-wire connection according the international standard IEC 1158-2. This two-wire connection is used for both power supply and digital communication of fieldbus. The general condition for the fieldbus agrees with the description of the communication protocol in [1] - [8].

The configuration of the transmitter LevelStar FF consists of two major parts: management configuration and device configuration.

1.1 Management Configuration

The management configuration is divided into network management and system management. Network management provides for the configuration of the communication stack in the device while system management provides for the synchronization of the execution of the device function blocks and the communication of block parameters on the fieldbus. In the LevelStar FF, the FF communication stack initializes implicitly most of the configuration parameters. Only some configuration parameters have to be customized for the FB application. Among these parameters, the following three are required in system management for identifying the device:

- Device identification (Device ID)
- Physical device tag
- Node address

For the LevelStar FF, they are initialized with the following values:

Name	Value
Device identification	3858842506<xx/yyyyyy>
Physical device tag	240FF-_<xx/yyyyyy>
Node address	248(0xf8) - Default

<xx/yyyyyy> = Device serial number (Fabrication number), e.g. 39/726561

The LevelStar FF may go through three major states before it can fully function on the network:

1. If the above values are assigned system management starts in state SM_UNINITIALIZED. In this state no other services but identifying the device and configuring the device with a physical device tag are available. For a more detailed description of system management services and procedures refer to [3].

2. If a Node address is assigned system management starts in the state SM_OPERATIONAL. The network management agent of the device activates the application layer protocols, allowing applications to communicate across the network. To become fully operational, further network communication configurations may be necessary.

3. If the station cannot use the assigned node address for that this address is already used by another device, the device is assigned one of the default addresses between 0xF8 - 0xFF and the state is set to SM_INITIALIZED. In this case no other services are available except assigning a node address, clearing the physical device tag and identifying the device.

The services listed below are supported by the LevelStar FF:

Service	Type
Variable Access	Read, Write and Information Report
Event Management	Event Notification Event Notification with Type Acknowledge Event Notification Alter Event Condition Monitoring
Context Management	Initiate, Abort and Reject
Object Dictionary (OD) Management	Get OD
VFD (Virtual Filed Device) Status	Status, Unsolicited Status, Identify

1.2 Device Configuration

Device configuration is devided into function block connection and parametrization. For the former, the LevelStar FF owns the following function blocks which can be connected to the inputs of the function blocks of other devices or the same device, depending on the application interested.

- 2 AI Function Blocks
- 1 PID Function Block
- IS Function Block
- OS Function Block
- AR Function Block

Parametrization includes the configuration of the FB application objects like parameters, trend, alert and AP directory objects. The LevelStar FF has an internal database containing all these objects that are a list of references to the parameters making up this application with data accessible via parameter indices, parameter names or DD-items (Device Description items). The device is configured via accessing the database through the communication of fieldbus. Together with the management configuration data, the database is stored in the device EEPROM with a static version number that increases after each of its updates. The parameters remain unchanged in case of power-off and keep so long until they are updated again.

The LevelStar FF provides the Action Object to allow Block Instantiation/Destantiation. Per default all Function Blocks are instantiated but with the exception of the first AI Function Block all other Function Blocks can be destantiated.

Per default the LevelStar FF is configured as a Basic Field Device but the LevelStar FF can also be configured as a Link Master device with the capability to become a Link Active Scheduler (LAS). A LAS initiate's scheduled communication, publishing data to all devices on the fieldbus. Scheduled data are typically used for regular, cyclic transfer of control loop data between devices.

A Fieldbus may have multiple Link Masters. If the current LAS fail, one of the remaining Link Masters will become the LAS and operation of the Fieldbus will continue.

The LevelStar FF is set in plant with a factory setting. A user can do further configurations of his own based on this elementary setting. Inversely, the user can also restore this setting whenever required (see Section 2).

2 PARAMETER

The internal database of the LevelStar FF is provided according the FF Standard Function Blocks with additional manufacturer-specific extensions and FF Transducer Block called Standard Pressure with Calibration Basic Device Access with additional manufacturer-specific extensions. The data contained in the database are communicated over the fieldbus and the objects contain these data are described by object descriptions. A collection of all object descriptions is called Object Dictionary (OD).

2.1 Parameter Table

The following table shows all objects (parameters) of the object dictionary for the LevelStar FF.

Table Legends:

Store

S: Static, the parameter must be stored non-volatile in EEPROM. Changing the parameter increases the static revision counter.

N: Non-volatile parameter stored in EEPROM. Changing the parameter does not increase the static revision counter.

D: Dynamic, the parameter is dynamic and is calculated or changed by the block. It is stored only in RAM.

Access

RO: Read-only
RW: Readable and writeable
Mix: Some elements in data structure are writeable while the others are read-only

Abreviation:

URV Upper Range Value
LRV Lower Range Value
DS Data structure

Index	Parameter Name	Type	Size in Bytes	Store	Access	Valid Range	Default Value	Access Error Code
0	OD_OBJECT_DESCRIPTION	OD_HDR	44	N	RO	-	-	-
1-255	Reserved by FF	Data Type & DS	-	-	-	-	-	-
256 - 297	Reserved	Data Type & DS	-	-	-	-	-	-
298	AP_DIRECTORY	Array of USIGN16	60	N	RO	-	-	-
299	Unused/Reserved	-	-	-	-	-	-	-
Link Parameters								
300-321	*FB_LINK01-FB_LINK22*	DS-81	8	N	RW	-	-	-
322-339	Unused/Reserved	-	-	-	-	-	-	-
Trend Parameters								
340-365	TREND_FLT01-TREND_FLT26	DS-78	97	N	RW	-	-	-
366-372	TREND_DIS01-TREND_DISC07	DS-79	49	N	RW	-	-	-
373-394	Unused/Reserved	-	-	-	-	-	-	-
Alert Parameters								
395	ALERT_EVENT	DS-77	19	N	RW	-	-	-
396	ALERT_DISCRETE	DS-76	22	N	RW	-	-	-
397	ALERT_FLOAT	DS-75	25	N	RW	-	-	-
398	ALERT_FD_D IAG	DS-88	24	N	RW	-	-	-
Action Object								
399	ACTION OBJECT	DS-86	7	N	RW	-	-	-
Resource Block Parameters								
400	BLK_DATA	DS-64	62	S	RW			
401	ST_REV	USIGN16	2	S	RO		0	
402	TAG_DESC	OSTRING	32	S	RW		Spaces	
403	STRATEGY	USIGN16	2	S	RW		0	

404	ALERT_KEY	USIGN8	1	S	RW	1…255	0	0x0003 0x1000
405	MODE_BLK	DS-69	4	Mix	RW	O/S, Auto	OOS	0x0004
406	BLOCK_ERR	BSTRING	2	D	RO		0	
407	RS_STATE	ENUM	1	D	RO	0: Undefined 1: Start/Restart 2: Initialisation 3: On-line Linking 4: On-line 5: Standby 6: Failured	(0) Undefined	
408	TEST_RW	DS-85	126	D	RW			
409	DD_RESOURCE	VSTRING	32	S	RO		Spaces	
410	MANUFAC_ID	ENUM	4	S	RO	Controlled by FF	0x385884	
411	DEV_TYPE	ENUM	2	S	RO	Set by manufacturer	0x2506	
412	DEV_REV	USIGN8	1	S	RO	Set by manufacturer	8	
413	DD_REV	USIGN8	1	S	RO	Set by manufacturer	1	
414	GRANT_DENY	DS-70	2	D	RW		0,0	
415	HARD_TYPES	BSTRING	2	S	RO	Set by manufacturer		
416	RESTART	ENUM	1	D	RW	0: Uninitialized 1: Run 2: Resource 3: Defaults 4: Processor	Run	0x0003
417	FEATURES	BSTRING	2	S	RO	Reports Soft W Lock Multi-bit Alarm (Bit-Alarm) Support	Reports, Soft W Lock, Multi-bit Alarm (Bit-Alarm) Support	
418	FEATURE_SEL	BSTRING	2	S	RW	Reports Soft W Lock Multi-bit Alarm (Bit-Alarm) Support	Reports, Soft W Lock, Multi-bit Alarm (Bit-Alarm) Support	
419	CYCLE_TYPE	BSTRING	2	S	RO	Scheduled, Block Execution	Scheduled, Block Execution	
420	CYCLE_SEL	BSTRING	2	S	RW	Scheduled, Block Execution	0x0000	

421	MIN_CYCLE_T	USIGN32	4	S	RO	Set by manufacturer	3200 1/32 ms	
422	MEMORY_SIZE	USIGN16	2	S	RO	Set by manufacturer	0 Kbytes	
423	NV_CYCLE_T	USIGN32	4	S	RO		0 1/32 ms	
424	FREE_SPACE	FLOAT	4	D	RO		0%	
425	FREE_TIME	FLOAT	4	D	RO		0%	
426	SHED_RCAS	USIGN32	4	S	RW		640000 1/32 ms(20 sec)	
427	SHED_ROUT	USIGN32	4	S	RW		640000 1/32 ms(20 sec)	
428	FAULT_STATE	ENUM	1	N	RO	1: Clear 2: Active	(1) Clear	
429	SET_FSTATE	ENUM	1	D	RW	1: Off 2: Set	(1) OFF	0x0003
430	CLR_FSTATE	ENUM	1	D	RW	1: Off 2: Clear	(1) OFF	0x0003
431	MAX_NOTIFY	USIGN8	1	S	RO	Set by manufacturer	20	
432	LIM_NOTIFY	USIGN8	1	S	RW	0 to MAX_NOTIFY	20	0x0003
433	CONFIRM_TIME	USIGN32	4	S	RW		640000 1/32 ms	0x0003
434	WRITE_LOCK	ENUM	1	S	RW	0: Unitialized 1: Not Locked 2: Locked	(1) Not Locked	0x0003
435	UPDATE_EVT	DS-73	14	D	RW			0x0006
436	BLOCK_ALM	DS-72	13	D	RW			0x0006
437	ALARM_SUM	DS-74	8	Mix	RW			
438	ACK_OPTION	BSTRING	2	S	RW	Disc Alm Auto Ack Blk Alm Auto Ack Fail Alm Auto Ack Off Spec Alm Auto Ack Maint Alm Auto Ack Check Alm Auto Ack	0x0000	
439	WRITE_PRI	USIGN8	1	S	RW	0 … 15	0	0x0003
440	WRITE_ALM	DS-72	13	D	RW			0x0006
441	ITK_VER	USIGN16	2	N	RO	Set by FF	6	
442	FD_VER	USIGN16	2	S	RO	Set by manufacturer	1	

443	FD_FAIL_ACTIVE	BSTRING	4	D	RO			
444	FD_OFFSPEC_ACTIVE	BSTRING	4	D	RO			
445	FD_MAINT_ACTIVE	BSTRING	4	D	RO			
446	FD_CHECK_ACTIVE	BSTRING	4	D	RO			
447	FD_FAIL_MAP	BSTRING	4	S	RW	See 3.3.4	No Sensor detected, Sensor Current too high, Sensor ref. voltage error, Temp. Sensor failure Electronic Temp. Sensor failure, Error in 100 Ohm res. meas., ADC Gain Defect, ADC-Bits Error, System offset error	
448	FD_OFFSPEC_MAP	BSTRING	4	S	RW	See 3.3.4	Finger Print Data compensation error, Factory Settings missing, Diagnose procedure not completed	
449	FD_MAINT_MAP	BSTRING	4	S	RW	See 3.3.4	PV out of sensor limits, PV out of measurement range, Sensor Temp. out of limits, Electronic Temp. out of limits, Displacer too light or removed	
450	FD_CHECK_MAP	BSTRING	4	S	RW	See 3.3.4	Check Alarm	
451	FD_FAIL_MASK	BSTRING	4	S	RW	See 3.3.4	0x00000000	
452	FD_OFFSPEC_MASK	BSTRING	4	S	RW	See 3.3.4	0x00000000	
453	FD_MAINT_MASK	BSTRING	4	S	RW	See 3.3.4	0x00000000	
454	FD_CHECK_MASK	BSTRING	4	S	RW	See 3.3.4	0x00000000	
455	FD_FAIL_ALM	DS-87	15	D	RW			0x0006
456	FD_OFFSPEC_ALM	DS-87	15	D	RW			0x0006
457	FD_MAINT_ALM	DS-87	15	D	RW			0x0006
458	FD_CHECK_ALM	DS-87	15	D	RW			0x0006
459	FD_FAIL_PRI	USIGN8	1	S	RW	0 …15	0	0x0003

460	FD_OFFSPEC_PRI	USIGN8	1	S	RW	0 … 15	0	0x0003
461	FD_MAINT_PRI	USIGN8	1	S	RW	0 … 15	0	0x0003
462	FD_CHECK_PRI	USIGN8	1	S	RW	0 …15	0	0x0003
463	FD_SIMULATE	DS-89	9	D	RW			
464	FD_RECOMMEN_ACT	ENUM	2	D	RO	See 3.3.4	No Action	
465	TARGET_ERROR	DS-256	12	D	RO	See 2.2.2.1	0;0;0;0;0;0	
466	DIAGNOSIS	DS-257	10	D	RO		0;0;0;0;0;0;0;0;0;0	
467	RESET_HIST_STATUS	ENUM	1	D	RW	0: Uninitialized 1: Clear history status 2: Clear all device status	(0) Uninitialized	0x0003
468	FACTORY_RESET	ENUM	1	D	RW	0: Uninitialized 1: Create factory setting 2: Restore factory setting	(0) Uninitialized	0x0003
469	SOFTWARE_REVISION	VSTRING	16	N	RO		x.y.z (e.g.: 8.98.2)	
470	HARDWARE_REVISION	VSTRING	16	N	RO		3	
471	CAPABILITY_LEV	ENUM	1	N	RO	0: capability level not supported 1: Instantiable-Block-Level	(1) Instantiable-Block-Level	
472	DEVICE_SER_NUM	VSTRING	16	S	RO		72/000000	
473	MODEL_CODE	VSTRING	32	S	RW		Spaces	
474	ECEP	VSTRING	6	S	RW		Spaces	
475	LOCAL_KEYS_CTRL	ENUM	1	S	RW	0: Uninitialized 1: All keys enable 4: All keys disable	(1) All keys enable	0x0003
476	MESSAGE_1	VSTRING	32	S	RW		Message 1	
477	MESSAGE_2	VSTRING	32	S	RW		Message 2	
478	MESSAGE_3	VSTRING	32	S	RW		Message 3	
479	MESSAGE_4	VSTRING	32	S	RW		Message 4	
480	MESSAGE_5	VSTRING	32	S	RW		Message 5	

481	LCD_CONFIG	ENUM	1	S	RW	0: English-Normal 1: German-Normal 2: Downl. Lang.-Normal 16: English-Flipped 17: German-Flipped 18: Downl. Lang.-Flipped 32: English-Normal-Backlight 33: German-Normal-Backlight 34: Downl. Lang.-Normal-Backlight 48: English-Flipped-Backlight 49: German-Flipped-Backlight 50: Downl. Lang.-Flipped-Backlight	(32) English-Normal-Backlight	
482	LCD_CONTRAST	USIGN8	1	S	RW		50	
483	BLOCK_ERR_DESC_RB	BSTRING	4	D	RO			
484-499	Unused/Reserved	-	-	-	-	-	-	-
AI Function Block(1) Parameter								
500	BLK_DATA	DS-64	62	S	RW			
501	ST_REV	USIGN16	2	S	RO		0	
502	TAG_DESC	OSTRING	32	S	RW		Spaces	
503	STRATEGY	USIGN16	2	S	RW		0	
504	ALERT_KEY	USIGN8	1	S	RW	1…255	0	
505	MODE_BLK	DS-69	4	Mix	RW			
506	BLOCK_ERR	BSTRING	2	D	RO		0x0000	
507	PV	DS-65	5	D	RO			
508	OUT	DS-65	5	N	RW		0	
509	SIMULATE	DS-82	11	D	RW			
510	XD_SCALE	DS-68	11	S	RW		5.884;0.0;1120(N);2	
511	OUT_SCALE	DS-68	11	S	RW		100.0;0.0;1342(%);1	
512	GRANT_DENY	DS-70	2	D	RW			
513	IO_OPTS	BSTRING	2	S	RW	Low Cutoff	0x0000	

514	STATUS_OPTS	BSTRING	2	S	RW	Propagate Fault Fwd Uncertain if Limited Bad if Limited Uncertain if Man.	0x0000	
515	CHANNEL	ENUM	2	S	RW	(1)Primary Value	(1)Primary Value	
516	L_TYPE	ENUM	1	S	RW	1: Direct 2: Indirect 3: Indirect Sq Root 4: Indirect Custom	Indirect	
517	LOW_CUT	FLOAT	4	S	RW		0	
518	PV_FTIME	FLOAT	4	S	RW		0 Sec	
519	FIELD_VAL	DS-65	5	D	RO			
520	UPDATE_EVT	DS-73	14	D	RW			
521	BLOCK_ALM	DS-72	13	D	RW			
522	ALARM_SUM	DS-74	8	Mix	RW			
523	ACK_OPTION	BSTRING	2	S	RW		0x0000	
524	ALARM_HYS	FLOAT	4	S	RW	0 to 50%	0.5%	
525	HI_HI_PRI	USIGN8	1	S	RW	0 … 15	0	
526	HI_HI_LIM	FLOAT	4	S	RW		1.#INF	
527	HI_PRI	USIGN8	1	S	RW	0 … 15	0	
528	HI_LIM	FLOAT	4	S	RW		1.#INF	
529	LO_PRI	USIGN8	1	S	RW	0 … 15	0	
530	LO_LIM	FLOAT	4	S	RW		-1.#INF	
531	LO_LO_PRI	USIGN8	1	S	RW	0 … 15	0	
532	LO_LO_LIM	FLOAT	4	S	RW		-1.#INF	
533	HI_HI_ALM	DS-71	16	D	RW			
534	HI_ALM	DS-71	16	D	RW			
535	LO_ALM	DS-71	16	D	RW			
536	LO_LO_ALM	DS-71	16	D	RW			
537	BLOCK_ERR_DESC_AI	BSTRING	4	D	RO			

538-599	Unused/Reserved	-	-	-	-	-	-	-
AI Function Block(2) Parameter								
600-637	See AI Function Block(1)							
638-699	Unused/Reserved							
PID Function Block Parameter								
700	BLK_DATA	DS-64	62	S	RW			
701	ST_REV	USIGN16	2	S	RO		0	
702	TAG_DESC	OSTRING	32	S	RW		Spaces	
703	STRATEGY	USIGN16	2	S	RW		0	
704	ALERT_KEY	USIGN8	1	S	RW	1…255	0	
705	MODE_BLK	DS-69	4	Mix	RW			
706	BLOCK_ERR	BSTRING	2	D	RO		0x0000	
707	PV	DS-65	5	D	RO			
708	SP	DS-65	5	N	RW			
709	OUT	DS-65	5	N	RW			
710	PV_SCALE	DS-68	11	S	RW		100.0;0.0;1342(%);1	
711	OUT_SCALE	DS-68	11	S	RW		100.0;0.0;1342(%);1	
712	GRANT_DENY	DS-70	2	D	RW			
713	CONTROL_OPTS	BSTRING	2	S	RW		0x0000	
714	STATUS_OPTS	BSTRING	2	S	RW		0x0000	
715	IN	DS-65	5	D	RW			
716	PV_FTIME	FLOAT	4	S	RW		0 Sec	
717	BYPASS	ENUM	1	S	RW		Uninitialized	
718	CAS_IN	DS-65	5	D	RW			
719	SP_RATE_DN	FLOAT	4	S	RW		1.#INF PV/Sec	
720	SP_RATE_UP	FLOAT	4	S	RW		1.#INF PV/Sec	
721	SP_HI_LIM	FLOAT	4	S	RW		100	

722	SP_LO_LIM	FLOAT	4	S	RW		0	
723	GAIN	FLOAT	4	S	RW		0	
724	RESET	FLOAT	4	S	RW		1.#INF Sec	
725	BAL_TIME	FLOAT	4	S	RW		0 Sec	
726	RATE	FLOAT	4	S	RW		0 Sec	
727	BKCAL_IN	DS-65	5	D	RW			
728	OUT_HI_LIM	FLOAT	4	S	RW		100	
729	OUT_LO_LIM	FLOAT	4	S	RW		0	
730	BKCAL_HYS	FLOAT	4	S	RW		0.50%	
731	BKCAL_OUT	DS-65	5	D	RO			
732	RCAS_IN	DS-65	5	D	RW			
733	ROUT_IN	DS-65	5	D	RW			
734	SHED_OPT	ENUM	1	S	RW		Uninitialized	
735	RCAS_OUT	DS-65	5	D	RO			
736	ROUT_OUT	DS-65	5	D	RO			
737	TRK_SCALE	DS-68	11	S	RW		100.0;0.0;1342(%);1	
738	TRK_IN_D	DS-66	2	D	RW			
739	TRK_VAL	DS-65	5	D	RW			
740	FF_VAL	DS-65	5	D	RW			
741	FF_SCALE	DS-68	11	S	RW		100.0;0.0;1342(%);1	
742	FF_GAIN	FLOAT	4	S	RW		0	
743	UPDATE_EVT	DS-73	14	D	RW			
744	BLOCK_ALM	DS-72	13	D	RW			
745	ALARM_SUM	DS-74	8	D	RW			
746	ACK_OPTION	BSTRING	2	S	RW		0x0000	
747	ALARM_HYS	FLOAT	4	S	RW	0.0 to 50.0%	0.50%	
748	HI_HI_PRI	USIGN8	1	S	RW	0 … 15	0	
749	HI_HI_LIM	FLOAT	4	S	RW		1.#INF	

750	HI_PRI	USIGN8	1	S	RW	0 … 15	0	
751	HI_LIM	FLOAT	4	S	RW		1.#INF	
752	LO_PRI	USIGN8	1	S	RW	0 … 15	0	
753	LO_LIM	FLOAT	4	S	RW		-1.#INF	
754	LO_LO_PRI	USIGN8	1	S	RW	0 … 15	0	
755	LO_LO_LIM	FLOAT	4	S	RW		-1.#INF	
756	DV_HI_PRI	USIGN8	1	S	RW	0 … 15	0	
757	DV_HI_LIM	FLOAT	4	S	RW		1.#INF	
758	DV_LO_PRI	USIGN8	1	S	RW	0 … 15	0	
759	DV_LO_LIM	FLOAT	4	S	RW		-1.#INF	
760	HI_HI_ALM	DS-71	16	D	RW			
761	HI_ALM	DS-71	16	D	RW			
762	LO_ALM	DS-71	16	D	RW			
763	LO_LO_ALM	DS-71	16	D	RW			
764	DV_HI_ALM	DS-71	16	D	RW			
765	DV_LO_ALM	DS-71	16	D	RW			
766	SP_LAG	FLOAT	4	S	RW		0	
767	KDERIV	FLOAT	4	S	RW		0	
768	BIAS	FLOAT	4	S	RW		0	
769	PID_TYPE	ENUM	1	S	RW		NIPID	
770	AUTO_TUNE	DS-262	34	S	RW			
771	BLOCK_ERR_DESC_PID	BSTRING	4	D	RO			
772-799	Unused/Reserved							
IS Function Block Parameter								
800	BLK_DATA	DS-64	62	S	RW			
801	ST_REV	USIGN16	2	S	RO		0	
802	TAG_DESC	OSTRING	32	S	RW		Spaces	

803	STRATEGY	USIGN16	2	S	RW		0	
804	ALERT_KEY	USIGN8	1	S	RW	1…255	0	
805	MODE_BLK	DS-69	4	Mix	RW			
806	BLOCK_ERR	BSTRING	2	D	RO		0x0000	
807	OUT	DS-65	5	N	RW			
808	OUT_RANGE	DS-68	11	D	RW		100.0;0.0;0;0	
809	GRANT_DENY	DS-70	2	D	RW			
810	STATUS_OPTS	BSTRING	2	S	RW		0x0000	
811	IN_1	DS-65	5	D	RW			
812	IN_2	DS-65	5	D	RW			
813	IN_3	DS-65	5	D	RW			
814	IN_4	DS-65	5	D	RW			
815	DISABLE_1	DS-66	2	N	RW			
816	DISABLE_2	DS-66	2	N	RW			
817	DISABLE_3	DS-66	2	N	RW			
818	DISABLE_4	DS-66	2	N	RW			
819	SELECT_TYPE	ENUM	1	S	RW		Uninitalized	
820	MIN_GOOD	USIGN8	1	S	RW		0	
821	SELECTED	DS-66	2	N	RO			
822	OP_SELECT	DS-66	2	N	RW			
823	UPDATE_EVT	DS-73	14	D	RW			
824	BLOCK_ALM	DS-72	13	D	RW			
825	BLOCK_ERR_DESC_IS	BSTRING	4	D	RO			
826-899	Unused/Reserved							
OS Function Block Parameter								
900	BLK_DATA	DS-64	62	S	RW			
901	ST_REV	USIGN16	2	S	RO		0	

902	TAG_DESC	OSTRING	32	S	RW		Spaces	
903	STRATEGY	USIGN16	2	S	RW		0	
904	ALERT_KEY	USIGN8	1	S	RW	1…255	0	
905	MODE_BLK	DS-69	4	Mix	RW			
906	BLOCK_ERR	BSTRING	2	D	RO		0x0000	
907	SP	DS-65	5	N	RW			
908	OUT_1	DS-65	5	D	RO			
909	OUT_2	DS-65	5	D	RO			
910	OUT_1_RANGE	DS-68	11	S	RW		100.0;0.0,0;0	
911	OUT_2_RANGE	DS-68	11	S	RW		100.0;0.0;0;0	
912	GRANT_DENY	DS-70	2	D	RW			
913	STATUS_OPTS	BSTRING	2	S	RW		0x0000	
914	CAS_IN	DS-65	5	D	RW			
915	BKCAL_OUT	DS-65	5	D	RO			
916	IN_ARRAY	FLOAT	16	S	RW		0;0;0;0	
917	OUT_ARRAY	FLOAT	16	S	RW		0;0;0;0	
918	LOCKVAL	ENUM	1	S	RW		Uninitialized	
919	BKCAL_IN_1	DS-65	5	D	RW			
920	BKCAL_IN_2	DS-65	5	D	RW			
921	BAL_TIME	FLOAT	4	S	RW		0 Sec	
922	HYSTVAL	FLOAT	4	S	RW		0	
923	UPDATE_EVT	DS-73	14	D	RW			
924	BLOCK_ALM	DS-72	13	D	RW			
925	BLOCK_ERR_DESC_OS	BSTRING	4	D	RO			
926-999	Unused/Reserved							
AR Function Block Parameter								
1000	BLK_DATA	DS-64	62	S	RW			

1001	ST_REV	USIGN16	2	S	RO		0	
1002	TAG_DESC	OSTRING	32	S	RW		Spaces	
1003	STRATEGY	USIGN16	2	S	RW		0	
1004	ALERT_KEY	USIGN8	1	S	RW	1…255	0	
1005	MODE_BLK	DS-69	4	Mix	RW			
1006	BLOCK_ERR	BSTRING	2	D	RO		0x0000	
1007	PV	DS-65	5	D	RO			
1008	OUT	DS-65	5	N	RW			
1009	PRE_OUT	DS-65	5	D	RO			
1010	PV_SCALE	DS-68	11	S	RW		100.0;0.0;0;0	
1011	OUT_RANGE	DS-68	11	S	RW		100.0;0.0;0;0	
1012	GRANT_DENY	DS-70	2	S	RW			
1013	INPUT_OPTS	BSTRING	2	S	RW		0x0000	
1014	IN	DS-65	5	D	RW			
1015	IN_LO	DS-65	5	N	RW			
1016	IN_1	DS-65	5	D	RW			
1017	IN_2	DS-65	5	D	RW			
1018	IN_3	DS-65	5	D	RW			
1019	RANGE_HI	FLOAT	4	S	RW		100	
1020	RANGE_LO	FLOAT	4	S	RW		0	
1021	BIAS_IN_1	FLOAT	4	S	RW		0	
1022	GAIN_IN_1	FLOAT	4	S	RW		1	
1023	BIAS_IN_2	FLOAT	4	S	RW		0	
1024	GAIN_IN_2	FLOAT	4	S	RW		1	
1025	BIAS_IN_3	FLOAT	4	S	RW		0	
1026	GAIN_IN_3	FLOAT	4	S	RW		1	
1027	COMP_HI_LIM	FLOAT	4	S	RW		100	
1028	COMP_LO_LIM	FLOAT	4	S	RW		0	

1029	ARITH_TYPE	ENUM	1	S	RW		Uninitalized	
1030	BAL_TIME	FLOAT	4	S	RW		10 Sec	
1031	BIAS	FLOAT	4	S	RW		0	
1032	GAIN	FLOAT	4	S	RW		1	
1033	OUT_HI_LIM	FLOAT	4	S	RW		100	
1034	OUT_LO_LIM	FLOAT	4	S	RW		0	
1035	UPDATE_EVT	DS-73	14	D	RW			
1036	BLOCK_ALM	DS-72	13	D	RW			
1037	BLOCK_ERR_DESC_AR	BSTRING	4	D	RO			
1038-1999	Unused/Reserved							
Transducer Block Parameter								
2000	BLK_DATA	DS-64	62	S	RW			
2001	ST_REV	USIGN16	2	S	RO		0	
2002	TAG_DESC	OSTRING	32	S	RW		Spaces	
2003	STRATEGY	USIGN16	2	S	RW		0	
2004	ALERT_KEY	USIGN8	1	S	RW	1…255	0	0x0003
2005	MODE_BLK	DS-69	4	Mix	RW	O/S, Auto	AUTO	0x0004
2006	BLOCK_ERR	BSTRING	2	D	RO		0x0000	
2007	UPDATE_EVT	DS-73	14	D	RW			0x0006
2008	BLOCK_ALM	DS-72	13	D	RW			0x0006
2009	TRANSDUCER_DIRECTORY	Array of USIGN16	2	N	RO		0	
2010	TRANSDUCER_TYPE	ENUM	2	N	RO		(100) Standard Pressure with Calibration	
2011	XD_ERROR	ENUM	1	D	RO		0x0000	
2012	COLLECTION_DIRECTORY	Array of USiGN32	4	N	RO		0	
2013	PRIMARY_VALUE_TYPE	ENUM	2	S	RW		(110) level	0x0003 0x0005
2014	PRIMARY_VALUE	DS_65	5	D	RO			

2015	PRIMARY_VALUE_RANGE	DS-68	11	S (N)	RW		19.613;0.0;1120(N);3	0x0003 0x0005
2016	CAL_POINT_HI	FLOAT	4	S	RW		0.0	0x0005
2017	CAL_POINT_LO	FLOAT	4	S	RW		-100.0	0x0005
2018	CAL_MIN_SPAN	FLOAT	4	N	RO		0.0	0x0005 0x0003
2019	CAL_UNIT	ENUM	2	S	RW		1342(%)	0x0003
2020	SENSOR_TYPE	ENUM	2	S	RW		(115) Level sensor unknown	0x0003 0x0005
2021	SENSOR_RANGE	DS-68	11	S (N)	RO		19.6133;0;1120(N);3	
2022	SENSOR_SN	VSTRING	32	N	RO		02267189 / DEFAU	
2023	SENSOR_CAL_METHOD	ENUM	1	S	RW		(103) factory trim standard calibration	0x0003
2024	SENSOR_CAL_LOC	VSTRING	32	S	RW		Eckardt Stuttgart Germany	
2025	SENSOR_CAL_DATE	date	7	S	RW			
2026	SENSOR_CAL_WHO	VSTRING	32	S	RW		Final Assembly	
2027	SENSOR_ISOLATOR_MTL	ENUM	2	N	RO		(0) Undefined	
2028	SENSOR_FILL_FLUID	ENUM	2	N	RO		(0) Undefined	
2029	SECONDARY_VALUE	DS-65	5	D	RO			
2030	SECONDARY_VALUE_UNIT	ENUM	2	S	RW		1342(%)	0x0005
2031	TARGET_ERROR	DS-256	12	D	RO	See 2.2.2.1	0,0,0,0,0,0	
2032	SENSOR_ID	VSTRING	7	N	RO		"DEFAU"	
2033	SENSOR_SUBTYPE	ENUM	1	N	RO		(12) 244LD	
2034	RAW_VALUE	FLOAT	4	D	RO			
2035	DAMPING	FLOAT	4	S	RW		8.0	0x0005
2036	SMART_SMOOTH	DS-258	8	S	RW	See 2.2.2.3	10,0,2	0x0005
2037	SENSOR_ZERO_TRIM	ENUM	1	D	RW	0: Uninitialized 1: Sensor Zero Point Trim 2: Sensor Zero Point Reset	(0) Uninitialized	0x0003 0x0005
2038	MAX_SENSOR_VALUE	FLOAT	4	D	RO		-1.#INF	
2039	MIN_SENSOR_VALUE	FLOAT	4	D	RO		1.#INF	

2040	MAX_SENSOR_TEMPERATURE	FLOAT	4	D	RO		-1.#INF	
2041	MIN_SENSOR_TEMPERATURE	FLOAT	4	D	RO		1.#INF	
2042	ELECTRONICS_TEMP	DS-65	5	D	RO			
2043	SENSOR_TEMP	DS-65	5	D	RO			
2044	TEMP_UNIT	ENUM	2	S	RW	1001 °C 1002 °F	(1001) °C	0x0003 0x0005
2045	ELECTRONICS_PRODUCTION_NO	USIGN16	2	N	RO			
2046	ELECTRONICS_CAL_DATE	date	7	N	RO			
2047	APPLY_VALUE	ENUM	1	D	RW	0: Uninitialized 1: Apply Lower Range Value 2: Apply Upper Range Value	(0) Uninitialized	0x0003
2048	TAB_MAX_NUMBER	USIGN8	1	N	RO		32	
2049	TAB_MIN_NUMBER	USIGN8	1	N	RO		2	
2050	TAB_OP_CODE	ENUM	1	S	RW	0: Uninitialized 1: Load new 2: End of transmission	(0) Uninitialized	0x0005 0x2001
2051	TAB_STATUS	ENUM	1	D	RO	0: Uninitialized 1: Good 2: Not monoton 3: Not enough 4: Loading	(0) Uninitialized	
2052	TAB_ACTUAL_NUMBER	USIGN8	1	N	RO		2	
2053	TAB_XY_VAL_0	DS-259	8	N	RW	See 2.2.2.4	0.0;0.0	0x0005
2054	TAB_XY_VAL_1	DS-259	8	N	RW		100.0;100.0	
2055	TAB_XY_VAL_2	DS-259	8	N	RW		0.0;0.0	
2056	TAB_XY_VAL_3	DS-259	8	N	RW		0.0;0.0	
2057	TAB_XY_VAL_4	DS-259	8	N	RW		0.0;0.0	
2058	TAB_XY_VAL_5	DS-259	8	N	RW		0.0;0.0	
2059	TAB_XY_VAL_6	DS-259	8	N	RW		0.0;0.0	
2060	TAB_XY_VAL_7	DS-259	8	N	RW		0.0;0.0	
2061	TAB_XY_VAL_8	DS-259	8	N	RW		0.0;0.0	

2062	TAB_XY_VAL_9	DS-259	8	N	RW		0.0;0.0	
2063	TAB_XY_VAL_10	DS-259	8	N	RW		0.0;0.0	
2064	TAB_XY_VAL_11	DS-259	8	N	RW		0.0;0.0	
2065	TAB_XY_VAL_12	DS-259	8	N	RW		0.0;0.0	
2066	TAB_XY_VAL_13	DS-259	8	N	RW		0.0;0.0	
2067	TAB_XY_VAL_14	DS-259	8	N	RW		0.0;0.0	
2068	TAB_XY_VAL_15	DS-259	8	N	RW		0.0;0.0	
2069	TAB_XY_VAL_16	DS-259	8	N	RW		0.0;0.0	
2070	TAB_XY_VAL_17	DS-259	8	N	RW		0.0;0.0	
2071	TAB_XY_VAL_18	DS-259	8	N	RW		0.0;0.0	
2072	TAB_XY_VAL_19	DS-259	8	N	RW		0.0;0.0	
2073	TAB_XY_VAL_20	DS-259	8	N	RW		0.0;0.0	
2074	TAB_XY_VAL_21	DS-259	8	N	RW		0.0;0.0	
2075	TAB_XY_VAL_22	DS-259	8	N	RW		0.0;0.0	
2076	TAB_XY_VAL_23	DS-259	8	N	RW		0.0;0.0	
2077	TAB_XY_VAL_24	DS-259	8	N	RW		0.0;0.0	
2078	TAB_XY_VAL_25	DS-259	8	N	RW		0.0;0.0	
2079	TAB_XY_VAL_26	DS-259	8	N	RW		0.0;0.0	
2080	TAB_XY_VAL_27	DS-259	8	N	RW		0.0;0.0	
2081	TAB_XY_VAL_28	DS-259	8	N	RW		0.0;0.0	
2082	TAB_XY_VAL_29	DS-259	8	N	RW		0.0;0.0	
2083	TAB_XY_VAL_30	DS-259	8	N	RW		0.0;0.0	
2084	TAB_XY_VAL_31	DS-259	8	N	RW		0.0;0.0	
2085	SENSOR_BASIC_DATA	DS-260	16	S	RW	see 2.2.2.5		
2086	DISPLACER_DATA	DS-261	88	S	RW	see 2.2.2.6		0x0005
2087	SPECIAL_UNIT_OUT	VSTRING	9	S	RW		%	
2088	CONFIG_MODE	ENUM	1	S	RW	0: Manual 1: Auto-Range	(1) Auto-Range	0x0003 0x0005

2089	FORCE_EQUIV	FLOAT	4	D	RO			
2090	PHYSICALZERO	FLOAT	4	D	RO			
2091	ZEROBASIC	FLOAT	4	S	RO			
2092	ZEROCORR	FLOAT	4	S	RW		0.0	0x0005
2093	ZEROSPECMODE	ENUM	1	S	RW	0: Special Zero OFF 1: Special Zero ON 2: Special Zero Reset 4: Special Zero Set Value 8: Special Zero Apply	(0) Special Zero OFF	0x0005
2094	ZEROSPECOFF	FLOAT	4	S	RW		0.0	0x0005
2095	DISPLAY_MODE	ENUM	1	S	RW	0: Uninitialized 1: NONE 2: PV in Eng Units(AI1.OUT) 3: PV in % 4: Force Equivalent 5: PV Equivalent 6: Sensor Temp 7: ISEL In 1 8: ISEL In 2 9: ISEL In 3 10: ISEL In 4	(2) PV in Eng Units(AI1.OUT)	0x0003
2096	DISPLAY_VAL	FLOAT	4	D	RO			
2097	DISPLAY_UNIT	ENUM	2	S	RW		(1342) %	0x0003
2098	BLOCK_ERR_DESC_TB	BSTRING	4	D	RO			

2.2 Description of Parameters

A parameter is identified by its index in the OD. Index 0, called the object dictionary header, provides a description of the dictionary itself, and defines the first index for the object descriptions of the FB application. The object description of LevelStar FF starts at the index 298.

2.2.1 OD Object Description

The OD object description is part of the device management, which provides a guide to all objects within the device [5]. An interface device such as a host desiring to access the objects described by the OD may read the information contained in this description. Besides, by reading the OD object description the structure description and the version number of the OD are made available. The OD object description has the following structure:

Name	Description	Range	Value
Obj_code	Object code	1 = OD Object	1
Flag	Configure write protection	1 = no write protection 0 = write protection	0
Length	Size of names	0 to 32	32
Protection	Access protection	0 = no access protection 1 = access protection	0
Version	OD version		1
Int_addr	Internal address of OD		
Len_st_od	Length of S_OD		262
Int_addr_st_od	Internal address of S_OD		
First_index_s_od	Start index of ST_OD		298
Len_s_od	Length of ST_OD		1801
Int_addr_s_od	Internal address of ST_OD		
First_index_dv_od	Start index of DV_OD		3000
Len_dv_od	Length of DV_OD		1009
Int_addr_dv_od	Internal address of DV_OD		
First_index_dp_od	Start index of DP_OD		0
Len_dp_od	Length of DP_OD		0
Int_addr_dp_od	Internal address of DP_OD		

Legends:

OD Object Dictionary

S_OD Static Object Dictionary which includes Action Object), Resource Block, Function Block(s), Transducer Block(s), Link Objects, Alert Objects, Trend Objects, Domain Object (not used in this application)

ST_OD Standard Object Dictionary

DV_OD Dynamic List of Variable Lists (View Object(s))

DP_OD Dynamic List of Program Invocations (Program Invocation Objects, not used in this application)

2.2.2 Data Types and Data Structures

Object indices 1 to 255 are reserved for standard Foundation data types and data structures. This portion of the OD is listed below. The C-type names of the various data types and structures are listed on the last column.

Index	Data Type	Name	C-Type
1	Data	Boolean	BOOL

2	Data	Integer 8	INT8
3	Data	Integer 16	INT16
4	Data	Integer 32	INT32
5	Data	Unsigned 8	USIGN8
6	Data	Unsigned 16	USIGN16
7	Data	Unsigned 32	USIGN32
8	Data	Floating Point	FLOAT
9	Data	Visible String	VSTRING
10	Data	Octet String	OSTRING
11	Data	Date	DATE_S
12	Data	Time of Day	TIME_OF_DAY_S
13	Data	Time Difference	TIME_DIFF_S
14	Data	Bit String	BSTRING
…			
21	Data	Time Value	TIME_VALUE_S
…			
64	Structure (DS-64)	Block	F_BLOCK
65	Structure (DS-65)	Value & Status - Float	FLOAT_S
66	Structure (DS-66)	Value & Status - Discrete	DISCRETE_S
67	Structure (DS-67)	Value & Status - Bitstring	BIT_STRING_S
68	Structure (DS-68)	Scaling	SCALE
69	Structure (DS-69)	Mode	MODE
70	Structure (DS-70)	Access Permissions	ACCESS_PERM
71	Structure (DS-71)	Alarm - Float	ALARM_FLOAT
72	Structure (DS-72)	Alarm - Discrete	ALARM_DISCRETE
73	Structure (DS-73)	Event - Update	EVENT
74	Structure (DS-74)	Alarm - Summary	ALARM_SUMMARY
75	Structure (DS-75)	Alert - Analog	ALERT_FLOAT
76	Structure (DS-76)	Alert - Discrete	ALERT_DISCRETE
77	Structure (DS-77)	Alert - Update	ALERT_EVENT
78	Structure (DS-78)	Trend - Float	TREND_FLOAT
79	Structure (DS-79)	Trend - Discrete	TREND_DISCRETE
80	Structure (DS-80)	Trend - Bitstring	TREND_BIT_STRING
81	Structure (DS-81)	FB Link	FB_LINK
82	Structure (DS-82)	Simulate - Float	SIMULATE_FLOAT
83	Structure (DS-83)	Simulate - Discrete	SIMULATE_DISCRETE
84	Structure (DS-84)	Simulate - Bitstring	SIMULATE_BIT_STRING
85	Structure (DS-85)	Test	TEST
86	Structure (DS-86)	Action - Instantiate/Delete	ACTION
87	Structure (DS-87)	Alarm Field Diagnosis	
88	Structure (DS-88)	Alert Field Diagnosis	

Following the standard foundation data types and structures are the manufacturer-specific data types and structures, which reserve the indices 256 to 297. The LevelStar FF has seven manufacturer-specific data structures defined:

Index	Data Type & Structure	Name	C-Type
256	Structure (target_error)	Target error	TARGET_ERROR_FIELD
257	Structure (diagnosis)	Diagnosis	DIAGNOSIS
258	Structure (smart_smooth)	Smart smoothing	SMART_SMOOTHING
259	Structure	One couple table value	XY_VALUE_FIELD

	(xy_value_field)		
260	Structure (sensor_basic_data)	Collection of sensor basic data	SENSOR_BASIC_DATA
261	Structure (displacer_data)	Collection of Displacer data	DISPLACER_DATA
262	Structure (at_tune)	Auto Tune data of the PID	AT_TUNE

2.2.2.1 Data Structure TARGET_ERROR (DS-256)

In the last column of the parameter table, error codes for write access to corresponding parameters via FF communication are listed. These codes are shown in the TARGET_ERROR parameter of the Resource or Transducer Block. The TARGET_ERROR parameter is a record of 6 USIGN16 elements and contains the last 6 access errors occurred.

Sub Index	Name	Description
1	TARGET_ERROR_1	Target Error Reason
2	TARGET_ERROR_2	Target Error Reason
3	TARGET_ERROR_3	Target Error Reason
4	TARGET_ERROR_4	Target Error Reason
5	TARGET_ERROR_5	Target_Error Reason
6	TARGET_ERROR_6	Target Error Reason

Access Error Code	Error Name	Description
0x0000	TARGET_NOT_INIT	Current block is not running.
0x0001	TARGET_NO_ERROR	No error for access.
0x0002	TARGET_WRITE_LOCKED	Parameters are write-protected.
0x0003	TARGET_RANGE_ERROR	Value entered is beyond the value range of this parameter.
0x0004	TARGET_MODE_CHECK_ERROR	Mode entered is not allowed.
0x0005	TARGET_WRONG_MODE2WRITE	The mode for writing this parameter is wrong.
0x0006	TARGET_ALM_CHECK_ERROR	Alarm is acknowledged already.
0x1000	TARGET_RB_OOS	Target mode of the resource block is set to Out of Service.
0x2000	TARGET_TD_OOS	Target Mode of the Transducer block is set to Out of Service
0x2001	TARGET_TD_WRONG_TAB_OPCODE	The TAB_OPCODE parameter was set to a wrong value..

2.2.2.2 Data Structure DIAGNOSIS (DS-257)

The DIAGNOSIS parameter is a record of 10 USIGN8 elements containing the Device Specific Status Byte and 4 extended Status Bytes together with a Historical Device Specific Status and 4 historical extended Status Bytes.

Sub Index	Name	Description
1	DEVICE_SPEC_STAT	Device Specific Status
2	DIAGER_EXT_1	Current Ext. Status 1
3	DIAGER_EXT_2	Current Ext. Status 2
4	DIAGER_EXT_3	Current Ext. Status 3
5	DIAGER_EXT_4	Current Ext. Status 4
6	DEVICE_SPEC_STAT_HIST	Historical Device Specific Status
7	DIAGER_EXT_HIST_1	Historical Ext. Status 1
8	DIAGER_EXT_HIST_2	Historical Ext. Status 2
9	DIAGER_EXT_HIST_3	Historical Ext. Status 3
10	DIAGER_EXT_HIST_4	Historical Ext. Status 4

DEVICE_SPEC_STAT, DEVICE_SPEC_STAT_HIST:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Internal Calibration failed	Sensor signal exceeded	Write EEPROM impossible	Sensor invalid	PV out of sensor limits	Sensor temperature out of limits	Electronic temperature out of limits	Measurment range configuration invalid

DIAGER_EXT_1, DIAGER_EXT_HIST_1:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PV out of measuremen t range	Finger Print Data compensation error	Language Text Error	Diagnose procedure not completed	Displacer too light or removed	Factory Settings missing	Reserved	Sensor Current too high

DIAGER_EXT_2, DIAGER_EXT_HIST_2:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor ref. voltage error	Temp. Sensor failure	Electronic Temp. Sensor failure	Watchdog Error	ADC Gain Defect	Error in 100 Ohm resistor measurement	ADC-Bits Error	System offset error

DIAGER_EXT_3, DIAGER_EXT_HIST_3:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

DIAGER_EXT_4, DIAGER_EXT_HIST_4:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

2.2.2.3 Data Structure SMART_SMOOTH (DS-258)

The SMART_SMOOTH parameter is used for smart smoothing the Sensor Signal. It contains a filter time element, a deadband element and a reserved element for future use.

Sub Index	Name	Type	Description

1	SS_FILTER_TIME	USIGN16	Smart Smooth Filter Time
2	SS_RESERVED	USIGN16	Reserved for future use
3	SS_DEADBAND	FLOAT	Smart Smooth Deadband

2.2.2.4 Data Structure XY_VALUE_FIELD (DS-259)

The XY_VALUE_FIELD structure defines an entry in custom table.The custom table has 32 entries. Each entry has an X and a Y Value.

Sub Index	Name	Type	Description
1	X_VALUE	FLOAT	X-Value
2	Y_VALUE	FLOAT	Y-Value

2.2.2.5 Data Structure SENSOR_BASIC_DATA (DS-260)

This structure contains all the data which describes the sensor:

Sub Index	Name	Type	Size	Description
1	FLANGE_TYPE	Enum	1	Flange type code
2	FLANGE_MATERIAL	Enum	1	Material code
3	DIAPHRAGM_EXTENSION	Enum	1	Diaphragm extension code
4	SEALING_MATERIAL	Enum	1	Sealing material code
5	DRAIN_VENT_MATERIAL	Enum	1	Drain Vent Material Code
6	FLANGE_FACING	Enum	1	Flange facing code
7	CHEMICAL_SEAL_TYPE	Enum	1	Chemical seal type code
8	CHEMICAL_SEAL_FILL_FLUID	Enum	1	Fill fluid code
9	CHEMICAL_SEAL_ISOLATOR_MTL	Enum	1	Isolator material code
10	SENSOR_FILL_FLUID_COPY	Enum	1	Fill fluid code
11	SENSOR_ISOLATOR_MTL_COPY	Enum	1	Isolator material code
12	PRODUCT_CONNECT_NIPPLE	Enum	1	Product connect nipple code
13	NOMINAL_PRESSURE	Enum	1	Nominal pressure code
14	CAPILLARY_TYPE	Enum	1	Capillary type code
15	HEAD_MATERIAL	Enum	1	Head Material
16	TORQUE_TUBE_MATERIAL	Enum	1	Torque Tube Material

2.2.2.6 Data Structure DISPLACER_DATA (DS-261)

This structure contains all the data describing the Displacer.

Sub Index	Name	Access	Type	Size	Description
1	DISPLACER_MATERIAL	RW	ENUM	1	Displacer Material
2	DISPLACER_LENGTH	RW	FLOAT	4	Displacer Length
3	DISPLACER_VOLUME	RO	FLOAT	4	Displacer Volume
4	DISPLACER_WEIGHT	RW	FLOAT	4	Displacer Weight
5	DENSITY_UNIT	RW	ENUM	2	Density Unit
6	UPPER_DENSITY	RW	FLOAT	4	Upper Density
7	LOWER_DENSITY	RW	FLOAT	4	Lower Density

8	DISPLACER_HEAD	RW	ENUM	1	Displacer Head
9	DISPL_DIAMETER	RW	FLOAT	4	Displacer Diameter
10	DISPL_LOW_MEAS_PNT	RW	FLOAT	4	Lower Range Point
11	DISPL_MEAS_LEN	RW	FLOAT	4	Displ Measure Length
12	DISPL_MODEL_CODE	RW	STRING	32	Displ Model Code
13	DISPL_SUSP_LENGTH	RW	FLOAT	4	Suspension Length
14	DISPLACER_WEIGHT_FORCE	RO	FLOAT	4	Displacer Weight Force
15	LOWER_WEIGHT_FORCE	RO	FLOAT	4	Lower Weight Force
16	UPPER_WEIGHT_FORCE	RO	FLOAT	4	Upper Weight Force
17	GRAVITY	RW	FLOAT	4	Gravity

2.2.3 AP Directory

The AP (Application Process) Directory contains the OD indices for the network visible objects of an AP (see [1], Section 5.5). The AP Directory is assigned with the index 298 which can be read from the “First_index_s_od“ entry of the OD Description Header. The AP Directory is defined as an array of constant Unsigned 16 values with its first six entries as the AP Directory Header. All entries that follow the header are references each of which is composed of two Unsigned 16 entries. For AP object references the first is the OD index of the AP object. For composite object references, it is the OD index of the first AP object in the composite. In both cases, the second entry is the number of consecutive OD entries for the object [1]. The total number of directory entries follows the Instantiation/Destantiation of Function Blocks. As all Function Blocks except the AI Function Block 1 can be instantiated/destantiated the number of Function Blocks may varyfrom one to six. Whenever a Function Block is instantiated/destantiated the Directory Revision Number is modified too.

Index	Description	Value
1	Reserved by FB Specification	0
2	Directory revision number	*
3	Total number of directory objects	1
4	Total number of directory entries	18
5	Index of first composite	21
6	Number of composite entries	3
7	Starting index of Action Objects	399
8	Number of Action Objects	1
9	Starting index of Link Objects	300
10	Number of Link Objects	22
11	Starting index of Alert Objects	395
12	Number of Alert Objects	4
13	Starting index of Trend Objects	340
14	Number of Trend Objects	33
15	Starting index of Domain Objects	0
16	Number of Domain Objects	0
17	Starting index of MVC Objects	0
18	Number of MVC Objects	0
19	Starting index of MVC view objects	0
20	Number of MVC view objects	0
21	Resource Block AP directory index	27
22	Number of Resource Blocks	1
23	Transducer Block AP directory index	29
24	Number of Transducer Blocks	1

25	Function Block AP directory index	31
26	Number of Function Blocks	6
27	Resource Block starting OD index	400
28	Number of objects in Resource Block	84
29	Transducer Block 1 starting OD index	2000
30	Number of objects in Transducer Block 1	99
31	Function Block 1 starting OD index (AI)	500
32	Number of objects in Function Block 1	38
33	Function Block 2 starting OD index (AI)	600
34	Number of objects in Function Block 2	38
35	Function Block 3 starting OD index (PID)	700
36	Number of objects in Function Block 3	72
37	Function Block 4 starting OD index (IS)	800
38	Number of objects in Function Block 4	26
39	Function Block 5 starting OD index (OS)	900
40	Number of objects in Function Block 5	26
41	Function Block 6 starting OD index (AR)	1000
42	Number of objects in Function Block 6	38

2.2.4 Block Data Object (DS-64)

Block Data Object BLK_DATA is a universal parameter for all blocks. It is a data structure defined under index 64 and consists of the attributes of the related block. It has 13 elements defined:

Element Name	Data Type	Size	Values for Resource Block	Values for Transducer Block
Block Tag	VSTRING	32	240FF_RES-<xx/yyyyyy>	240FF_TD--<xx/yyyyyy>
DD Member	USIGN32	4	0	0
DD Item ID	USIGN32	4	0x80020AF0	0x80020630
DD Revision	USIGN16	2	1	1
Profile	USIGN16	2	0x133	0x115
Profile Revision	USIGN16	2	0x101	0x103
Execution Time	USIGN32	4	0	0
Period of Execution	USIGN32	4	0	0
Number of Parameters	USIGN16	2	84	99
Next FB to Execute	USIGN16	2	0	0
Starting index of Views	USIGN16	2	3000	4000
Number of VIEW_3	USIGN8	1	2	1
Number of VIEW_4	USIGN8	1	3	6

Element Name	Data Type	Size	Values for AI Function Block 1	Values for AI Function Block 2	Values for PID Function Block
Block Tag	VSTRING	32	240FF_AI1-<xx/yyyyyy>	240FF_AI2-<xx/yyyyyy>	240FF_PID-<xx/yyyyyy>
DD Member	USIGN32	4	0	0	0
DD Item ID	USIGN32	4	0x800201D0	0x800201D0	0x800202B0
DD Revision	USIGN16	2	1	1	1
Profile	USIGN16	2	0x101	0x101	0x108
Profile Revision	USIGN16	2	0x104	0x104	0x104
Execution Time	USIGN32	4	960	960	1280
Period of Execution	USIGN32	4	0	0	0
Number of Parameters	USIGN16	2	38	38	72
Next FB to Execute	USIGN16	2	0	0	0
Starting index of Views	USIGN16	2	3020	3030	3040
Number of VIEW_3	USIGN8	1	1	1	1
Number of VIEW_4	USIGN8	1	1	1	2

Element Name	Data Type	Size	Values for IS Function Block	Values for OS Function Block	Values for AR Function Block
Block Tag	VSTRING	32	240FF_IS--<xx/yyyyyy>	240FF_OS--<xx/yyyyyy>	240FF_AR--<xx/yyyyyy>
DD Member	USIGN32	4	0	0	0
DD Item ID	USIGN32	4	0x80028070	0x80020730	0x80020890
DD Revision	USIGN16	2	1	1	1
Profile	USIGN16	2	0x126	0x11C	0x127
Profile Revision	USIGN16	2	0x104	0x104	0x103
Execution Time	USIGN32	4	960	1600	1920
Period of Execution	USIGN32	4	0	0	0
Number of Parameters	USIGN16	2	26	26	38
Next FB to Execute	USIGN16	2	0	0	0
Starting index of Views	USIGN16	2	3050	3030	3070
Number of VIEW_3	USIGN8	1	1	1	1
Number of VIEW_4	USIGN8	1	1	1	1

<xx/yyyyyy>= Device serial number (Fabrication number), e.g. 39/726561

2.2.5 Block Parameter Description

The table below shows the description of the parameters for the Reource, Transducer and Function Blocks:

Parameter Name	**Description**
Common Parameters for different Blocks	
ST_REV	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
TAG_DESC	The user description of the intended application of the block.
STRATEGY	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	The actual, target, permitted, and normal modes of the block.
BLOCK_ERR	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
BLOCK_ALM	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set

	the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
ACK_OPTION	Selection of whether alarms associated with the function block will be automatically acknowledged.
GRANT_DENY	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block.
BLOCK_ERR_DESC_XX	Detailed help for BLOCK_ERR bits
Resource Block Parameters	
RS_STATE	State of the function block application state machine.
TEST_RW	Read/write test parameter - used only for conformance testing.
DD_RESOURCE	String identifying the tag of the resource which contains the Device Description for this resource.
MANUFAC_ID	Manufacturer identification number - used by an interface device to locate the DD file for the resource.
DEV_TYPE	Manufacturer''s model number associated with the resource - used by interface devices to locate the DD file for the resource.
DEV_REV	Manufacturer revision number associated with the resource - used by an interface device to locate the DD file for the resource.
DD_REV	Revision of the DD associated with the resource - used by an interface device to locate the DD file for the resource.
HARD_TYPES	The types of hardware available as channel numbers.
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, and 4: Restart processor.
FEATURES	Used to shows supported resource block options.
FEATURE_SEL	Used to select resource block options.
CYCLE_TYPE	Identifies the block execution methods available for this resource.
CYCLE_SEL	Used to select the block execution method for this resource.
MIN_CYCLE_T	Time duration of the shortest cycle interval of which the resource is capable.
MEMORY_SIZE	Available configuration memory in the empty resource. To be checked before attempting a download.
NV_CYCLE_T	Interval between writing copies of NV parameters to non-volatile memory. Zero means never.
FREE_SPACE	Percent of memory available for further configuration. Zero in a preconfigured device.
FREE_TIME	Percent of the block processing time that is free to process additional blocks.
SHED_RCAS	Time duration at which to give up on computer writes to function block RCas locations.
SHED_ROUT	Time duration at which to give up on computer writes to function block ROut locations.
FAULT_STATE	Condition set by loss of communcation to an output block, failure promoted to an output block or a physical contact. When faultstate condition is set, then output function blocks will perform their FSTATE actions.
SET_FSTATE	Allows the faultstate condition to be manually initiated by selecting Set.
CLR_FSTATE	Writing a Clear to this parameter will clear the device faultstate state if the field condition, if any, has cleared.
MAX_NOTIFY	Maximum number of unconfirmed alert notify messages possible.
LIM_NOTIFY	Maximum number of unconfirmed alert notify messages allowed.
CONFIRM_TIME	The minimum time between retries of alert reports.

WRITE_LOCK	If set, no writes from anywhere are allowed, except to clear WRITE_LOCK. Block inputs will continue to be updated.
ALARM_SUM	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
WRITE_PRI	Priority of the alarm generated by clearing the write lock.
WRITE_ALM	This alert is generated if the write lock parameter is cleared.
ITK_VER	Major revision number of the interoperability test case used to register this device.
FD_VER	The major version of the Field Diagnostics specification used for the development of this device.
FD_FAIL_ACTIVE	This parameter reflects the error conditions that are being detected as active as selected for this category. It is a bit string, so that multiple conditions may be shown.
FD_OFFSPEC_ACTIVE	This parameter reflects the error conditions that are being detected as active as selected for this category. It is a bit string, so that multiple conditions may be shown.
FD_MAINT_ACTIVE	This parameter reflects the error conditions that are being detected as active as selected for this category. It is a bit string, so that multiple conditions may be shown.
FD_CHECK_ACTIVE	This parameter reflects the error conditions that are being detected as active as selected for this category. It is a bit string, so that multiple conditions may be shown. See section 2.9
FD_FAIL_MAP	This parameter enables or disables conditions to be detected as active for this alarm category. Thus the same condition may be active in all, some, or none of the 3 alarm categories.
FD_OFFSPEC_MAP	This parameter enables or disables conditions to be detected as active for this alarm category. Thus the same condition may be active in all, some, or none of the 3 alarm categories.
FD_MAINT_MAP	This parameter enables or disables conditions to be detected as active for this alarm category. Thus the same condition may be active in all, some, or none of the 3 alarm categories.
FD_CHECK_MAP	This parameter enables or disables conditions to be detected as active for this alarm category.
FD_FAIL_MASK	This parameter allows the user to suppress any single or multiple conditions that are active, in this category, from being broadcast to the host through the alarm parameter.
FD_OFFSPEC_MASK	This parameter allows the user to suppress any single or multiple conditions that are active, in this category, from being broadcast to the host through the alarm parameter.
FD_MAINT_MASK	This parameter allows the user to suppress any single or multiple conditions that are active, in this category, from being broadcast to the host through the alarm parameter.
FD_CHECK_MASK	This parameter allows the user to suppress any single or multiple conditions that are active, in this category, from being broadcast to the host through the alarm parameter.
FD_FAIL_ALM	This parameter is used primarily to broadcast a change in the associated active conditions, which are not masked, for this alarm category to a Host System.
FD_OFFSPEC_ALM	This parameter is used primarily to broadcast a change in the associated active conditions, which are not masked, for this alarm category to a Host System.
FD_MAINT_ALM	This parameter is used primarily to broadcast a change in the associated active conditions, which are not masked, for this alarm category to a Host System.
FD_CHECK_ALM	This parameter is used primarily to broadcast a change in the associated active conditions, which are not masked, for this alarm category to a Host System.
FD_FAIL_PRI	This parameter allows the user to specify the priority of this alarm category.

FD_OFFSPEC_PRI	This parameter allows the user to specify the priority of this alarm category.
FD_MAINT_PRI	This parameter allows the user to specify the priority of this alarm category.
FD_CHECK_PRI	This parameter allows the user to specify the priority of this alarm category.
FD_SIMULATE	Used as the field diagnostic condition when the simulation is enabled.
FD_RECOMMEN_ACT	This parameter is a device enumerated summarization of the most severe condition or conditions detected. The DD help should describe by enumerated action, what should be done to alleviate the condition or conditions.
TARGET_ERROR	Six target error words recording the last six target status changes
DIAGNOSIS	Field device specific status bytes
RESET_HIST_STATUS	Clear history/device status
FACTORY_RESET	Create / Restore factory setting
SOFTWARE_REVISION	Software revision
HARDWARE_REVISION	Hardware revision
CAPABILITY_LEV	Capability level of the device.
DEVICE_SER_NUM	Device serial number
MODEL_CODE	Device model code
ECEP	No Help Available
LOCAL_KEYS_CTRL	Local keys control
MESSAGE_1	Device Message 1
MESSAGE_2	Device Message 2
MESSAGE_3	Device Message 3
MESSAGE_4	Device Message 4
MESSAGE_5	Device Message 5
LCD_CONFIG	LCD Configuration
LCD_CONTRAST	LCD Contrast
Transducer Block Parameters	
TRANSDUCER_DIRECTORY	A directory that specifies the number and starting indices of the data collections in the transducer block.
TRANSDUCER_TYPE	Identifes the transducer that follows.
XD_ERROR	One of the transducer error codes defined in the FF Transducer Specifications in section 4.7 Block Alarm Subcodes.
COLLECTION_DIRECTORY	A directory that specifies the number, starting indicies, and DD Item IDs of the data collections in each transducer within a transducer block.
PRIMARY_VALUE_TYPE	The type of measurement represented by the primary value. For Example: Mass Flow, Absolute Pressure, Differential Temperature.
PRIMARY_VALUE	The measured value and status of available to the Function Block.
PRIMARY_VALUE_RANGE	The High and Low range limit values, the engineering units code and the number of digits to the right of the decimal point to be used to display the Primary Value.
CAL_POINT_HI	The highest calibrated value.
CAL_POINT_LO	The lowest calibrated value.
CAL_MIN_SPAN	The minimum calibration span allowed. Ensures that the two calibrated points (high and low) are not too close together.
CAL_UNIT	The Device description engineering units code index for the calibration values.

SENSOR_TYPE	The type of sensor.
SENSOR_RANGE	The High and Low range limit values, the engineering units code and the number of digits to the right of the decimal point for the sensor.
SENSOR_SN	The sensor serial number.
SENSOR_CAL_METHOD	The method of last sensor calibration. It could be one of the several standard calibration methods defined by ISO or some other method.
SENSOR_CAL_LOC	The last physical location at which the sensor was calibrated. (ex. Acme Labs)
SENSOR_CAL_DATE	The date of the last sensor calibration.
SENSOR_CAL_WHO	The name of the person responsible for the last sensor calibration.
SENSOR_ISOLATOR_MTL	Defines the construction material of the isolating diaphragms.
SENSOR_FILL_FLUID	Defines the type of fluid used in the sensor.
SECONDARY_VALUE	The secondary value related to the sensor.
SECONDARY_VALUE_UNIT	The engineering units to be used with SECONDARY_VALUE.
TARGET_ERROR	Six target error words recording the last six target status changes
SENSOR_ID	Sensor ID
SENSOR_SUBTYPE	Sensor subtype
RAW_VALUE	Raw value
DAMPING	Damping of Sensor Signal
SMART_SMOOTH	Smart smoothing
SENSOR_ZERO_TRIM	Sensor zero point trim/reset
MAX_SENSOR_VALUE	Maximum sensor value
MIN_SENSOR_VALUE	Minimum sensor value
MAX_SENSOR_TEMPERATURE	Maximum sensor (process) temperature
MIN_SENSOR_TEMPERATURE	Minimum sensor (process) temperature
ELECTRONICS_TEMP	Electronics temperature
SENSOR_TEMP	Sensor (process) temperature
TEMP_UNIT	Engineering unit for electronics&sensor temperature
ELECTRONICS_PRODUCTION_NO	Production number of the device electronics
ELECTRONICS_CAL_DATE	Calibration date of the device electronics
APPLY_VALUE	Apply Upper/Lower Range Value
TAB_MAX_NUMBER	Maximum number of table entries
TAB_MIN_NUMBER	Minimum number of table entries
TAB_OP_CODE	Controls the transaction of table
TAB_STATUS	Table status: Loading, not monoton, not enough, good.
TAB_ACTUAL_NUMBER	Actual number of table entries
TAB_XY_VAL_0 … TAB_XY_VAL_31	Custom Table
SENSOR_BASIC_DATA	Sensor basic data
DISPLACER_DATA	Displacer data
SPECIAL_UNIT_OUT	Unit Text for OUT_SCALE
CONFIG_MODE	Manual - LRV and URV can be changed / Auto-Range - LRV and the URV are calculated in the transmitter
FORCE_EQUIV	Force or Pressure Equivalent
PHYSICALZERO	Total Zero Point
ZEROBASIC	Basic Zero Offset
ZEROCORR	Nullpunkt Korrekturwert

ZEROSPECMODE	Zero Special Mode
ZEROSPECOFF	Special zero offset for e.g. high or low temperature compensation
DISPLAY_MODE	LCD display choice
DISPLAY_VAL	Display value
DISPLAY_UNIT	Unit shown at the Display in case ISEL In 1...4 is selected
AI Function Block Parameter	
PV	Either the primary analog value for use in executing the function, or a process value associated with it. May also be calculated from the READBACK value of an AO block.
OUT	The primary analog value calculated as a result of executing the function block.
SIMULATE	Allows the transducer analog input or output to the block to be manually supplied when simulate is enabled. When simulate is disabled, the simulate value and status track the actual value and status.
XD_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point used with the value obtained from the transducer for a specified channel.
OUT_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point to be used in displaying the OUT parameter and parameters which have the same scaling as OUT.
IO_OPTS	Option which the user may select to alter input and output block processing.
STATUS_OPTS	Options which the user may select in the block processing of status.
CHANNEL	The number of the logical hardware channel that is connected to this I/O block. This information defines the transducer to be used going to or from the physical world.
L_TYPE	Determines if the values passed by the transducer block to the AI block may be used directly (Direct) or if the value is in different units and must be converted linearly (Indirect) , or with square root (Ind Sqr Root), using the input range defined for the transducer and the associated output range.
LOW_CUT	Limit used in square root processing. A value of zero percent of scale is used in block processing if the transducer value falls below this limit, in % of scale. This feature may be used to eliminate noise near zero from a flow sensor.
PV_FTIME	Time constant of a single exponential filter for the PV, in seconds.
FIELD_VAL	Raw value of the field device in % of PV range, with a status reflecting the Transducer condition, before signal characterization (L_TYPE) or filtering (PV_FTIME).
ALARM_SUM	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ALARM_HYS	Amount the PV must return within the alarm limits before the alarm condition clears. Alarm hysteresis expressed as a percent of the span of the PV.
HI_HI_PRI	Priority of the high high alarm.
HI_HI_LIM	The setting for high high alarm in engineering units.
HI_PRI	Priority of the high alarm.
HI_LIM	The setting for high alarm in engineering units.
LO_PRI	Priority of the low alarm.
LO_LIM	The setting for the low alarm in engineering units.
LO_LO_PRI	Priority of the low low alarm.
LO_LO_LIM	The setting of the low low alarm in engineering units.

HI_HI_ALM	The status for high high alarm and its associated time stamp.
HI_ALM	The status for high alarm and its associated time stamp.
LO_ALM	The status of the low alarm and its associated time stamp.
LO_LO_ALM	The status of the low low alarm and its associated time stamp.
PID Function Block Parameter	
PV	Either the primary analog value for use in executing the function, or a process value associated with it. May also be calculated from the READBACK value of an AO block.
SP	The analog setpoint of this block.
OUT	The primary analog value calculated as a result of executing the function block.
PV_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point to be used in displaying the PV parameter and parameters which have the same scaling as PV.
OUT_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point to be used in displaying the OUT parameter and parameters which have the same scaling as OUT.
CONTROL_OPTS	Options which the user may select to alter the calculations done in a control block.
STATUS_OPTS	Options which the user may select in the block processing of status.
IN	Primary input value of the block, required for blocks that filter the input to get the PV.
PV_FTIME	Time constant of a single exponential filter for the PV, in seconds.
BYPASS	The normal control algorithm may be bypassed through this parameter. When bypass is set, the setpoint value (in percent) will be directly transferred to the output. To prevent a bump on transfer to/from bypass, the setpoint will automatically be initialized to the output value or process variable, respectively, and the path broken flag will be set for one execution.
CAS_IN	This parameter is the remote setpoint value, which must come from another Fieldbus block, or a DCS block through a defined link.
SP_RATE_DN	Ramp rate at which downward setpoint changes are acted on in Auto mode, in PV units per second. If the ramp rate is set to zero or the block is in a mode other than Auto, then the setpoint will be used immediately.
SP_RATE_UP	Ramp rate at which upward setpoint changes are acted on in Auto mode, in PV units per second. If the ramp rate is set to zero or the block is in a mode other than Auto, then the setpoint will be used immediately.
SP_HI_LIM	The setpoint high limit is the highest setpoint operator entry that can be used for the block.
SP_LO_LIM	The setpoint low limit is the lowest setpoint operator entry that can be used for the block.
GAIN	Dimensionless value used by the block algorithm in calculating the block output.
RESET	The integral time constant, in seconds per repeat.
BAL_TIME	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds. In the PID block, it may be used to specify the time constant at which the integral term will move to obtain balance when the output is limited and the mode is Auto, Cas, or RCas.
RATE	Defines the derivative time constant, in seconds.
BKCAL_IN	The value and status used for backwards tracking of the output, provided by a link to the back calculation output parameter of a downstream block.

OUT_HI_LIM	Limits the maximum output value for modes other than Manual.
OUT_LO_LIM	Limits the minimum output value for modes other than Manual.
BKCAL_HYS	The amount that the block output must change away from its output limit before the limit status is turned off, expressed as a percent of the span of the output.
BKCAL_OUT	The output value and status provided to an upstream block for output tracking when the loop is broken or limited, as determined by the status bits. This information is used to provide bumpless transfer to closed loop control and to prevent windup under limited conditions when that becomes possible.
RCAS_IN	Target setpoint and status provided by a supervisory Host to a analog control or output block.
ROUT_IN	Target output and status provided by a Host to the control block for use as the output (ROut mode).
SHED_OPT	Defines action to be taken on remote control device timeout.
RCAS_OUT	Block setpoint and status after ramping - provided to a supervisory Host for back calculation and to allow action to be taken under limiting conditions or mode change.
ROUT_OUT	Block output and status - provided to a Host for back calculation in ROut mode and to allow action to be taken under limited conditions or mode change.
TRK_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with TRK_VAL.
TRK_IN_D	This discrete input is used to initiate external tracking of the block output to the value specified by TRL_VAL.
TRK_VAL	This input is used as the track value when external tracking is enabled by TRK_IN_D.
FF_VAL	The feed forward value and status.
FF_SCALE	The feed forward input high and low scale values, engineering units code, and number of digits to the right of the decimal point.
FF_GAIN	The gain that the feed forward input is multiplied by before it is added to the calculated control output.
ALARM_SUM	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ALARM_HYS	Amount the PV must return within the alarm limits before the alarm condition clears. Alarm hysteresis expressed as a percent of the span of the PV.
HI_HI_PRI	Priority of the high high alarm.
HI_HI_LIM	The setting for high high alarm in engineering units.
HI_PRI	Priority of the high alarm.
HI_LIM	The setting for high alarm in engineering units.
LO_PRI	Priority of the low alarm.
LO_LIM	The setting for the low alarm in engineering units.
LO_LO_PRI	Priority of the low low alarm.
LO_LO_LIM	The setting of the low low alarm in engineering units.
DV_HI_PRI	Priority of the high deviation alarm.
DV_HI_LIM	The setting of the high deviation alarm limit in engineering units.
DV_LO_PRI	Priority of the low deviation alarm.
DV_LO_LIM	The setting of the low deviation alarm limit in engineering units.
HI_HI_ALM	The status for high high alarm and its associated time stamp.
HI_ALM	The status for high alarm and its associated time stamp.
LO_ALM	The status of the low alarm and its associated time stamp.

LO_LO_ALM	The status of the low low alarm and its associated time stamp.
DV_HI_ALM	The status and time stamp associated with the high deviation alarm.
DV_LO_ALM	The status and time stamp associated with the low deviation alarm.
SP_LAG	FFU: The Setpoint compensation lag filter
KDERIV	FFU: Part of measurement filter
BIAS	FFU: Bias added to output for P and PD type algorithms
PID_TYPE	FFU: Algorithm executing in PID block
AUTO_TUNE	FFU: Sets up and controls auto tuning. DTM required
IS Function Block Parameter	
OUT	The primary analog value calculated as a result of executing the function block.
OUT_RANGE	This is the display scaling for the output. It has no effect on the block. It is used by many blocks.
STATUS_OPTS	Options which the user may select in the block processing of status.
IN_1	Auxiliary input value to the block, used for other values than the PV.
IN_2	Input required by the characterizer.
IN_3	Numbered input required by Selector block.
IN_4	Numbered input required by Selector block.
DISABLE_1	Parameter to switch off the input from being used. If this parameter is true then don't use this input in determining the output.
DISABLE_2	Parameter to switch off the input from being used. If this parameter is true then don't use this input in determining the output.
DISABLE_3	Parameter to switch off the input from being used. If this parameter is true then don't use this input in determining the output.
DISABLE_4	Parameter to switch off the input from being used. If this parameter is true then don't use this input in determining the output.
SELECT_TYPE	Selector action. max = select the max from all the connected and good inputs, min = select the min from all the connected and good inputs, mid = select the mid value from all the connected and good inputs, if less than min_good inputs are connected then an error code is generated. An error code is also generated if less than min_good values have good status. Not intended for use with 2 or 4 inputs.First Good = determine the first good input encountered based on ascending evaluation of the inputs, avg = compute the average for all the connected and good inputs, if less than two inputs are connected then set the output equal to the input an generate an error code. An error code is also generated if less than min_good inputs have good status.
MIN_GOOD	If the number of inputs which are good is less than the value of MIN_GOOD then set the out status to bad.
SELECTED	An integer indicating which input has been selected.
OP_SELECT	An operator settable parameter to force a given input to be used.
OS Function Block Parameter	
SP	The analog setpoint of this block.
OUT_1	A block output required by the OS and Analog Calculate blocks.
OUT_2	A block output required by the OS and Analog Calculate blocks.
OUT_1_RANGE	The display scaling for the corresponding output. It has no effect on the block.
OUT_2_RANGE	The display scaling for the corresponding output. It has no effect on the block.
STATUS_OPTS	Options which the user may select in the block processing of status.
CAS_IN	This parameter is the remote setpoint value, which must come from

	another Fieldbus block, or a DCS block through a defined link.
BKCAL_OUT	The output value and status provided to an upstream block for output tracking when the loop is broken or limited, as determined by the status bits. This information is used to provide bumpless transfer to closed loop control and to prevent windup under limited conditions when that becomes possible.
IN_ARRAY	An array which contains the values of the input or X variables.
OUT_ARRAY	An array which contains the values of the output or Y variables.
LOCKVAL	Flag for holding the first output at current value when the other output is non-zero.
BKCAL_IN_1	Back calculated input.
BKCAL_IN_2	Back calculated input.
BAL_TIME	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds. In the PID block, it may be used to specify the time constant at which the integral term will move to obtain balance when the output is limited and the mode is Auto, Cas, or RCas.
HYSTVAL	Sets the hysteresis for the operation of LOCKVAL.
AR Function Block Parameter	
PV	Either the primary analog value for use in executing the function, or a process value associated with it. May also be calculated from the READBACK value of an AO block.
OUT	The primary analog value calculated as a result of executing the function block.
PRE_OUT	Displays what would be the OUT value and status if the mode was Auto or lower.
PV_SCALE	The high and low scale values, engineering units code, and number of digits to the right of the decimal point to be used in displaying the PV parameter and parameters which have the same scaling as PV.
OUT_RANGE	This is the display scaling for the output. It has no effect on the block. It is used by many blocks.
INPUT_OPTS	Option bit string for handling the status of the auxiliary inputs.
IN	Primary input value of the block, required for blocks that filter the input to get the PV.
IN_LO	Input for the low range transmitter, in a range extension application.
IN_1	Auxiliary input value to the block, used for other values than the PV.
IN_2	Input required by the characterizer.
IN_3	Numbered input required by Selector block.
RANGE_HI	Constant value above which the range extension has switched to the high range transmitter.
RANGE_LO	Constant value below which the range extension has switched to the low range transmitter.
BIAS_IN_1	The constant to be added to IN_1.
GAIN_IN_1	The constant to be multiplied times (IN_1 + bias).
BIAS_IN_2	The constant to be added to IN_2.
GAIN_IN_2	The constant to be multiplied times (IN_2 + bias).
BIAS_IN_3	The constant to be added to IN_3.
GAIN_IN_3	The constant to be multiplied times (IN_3 + bias).
COMP_HI_LIM	The high limit imposed on the PV compensation term.
COMP_LO_LIM	The low limit imposed on the PV compensation term.
ARITH_TYPE	The identification number of the arithmetic algorithm.
BAL_TIME	This specifies the time for the internal working value of bias or ratio

	to return to the operator set bias or ratio, in seconds. In the PID block, it may be used to specify the time constant at which the integral term will move to obtain balance when the output is limited and the mode is Auto, Cas, or RCas.
BIAS	The bias value used in computing the function block output, expressed in engineering units.
GAIN	Dimensionless value used by the block algorithm in calculating the block output.
OUT_HI_LIM	Limits the maximum output value for modes other than Manual.
OUT_LO_LIM	Limits the minimum output value for modes other than Manual.

2.2.6 View Objects

View objects allow groups of function block parameter values to be read with one read request. Such capability will be provided to enable group information to be efficiently communicated in a timely fashion. The table below shows the View Objects of the different blocks.

Resource Block		
VIEW_1	3000	ST_REV, MODE_BLK, BLOCK_ERR, RS_STATE, FREE_TIME, FAULT_STATE, ALARM_SUM, FD_FAIL_ACTIVE, FD_OFFSPEC_ACTIVE, FD_MAINT_ACTIVE, FD_CHECK_ACTIVE, FD_RECOMMEN_ACT, BLOCK_ERR_DESC_RB
VIEW_2	3001	ST_REV, GRANT_DENY, FEATURE_SEL, CYCLE_SEL, NV_CYCLE_T, FREE_SPACE, SHED_RCAS, SHED_ROUT, LIM_NOTIFY, CONFIRM_TIME, WRITE_LOCK
VIEW_3	3002	ST_REV, MODE_BLK, BLOCK_ERR, RS_STATE, FREE_TIME, FAULT_STATE, ALARM_SUM, FD_FAIL_ACTIVE, FD_OFFSPEC_ACTIVE, FD_MAINT_ACTIVE, FD_CHECK_ACTIVE, FD_SIMULATE, FD_RECOMMEN_ACT, BLOCK_ERR_DESC_RB
	3003	ST_REV, TARGET_ERROR, DIAGNOSIS, SOFTWARE_REVISION, HARDWARE_REVISION, CAPABILITY_LEV, DEVICE_SER_NUM, MODEL_CODE, ECEP
VIEW_4	3004	ST_REV, STRATEGY, ALERT_KEY, MANUFAC_ID, DEV_TYPE, DEV_REV, DD_REV, HARD_TYPES, FEATURES, CYCLE_TYPE, MIN_CYCLE_T, MEMORY_SIZE, MAX_NOTIFY, ACK_OPTION, WRITE_PRI, ITK_VER, FD_VER, FD_FAIL_MAP, FD_OFFSPEC_MAP, FD_MAINT_MAP, FD_CHECK_MAP, FD_FAIL_MASK, FD_OFFSPEC_MASK, FD_MAINT_MASK, FD_CHECK_MASK, FD_FAIL_PRI, FD_OFFSPEC_PRI, FD_MAINT_PRI, FD_CHECK_PRI
	3005	ST_REV, MESSAGE_1, MESSAGE_2, MESSAGE_3
	3006	ST_REV, MESSAGE_4, MESSAGE_5, LOCAL_KEYS_CTRL, LCD_CONFIG, LCD_CONTRAST
Transducer Block		
VIEW_1	4000	ST_REV, MODE_BLK, BLOCK_ERR, TRANSDUCER_TYPE, XD_ERROR, PRIMARY_VALUE, SECONDARY_VALUE, FORCE_EQUIV, BLOCK_ERR_DESC_TB
VIEW_2	4001	ST_REV, TRANSDUCER_TYPE, PRIMARY_VALUE_TYPE, CAL_POINT_HI, CAL_POINT_LO, SECONDARY_VALUE_UNIT, SENSOR_ID, SENSOR_SUBTYPE, ELECTRONICS_PRODUCTION_NO, ELECTRONICS_CAL_DATE, MAX_SENSOR_VALUE, MIN_SENSOR_VALUE, MAX_SENSOR_TEMPERATURE, MIN_SENSOR_TEMPERATURE
VIEW_3	4002	ST_REV, MODE_BLK, BLOCK_ERR, TRANSDUCER_TYPE, XD_ERROR, PRIMARY_VALUE, SECONDARY_VALUE, RAW_VALUE, ELECTRONICS_TEMP, SENSOR_TEMP, FORCE_EQUIV,

		BLOCK_ERR_DESC_TB
VIEW_4	4003	ST_REV, STRATEGY, ALERT_KEY, TRANSDUCER_TYPE, PRIMARY_VALUE_RANGE, CAL_MIN_SPAN, CAL_UNIT, SENSOR_TYPE, SENSOR_RANGE, SENSOR_ISOLATOR_MTL, SENSOR_FILL_FLUID
	4004	ST_REV, SENSOR_SN, SENSOR_CAL_METHOD, SENSOR_CAL_LOC, SENSOR_CAL_DATE, SENSOR_CAL_WHO
	4005	ST_REV, TEMP_UNIT, CONFIG_MODE, PHYSICALZERO, ZEROBASIC, ZEROCORR, ZEROSPECMODE, ZEROSPECOFF, DISPLAY_MODE, DISPLAY_VAL, DISPLAY_UNIT
	4006	ST_REV, TAB_MAX_NUMBER, TAB_MIN_NUMBER, TAB_OP_CODE, TAB_STATUS, TAB_ACTUAL_NUMBER, TAB_XY_VAL_0, TAB_XY_VAL_1, TAB_XY_VAL_2, TAB_XY_VAL_3, TAB_XY_VAL_4, TAB_XY_VAL_5, TAB_XY_VAL_6, TAB_XY_VAL_7, TAB_XY_VAL_8, TAB_XY_VAL_9
	4007	ST_REV, TAB_XY_VAL_10, TAB_XY_VAL_11, TAB_XY_VAL_12, TAB_XY_VAL_13, TAB_XY_VAL_14, TAB_XY_VAL_15, TAB_XY_VAL_16, TAB_XY_VAL_17, TAB_XY_VAL_18, TAB_XY_VAL_19
	4008	ST_REV, TAB_XY_VAL_20, TAB_XY_VAL_21, TAB_XY_VAL_22, TAB_XY_VAL_23, TAB_XY_VAL_24, TAB_XY_VAL_25, TAB_XY_VAL_26, TAB_XY_VAL_27, TAB_XY_VAL_28, TAB_XY_VAL_29, TAB_XY_VAL_30, TAB_XY_VAL_31
AI Function Block 1		
VIEW_1	3020	ST_REV, MODE_BLK, BLOCK_ERR, PV, OUT, FIELD_VAL, ALARM_SUM, BLOCK_ERR_DESC_AI
VIEW_2	3021	ST_REV, XD_SCALE, OUT_SCALE, GRANT_DENY
VIEW_3	3022	ST_REV, MODE_BLK, BLOCK_ERR, PV, OUT, FIELD_VAL, ALARM_SUM, BLOCK_ERR_DESC_AI
VIEW_4	3023	ST_REV, STRATEGY, ALERT_KEY, IO_OPTS, STATUS_OPTS, CHANNEL, L_TYPE, LOW_CUT, PV_FTIME, ACK_OPTION, ALARM_HYS, HI_HI_PRI, HI_HI_LIM, HI_PRI, HI_LIM, LO_PRI, LO_LIM, LO_LO_PRI, LO_LO_LIM
AI Function Block 2		
VIEW_1	3030	ST_REV, MODE_BLK, BLOCK_ERR, PV, OUT, FIELD_VAL, ALARM_SUM, BLOCK_ERR_DESC_AI
VIEW_2	3031	ST_REV, XD_SCALE, OUT_SCALE, GRANT_DENY
VIEW_3	3032	ST_REV, MODE_BLK, BLOCK_ERR, PV, OUT, FIELD_VAL, ALARM_SUM, BLOCK_ERR_DESC_AI
VIEW_4	3033	ST_REV, STRATEGY, ALERT_KEY, IO_OPTS, STATUS_OPTS, CHANNEL, L_TYPE, LOW_CUT, PV_FTIME, ACK_OPTION, ALARM_HYS, HI_HI_PRI, HI_HI_LIM, HI_PRI, HI_LIM, LO_PRI, LO_LIM, LO_LO_PRI, LO_LO_LIM
PID Function Block		
VIEW_1	3040	ST_REV, MODE_BLK, BLOCK_ERR, PV, SP, OUT, CAS_IN, TRK_IN_D, TRK_VAL, ALARM_SUM, BLOCK_ERR_DESC_PID
VIEW_2	3041	ST_REV, PV_SCALE, OUT_SCALE, GRANT_DENY, BYPASS, SP_HI_LIM, SP_LO_LIM, OUT_HI_LIM, OUT_LO_LIM
VIEW_3	3042	ST_REV, MODE_BLK, BLOCK_ERR, PV, SP, OUT, IN, CAS_IN, BKCAL_IN, BKCAL_OUT, RCAS_IN, ROUT_IN, RCAS_OUT, ROUT_OUT, TRK_IN_D, TRK_VAL, FF_VAL, ALARM_SUM, BLOCK_ERR_DESC_PID

VIEW_4	3043	ST_REV, STRATEGY, ALERT_KEY, CONTROL_OPTS, STATUS_OPTS, PV_FTIME, SP_RATE_DN, SP_RATE_UP, GAIN, RESET, BAL_TIME, RATE, BKCAL_HYS, SHED_OPT, TRK_SCALE, FF_SCALE, FF_GAIN, ACK_OPTION, ALARM_HYS, HI_HI_PRI, HI_HI_LIM, HI_PRI, HI_LIM, LO_PRI, LO_LIM, LO_LO_PRI, LO_LO_LIM, DV_HI_PRI, DV_HI_LIM, DV_LO_PRI, DV_LO_LIM
	3044	ST_REV, SP_LAG, KDERIV, BIAS, PID_TYPE
IS Function Block		
VIEW_1	3050	ST_REV, MODE_BLK, BLOCK_ERR, OUT, IN_1, IN_2, IN_3, IN_4, DISABLE_1, DISABLE_2, DISABLE_3, DISABLE_4, SELECTED, OP_SELECT, BLOCK_ERR_DESC_IS
VIEW_2	3051	ST_REV, OUT_RANGE, GRANT_DENY
VIEW_3	3052	ST_REV, MODE_BLK, BLOCK_ERR, OUT, IN_1, IN_2, IN_3, IN_4, DISABLE_1, DISABLE_2, DISABLE_3, DISABLE_4, SELECTED, OP_SELECT, BLOCK_ERR_DESC_IS
VIEW_4	3053	ST_REV, STRATEGY, ALERT_KEY, STATUS_OPTS, SELECT_TYPE, MIN_GOOD
OS Function Block		
VIEW_1	3060	ST_REV, MODE_BLK, BLOCK_ERR, SP, OUT_1, OUT_2, CAS_IN, BLOCK_ERR_DESC_OS
VIEW_2	3061	ST_REV, OUT_1_RANGE, OUT_2_RANGE, GRANT_DENY
VIEW_3	3062	ST_REV, MODE_BLK, BLOCK_ERR, SP, OUT_1, OUT_2, CAS_IN, BKCAL_OUT, BKCAL_IN_1, BKCAL_IN_2, BLOCK_ERR_DESC_OS
VIEW_4	3063	ST_REV, STRATEGY, ALERT_KEY, STATUS_OPTS, IN_ARRAY, OUT_ARRAY, LOCKVAL, BAL_TIME, HYSTVAL
AR Function Block		
VIEW_1	3070	ST_REV, MODE_BLK, BLOCK_ERR, PV, OUT, PRE_OUT, BLOCK_ERR_DESC_AR
VIEW_2	3071	ST_REV, PV_SCALE, OUT_RANGE, GRANT_DENY
VIEW_3	3072	ST_REV, MODE_BLK, BLOCK_ERR, PV, OUT, PRE_OUT, IN, IN_LO, IN_1, IN_2, IN_3, BLOCK_ERR_DESC_AR
VIEW_4	3073	ST_REV, STRATEGY, ALERT_KEY, INPUT_OPTS, RANGE_HI, RANGE_LO, BIAS_IN_1, GAIN_IN_1, BIAS_IN_2, GAIN_IN_2, BIAS_IN_3, GAIN_IN_3, COMP_HI_LIM, COMP_LO_LIM, ARITH_TYPE, BAL_TIME, BIAS, GAIN, OUT_HI_LIM, OUT_LO_LIM

VIEW_1 to VIEW_4 are categorized according to the information that the parameters may contain:

- VIEW_1 – Operration – Information required by a plant operator to run the process.

- VIEW_2 – Operation Static – Information which may need to be read once and then displayed along with the dynamic data.

- VIEW_3 – All Dynamic – Information which is changing and may need to be referenced in a detailed display.

- VIEW_4 – Other Static – Configuration and maintenance information.

3 OPERATION

3.1 Status

The AI function blocks of the LevelStar FF receive their input from the transducer block and make it available at their output hold by the OUT parameter. As has been seen from the parameter table in Section 2.1, OUT is a data structure of type DS-65 containing two elements, i.e., the value and the status to this value. Such a data structure is also used by different other parameters in the transducer block and other function blocks.

The status is one byte long, bitwize coded, and provides information about the quality and state of the value. The coding of this byte is defined in FF specification, which is applied to the LevelStar FF as below.

Status:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Quality		Quality Substatus				Limits	

3.1.1 Quality

7	6	5	4	3	2	1	0	
Quality		Substatus				Limits		
0	0							Bad
0	1							Uncertain
1	0							Good (Non Cascade)
1	1							Not used

3.1.2 Substatus

The coding of Substatus depends on the coding of Quality.

Quality = Bad (00):

7	6	5	4	3	2	1	0	
Quality		Substatus				Limits		
0	0	0	0	0	0			Non-specific
0	0	0	0	1	1			Device Failure
0	0	0	1	0	0			Sensor Failure
0	0	0	1	1	1			Out of Service

Quality = Uncertain (01):

7	6	5	4	3	2	1	0	
Quality		Substatus				Limits		
0	1	0	0	0	0			Non-specific
0	1	0	0	0	1			Last Usable Value
0	1	0	0	1	0			Substitute Value
0	1	0	1	0	0			Sensor Conversion not Accurate
0	1	0	1	0	1			Engineering Unit Range Violation
0	1	0	1	1	1			Configuration Error
0	1	1	0	0	0			Simulated Value

Quality = Good (Non Cascade) (10):

7	6	5	4	3	2	1	0	
Quality		Substatus				Limits		
1	0	0	0	0	0			Ok
1	0	0	0	0	1			Active Update Event
1	0	0	0	1	0			Active Advisory Alarm (Priority < 8)
1	0	0	0	1	1			Active Critical Alarm (Priority > 8)

3.1.3 Limits

The Limits bits indicate if the value from the sensor is in a valid conversion range or crosses already the sensor conversion boundaries.

Limits:

7	6	5	4	3	2	1	0	
Quality		Substatus				Limits		
						0	0	Ok
						0	1	Low Limit acceded
						1	0	High Limit acceded
						1	1	-

3.2 Operation Mode

For the various blocks of the LevelStar FF different operation modes are supported:

Block	Supported Modes
RB	O/S, AUTO
TB	O/S, AUTO
AI1	O/S, AUTO, MAN
AI2	O/S, AUTO, MAN
PID	O/S,MAN, AUTO, CAS, RCAS, ROUT
IS	O/S, AUTO, MAN
OS	O/S, AUTO, CAS
AR	O/S, AUTO, MAN

An operator can set the desired mode for operation in the individual blocks via accessing the TARGET_MODE element in the MODE_BLK structure. Without a pre-setting, the default value for TARGET_MODE is O/S.

3.2.1 Automatic Mode (AUTO)

This mode is the normal operation mode of the related block. For function block, e.g., in this mode, the block gets input value from the transducer block, processes this value and outputs it in the OUT parameter. The function block changes to AUTO when TARGET_MODE is set to AUTO.

3.2.2 Out of Service (O/S)

This mode means that the block and hence the functionality of the block is out of service. This may take place, e.g. when the device is in offline state where configuration parameters are sending to the device. After the configuration, the operation mode will return to AUTO after the TARGET_MODE element in the MODE_BLK parameter is set to AUTO.

3.2.3 Manual Mode (MAN)

During device operation, this mode can be achieved after TARGET_MODE has been set to MAN. For function block e.g., this mode is required for doing override of the output, for which OUT is disconnected from the function block algorithm part and is written directly by operator. Using this mode, an operator can produce the output manually for other function blocks if the device is interfaced to other function block applications.

3.2.4 Cascade Mode (CAS)

In Cascade Mode a setpoint value supplied by another function block through the Cascade input parameter is used by the normal block algorithm to determine the primary output value. This connection between function blocks is defined by a link object.

3.2.5 Remote Cascade Mode (RCAS)

The block setpoint is being set by a Control Application running on an interface device through theremote-cascade in parameter. Based on this setpoint, the normal block algorithm determines the primary output value. A remotecascade out parameter is maintained by the block to support initialization of the control application when the block mode is not remote-cascade.

3.2.6 Remote Output (ROUT)

The block output is being set by a Control Application running on an interface Device through the remote-output in parameter. The algorithm must initialize so no bump is experienced when the mode switches. A remote-output out parameter is maintained by the block to support initialization of the control application when the block mode is not remoteoutput. The setpoint may be maintained or, optionally, be initialized to the process variable value.

3.3 Diagnosis

During device operation, the LevelStar FF sends error information to the BLOCK_ERROR and BLOCK_ERR_DESCR_xx parameters, the XD_ERROR parameter of the transducer block and the DIAGNOSIS parameter of the Resource Block for diagnosis. In addition the Resource Block provides a set of Field Diagnosis Parameters, which are described below individually.

3.3.1 Block Error

BLOCK_ERR is a standard parameter in all blocks and is used to reflect 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

BLOCK_ERR	Description
0x0001	Block is out of service.
0x0100	Input failure (available if the option “Propagate fault forward” in the STATUS_OPTS parameter is set).
0x1000	Simulate active, used in the resource block to indicate that a hardware simulate jumper is present.
0x4000	Block configuration error (e.g. if L_TYPE = 0 or XD_SCALE and OUT_SCALE are different when L_TYPE = 1, etc.).
0x8000	Other Error. (Set in Transducer when XD_ERROR is set

3.3.2 Block Error Description

Each Block contains a BLOCK_ERR_DESC_XX parameter which provides some more information about the current BLOCK_ERROR. The values are shown in the table below.. It is a bit string, so that multiple errors may be shown:

Value	Meaning	Description
0x00000002	Channel-Not-Init	Block channel is uninitialized
0x00000004	Wrong-Channel	Block has a wrong channel setting
0x00000008	Channel-Unit-Mismatch	Block channel unit setting error
0x00000010	L_type-Not-Init	L-type is uninitialized
0x00000020	Wrong-L_type	The direct L-type requires same values in XD_SCALE and OUT_SCALE
0x00000040	XD_Scale-Inconsist	Value EU_100 should be greater than EU_0
0x00000080	OUT_Scale-Inconsist	Value EU_100 should be greater than EU_0
0x00000100	PV_Scale-Inconsist	Value EU_100 should be greater than EU_0
0x00000200	TRK_Scale-Inconsist	Value EU_100 should be greater than EU_0
0x00000400	FF_Scale-Inconsist	Value EU_100 should be greater than EU_0
0x00000800	Bypass-Not-Init	Bypass is not set
0x00001000	Shed_Opt-Not-Init	Shed opt is not set
0x00002000	SP_Limits-Inconsist	Hi_Lim should be greater than or equal to Lo_Lim
0x00004000	OUT_Limits-Inconsist	Hi_Lim should be greater than or equal to Lo_Lim
0x00008000	Arith_Type-Not-Init	No arithmetic algorithm is selected
0x00010000	Select_Type-Not-Init	Selector processing type is not initialized
0x00020000	Integ_Type-Not-Init	Integration type is not initialized
0x00040000	Range-Inconsist	Hi should be greater than or equal to Lo
0x00080000	Compensation-Inconsist	Hi_Lim should be greater than or equal to Lo_Lim
0x00100000	Curve_X-Inconsist	Curve X is not continuous
0x00200000	Curve_X-Not-Monoton	Curve X is not monotonic
0x00400000	Curve_Y-Inconsist	Curve Y is not continuous
0x00800000	Swap_2-Not-Init	Swap 2 uninitialized
0x01000000	Curve_Y-Not-Monoton	Curve Y is not monotonic
0x02000000	In_Array-Inconsist	In-Array is inconsistent
0x04000000	Lockval-Not-Init	Lockval is not initialized
0x80000000	Period_Of_Exec-is-Zero	Period of execution must be greater than zero

3.3.3 XD Error

XD_ERROR is a standard parameter used only in transducer block. Because the BLOCK_ERR bitstring parameter described in FF-890 [9] is not useful for the many errors possible in the transducer block, XD_ERROR is introduced to hold the single error subcode that the manufacturer considers most important when one or more errors occur. BLOCK_ERR will have bit 0 set whenever XD_ERROR is non-zero. For the LevelStar FF, XD_ERROR may be set to the following status:

XD_ERROR	Error	Description
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	Set when the Device Diagnostic detects that the displacer is too light or removed
22	I/O Failure	Set when the Device Diagnostic detects a Sensor Current or Sensor Ref Voltage Error.
23	Data Integrity Error	Write to the EEPROM was not possible.
24	Software Error	The software has detected an error. It is set when the Device Diagnostic was not completed.

3.3.4 Field Diagnostics

The Field Diagnostics Parameters are used to implement a Foundation Fieldbus solution to the NAMUR NE-107 requirements as a parameter group in the Resource Block. There are four alarm categories defined as i.e. Failed, Off-Specification, Maintenance and Check Function. Four types of parameters *_MAP, *_ACTIVE, *_MASK and *_ALM are used for the implementation. For a detailed description of the Field Diagnostics Profile see [12].

- The *_MAP parameter enables or disables conditions to be detected as active for an alarm category
- The *_ACTIVE parameter reflects the error conditions that are being detected as active.
- The *_MASK parameter allows the user to suppress any single or multiple conditions that are active.
- The *_ALM parameter is used primarily to broadcast a change in the associated active conditions

The table below shows the values and meanings of the error conditions that are being detected as active for the different categories

Value	Meaning	Description
0x80000000	No Sensor detected	Is the Sensor cable connected to the electronics.
0x40000000	Sensor Current too high	Sensor Current too high.
0x20000000	Sensor ref. voltage error	Sensor ref. voltage error
0x10000000	Temp. Sensor failure	Temp. Sensor failure
0x08000000	Electronic Temp. Sensor failure	Electronic Temp. Sensor failure
0x04000000	Error in 100 Ohm res. meas.	Error in 100 Ohm resistor measurement
0x02000000	ADC Gain Defect	ADC Gain Defect
0x01000000	ADC-Bits Error	ADC-Bits Error
0x00800000	System offset error	System offset error
0x00400000	Finger Print Data compensation error	Check Factory settings.
0x00200000	Factory Settings missing	Factory setup has to be done.
0x001000000	Diagnose procedure not completed	Problems executing all diagnose procedures - Check Diagnosis settings.
0x00080000	PV out of sensor limits	PV was not in between +/-110% of Nominal Range.
0x00040000	PV out of measurement range	Check range configuration and calibration settings.
0x00020000	Sensor Temp. out of	Sensor temperature was out of limits.

	limits	
0x00010000	Electronic Temp. out of limits	The electronic temperature was outside the range of -40°C and 80°C.
0x00008000	Displacer too light or removed	Displacer too light or removed.
0x00000001	Check Alarm	Transducer is not in Auto Mode

The table below shows a device enumerated summarization of the most severe condition or conditions detected. It should help the user by enumerated action to decide, what should be done to alleviate the condition or conditions of an error.

Value	Meaning	Description
0	Not Initialized	Not Initialized
1	No Action	No Action Required
2	Disable Simulate	Disable Simualtion
3	Check sensor connection.	Check sensor connection and if necessary, exchange sensor.
4	Change sensor.	Change sensor. Change electronic if it doesn't help.
5	Change electronic.	Change electronic.
6	Change temperature sensor.	Change temperature sensor. Change electronic if it doesn't help.
7	Calibrate electronic.	Do electronic calibration again. Change electronic if it doesn't help.
8	Check finger print data.	Check finger print data and displacer weight.
9	Calibrate electronic.	Run all calibration functions again.
10	Check displacer weight.	Check displacer weight or run sensor calibration.
11	Check displacer weight.	Check displacer weight. Check also the configured measurement range as well as the zero point.
12	Decrease the process temperature.	Only in case that the temperature < -60°C or > 150°C, it is necessary to take action to decrease the process temperature.
13	Select remote mounting.	Select remote mounting to get suitable environment temperature.

3.4 Reset

In operating the LevelStar FF a user is provided with various alternatives to set or reset the device to some known states via accessing the FACTORY_RESET, RESTART and RESET_HIST_STATUS parameters.

3.4.1 Factory Reset

To ensure a reasonable start, the LevelStar FF is shipped with a factory setting satisfying some pre-defined application requirements. Based on the factory setting, a user is able to configure the device further. While doing that, it may be necessary to reset the device back to its factory state if something is wrong during the configuration. The manufacturer-specific parameter FACTORY_RESET provides this possibility. Factory setting can be restored if 2 ("Restore factory setting") is written to this parameter.

If 1 ("Create factory setting") is written to FACTORY_RESET, a new factory setting is created. This option is used by manufacturer during production phase and must be used carefully by the user since the old factory setting will be overwritten.

Note that a factory setting does not include the setting of the network parameters.

3.4.2 Restart

Fieldbus Foundation offers several levels of Restart functions, which can be initiated by choosing the suitable function in the Resource Block Parameter RESTART.

- Restart Resource:
- Restart Processor: Performing a Restart Processor has the same effect as power-cycle the device.
- Restart with Defaults: Performing a Restart with Defaults will reset all configurable function block application objects to their initialized state. It will also clear all configured Trend and Link Objects. A restart of the processor will be performed automatically after re-initialization has been done.

3.4.3 Clear Status

The manufacturer-specific parameter RESET_HIST_STATUS is used to handle device status. By writing 1 (“Clear history status”) to this parameter, the history status collected in the second five bytes of DIAGNOSIS (see Section 2.2.2.2) will be cleared. If 2 (“Clear all device status”) is written to this parameter, both the current status and the history status, i.e. all 10 elements in DIAGNOSIS will be set to their clear state.

3.5 Linearisation

The LevelStar FF is provided with the possibility to convert measurements with a user-specific characteristic other than just with linear scaling or square root conversion provided by the standard parameter L_TYPE. With the help of the parameters TAB_XY_VAL_0…TAB_XY_VAL_31, TAB_OP_CODE and TAB_STATUS, one can create a linearisation table and store it in the EEPROM. The AI Function Block 1 parameter L_TYPE can be used to select the table for measurement conversion.

The Resource Block provides the method 'Write_Custom_Characterisation which should be used to enter a custom table.

3.6 Config Mode

The LevelStar FF defines the CONFIG_MODE parameter which supports the following values:

- 0 "Manual": In this mode LRV and URV can be changed manually
- 1 "Auto-Range": In this mode LRV and URV are calculated by the device.

Note: LRV and URV are stored in the XD_SCALE parameter of the first AI Function Block.

4 MAINTENANCES

4.1 Installation

The Fieldbus Foundation™ has specified a Device Description Language (DDL) to achieve interoperability between devices from various manufacturers. The Device Description (DD) describes all the information available at the fieldbus interface. The DD is available in the standard fieldbus binary format and contains the following set of files for the LevelStar FF:

0801.ff5
08001.sy5.

Every fieldbus host application, which uses Device Description Services (DDS), is able to get information about a device description.

The file 080101.CFF is a common format file for use in configuring and maintaining devices and their function block applications. This is a human-readable document in plain text format.

The device description files need to be stored in the appropriate directories. It depends on the host system where the “device data” directory is localized

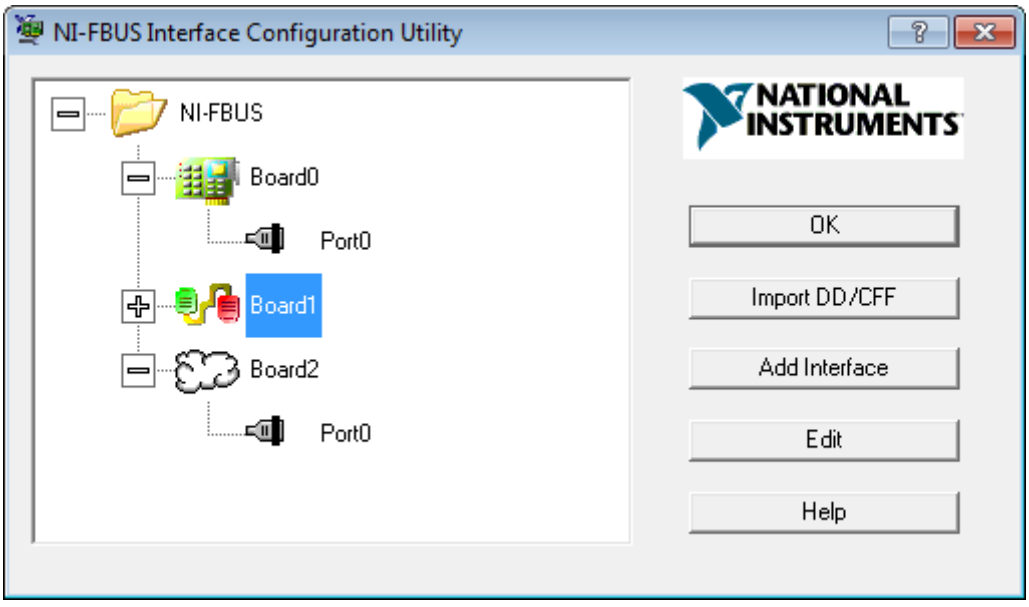
You can download the latest device description files from our website

http://www.foxboro-eckardt.de/products/244LD_en.html

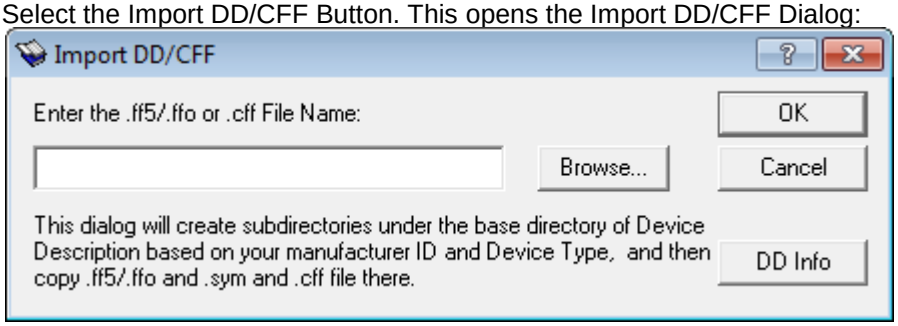
4.1.1 National Intruments Configurator

NI (National Instrument) configurator can be used as a host to operate the LevelStar FF. Please follow the steps below to install the Device Description (DD) files.

1. Start the NI-FBUS Interface Configuration Utility:

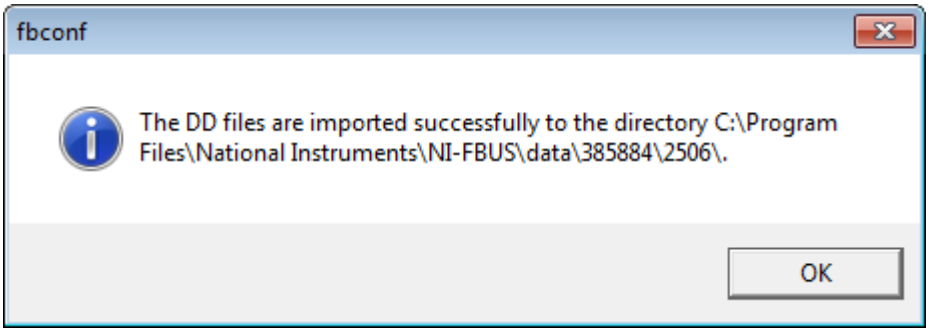


2. Select the Import DD/CFF Button. This opens the Import DD/CFF Dialog:



3. Enter the .ff5/.ffo or .cff File Name or use the Browse.., Button to select the according file.

4. Click OK.



5. Click OK to close the Messagebox above and to close the NI-FBUS Interface Configuration Utility.

The *.ff5 is the DD tokenizer output file, *.sy5 is the symbol file and *.cff is the common file format file.

For the LevelStar FF transmitter,

- ManufactuerID = 0x385884 (The Foxboro Company),
- Device Type = 0x2506 (sensor type = 0x25 (Eckardt DMU) and sensor sub-type = 0x06),
- DeviceRev (device revision) = 08,
- DDRev (DD revision) = 01 and
- CFFRev (common file format file revision) = 01.

Assume that the NI configurator is installed under C:\Program Files\National Instruments\. Then, the DD files of the LevelStar FF should be put into the directory:

C:\Program Files\National Instruments\NI-FBUS
|
Data
|
385884
|
2506
|
0801.ff5
0801.sy5
080101.cff

4.1.2 Foxboro I/A System

If you are attaching the LevelStar FF to a Foxboro I/A System, please refer to [13] for configuration details.

4.2 Access Right

4.2.1 Write Lock

The LevelStar FF supports software write protection. The software write protection is implemented by the standard parameter WRITE_LOCK in the resource block. When protected, all writes to static and non-volatile parameters are rejected by the device, not only for those writes via the fieldbus but also for those writes via external keys.

4.2.2 Local Operation

Local operation is provided in the LevelStar FF via the two external keys controlled by the LOCAL_KEYS_CTRL parameter.

The local operation menu offers the modification of the node address. Once the node address is modified using the local operation menu the device restarts automatically.

With the local operation menu the device can be configured as a Link Master or a Basic Device. Once this configuration is done the device restarts automatically.

Note: Both options should not be used if the device is connected to an application host or a schedule is downloaded to the device.

4.3 Calibration

The LevelStar FF supports sensor zero-point calibration by applying the SENSOR_ZERO_TRIM, ZEROCORR, ZEROSPECMODE and the ZEROSPECOFF parameters.

4.3.1 Sensor Zero-Point Calibration

Sensor zero-point calibration is provided to set another reference point for the process sensor value, which is done internally by subtracting an offset linearly from the process sensor value. Sensor zero-point calibration is a factory procedure and is used for the correction of the zero-point of the process sensor value during the production phase. This calibration follows the steps:

1. Set the transducer block to O/S mode.

2. Hang a weight on the sensor to get the desirable process value used as offset to create the zero-point (several secodes waitng time may be required to get a stable value).

3. Start calibration by writing 1 (“Sensor Zero Point Trim”) to SENSOR_ZERO_TRIM.

Writing the value 2 (“Sensor Zero Point Reset”) to SENSOR_ZERO_TRIM clear the calibrated sensor zero-point.

5 REFERENCES

[1] Foundation Specifications: System Architecture (FF-582 -1.3)

[2] Foundation Specifications: Communication Profile (FF-940 -1.5)

[3] Foundation Specifications: System Management (FF-880 -1.6)

[4] Foundation Specifications: Network Management (FF-801-1.8)

[5] Foundation Specifications: Fieldbus Message Specification (FF-870 -1.7)

[6] Foundation Specifications: Fieldbus Access Sublayer (FF-875 -1.5)

[7] Foundation Specifications: Data Link Services Subset (FF-821-1.4)

[8] Foundation Specifications: Data Link Protocol Specification (FF-822 -1.5)

[9] Foundation Specifications: Function Block Application Process Part 1 + 2 + 3 (FF-890-1.9 + FF-891-1.9 + FF-892-1.10)

[10] Foundation Specifications: Transducer Block Application Process Part 1 + 2 (FF-902-1.3 + FF-903-2.0)

[11] Foundation Specifications: Field Diagnostics Profile (FF-912-1.0)

[12] Master Instruction for 244LD: MI EML0710E-(en), Foxboro Eckardt GmbH, 2010,

[13] Implementing FOUNDATION fieldbus in Foxboro Control Software Applications (B0750DA, Rev.E, May 22, 2013)

[14] Product Specifications for 244LD, PSS EML0710 A –(en), Foxboro-Eckardt GmbH, 2011.