X20(c)DC2190

1 General information

This module can be used to determine paths and to calculate speeds at the same time. The ultrasonic transducer rods are connected directly to the RS422 interface. Communication to the transducer rod takes place using start/stop signals. With the DPI/IP protocol, it is also possible, for example, to read operational properties directly from the transducer. During service (when a transducer is being exchanged) the machine can be started again quickly without additional configuration work.

The module is designed for connecting 2 transducer rods with a total of up to 4 paths. That means, for example, that 2 ultrasonic transducers with 2 magnets each or one with 4 magnets can be used. The combination 3/1 is also possible. The module provides 24 VDC as an external supply for the sensor.

- Ultrasonic transducer module
- Path measurement (resolution 10 µm)
- Speed measurement (resolution 100 µm/s)
- 1, 2, 3 and 4 magnetic rod measurements possible
- DPI/IP protocol supported

2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.
The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days

3 Order data

Order number	Short description	Figure
	Counter functions	
X20DC2190	X20 digital counter module, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection	
X20cDC2190	X20 digital counter module, coated, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection	
	Required accessories	
	Bus modules	
X20BM11	X20 bus module, 24 VDC keyed, internal I/O supply continuous	
X20BM15	X20 bus module, with node number switch, 24 VDC keyed, internal I/O power supply connected through	
X20cBM11	X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20DC2190, X20cDC2190 - Order data

4 Technical data

Order number	X20DC2190	X20cDC2190
Short description		
I/O module	Ultrasonic transducer module, 2 transducer rods, 4 position detection, speed measurement	
General information		
B&R ID code	0x2188	0xEE9D
Status indicators	I/O function per channel, operating state, module status	
Diagnostics		
Module run/error	Yes, using status LED and software	
Power consumption		
Bus	0.01 W	
Internal I/O	1.1 W	
Additional power dissipation caused by actuators (resistive) [W]	-	
Certifications		
CE	Yes	
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X	
UL	cULus E115267 Industrial control equipment	
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5	-
EAC	Yes	
KC	Yes	-
Channels for path and speed measurements		
Quantity	2	
Supported encoder types	Start/Stop interface EP start/stop interface DPI/IP interface	
Encoder power supply		
Voltage	24 VDC, module-internal, max. 150 mA	
Monitoring	Configurable overvoltage/undervoltage monitoring (±10%, ±15%, ±20%, ±25%)	
Short-circuit proof	Rev. D0 and higher	Rev. D0 and later
Input and output level	RS422 differential level	
Multi-magnet measurement	Yes, in combination per rod, max. 4 magnets total	
Outputs	1.6 µs durational initialization pulse	
Inputs		
Path measurement	Resolution = 0.01 mm, measurement range = ±5.2 m	
Speed measurement	Resolution = 0.1 mm/s, measurement range = ±3.2 m/s	
Accuracy	±50 ppm ±5 ppm/year	
Short circuit protection	No	
Electrical properties		
Electrical isolation	Channel isolated from bus Channel not isolated from channel	
Operating conditions		
Mounting orientation		
Horizontal	Yes	
Vertical	Yes	
Installation elevation above sea level		
0 to 2000 m	No limitations	
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m	
Degree of protection per EN 60529	IP20	
Ambient conditions		
Temperature		
Operation		
Horizontal mounting orientation	-25 to 60°C	
Vertical mounting orientation	-25 to 50°C	
Derating	-	
Storage	-40 to 85°C	
Transport	-40 to 85°C	
Relative humidity		
Operation	5 to 95%, non-condensing	Up to 100%, condensing
Storage	5 to 95%, non-condensing	
Transport	5 to 95%, non-condensing	
Mechanical properties		
Note	Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately	Order 1x terminal block X20TB12 separately Order 1x bus module X20cBM11 separately
Pitch	$12.5^{+0.2}$ mm	

Table 2: X20DC2190, X20cDC2190 - Technical data

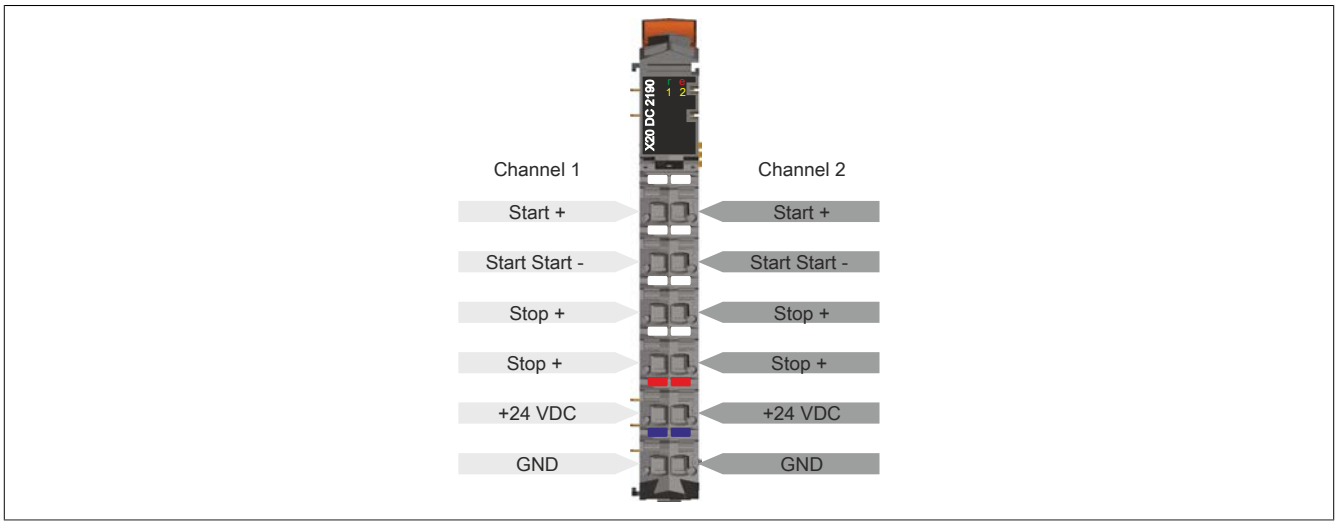
5 LED status indicators

For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" in the X20 system user's manual.

Figure	LED	Color	Status	Description
	r	Green	Off	No power to module
			Single flash	Reset mode
			Double flash	Boot mode (during firmware update)[1)]
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	e	Red	Off	No power to module or everything OK
			On	Error or reset status
	1 - 2	Yellow	Off	No transducer rod connected
			On	Transducer rod is connected to the respective measurement channel

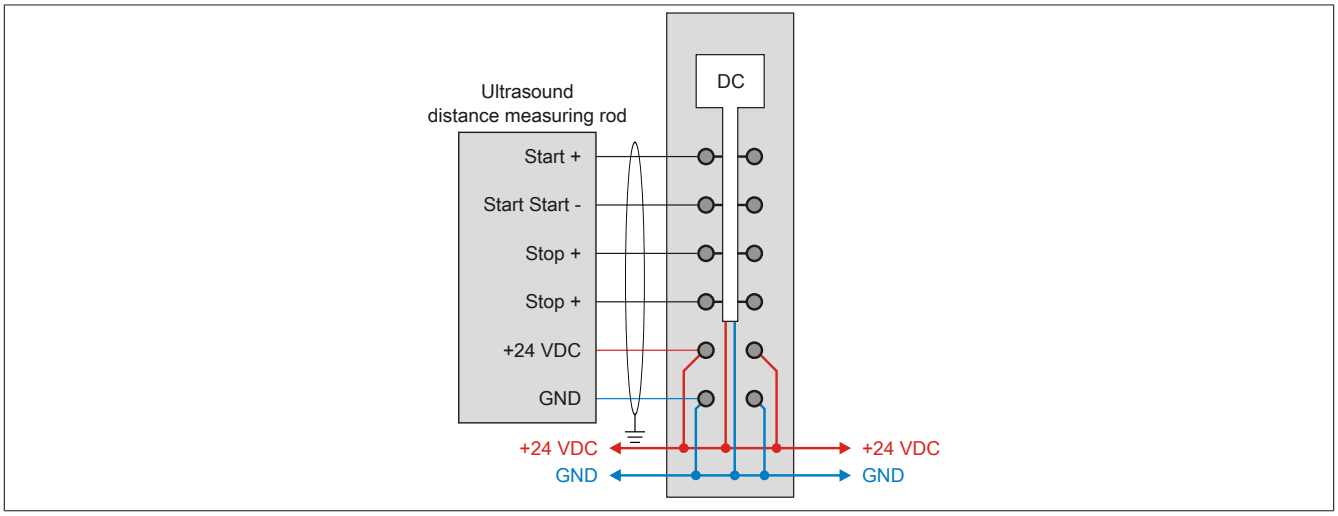
1) Depending on the configuration, a firmware update can take up to several minutes.

6 Pinout



The ultrasonic transducers should be connected using a shielded cable. The shield of the encoder cable is connected to the ground via the shield connection on the X20 bus module.

7 Connection example



8 Register description

8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "Additional information - General data points" in the X20 system user's manual.

8.2 Function model 0 - Standard

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Synchronous register						
0	Position01	DINT	•			
4	Position02	DINT	•			
8	Position03	DINT	•			
12	Position04	DINT	•			
16	Speed01	INT	•			
18	Speed02	INT	•			
20	Speed03	INT	•			
22	Speed04	INT	•			
24	ErrorStatus01	USINT	•			
25	ErrorStatus02	USINT	•			
26	ErrorStatus03	USINT	•			
27	ErrorStatus04	USINT	•			
28	StatusInput01	USINT	•			
30	USSpeed01	UDINT			•	
34	USSpeed02	UDINT			•	
68	StatusOutput01	USINT			•	
Configuration registers						
38	ConfigOutput01 (module configuration)	USINT				•
40	ConfigOutput02 (channel configuration)	UINT				•
60	ConfigOutput03 (rod length 1)	UDINT				•
64	ConfigOutput04 (rod length 2)	UDINT				•
134	ConfigOutput07 (offset position for magnet 1)	DINT				•
72	ConfigOutput08 (offset position for magnet 2)	DINT				•
84	ConfigOutput09 (minimum path for magnet 1)	DINT				•
88	ConfigOutput10 (minimum path for magnet 2)	DINT				•
92	ConfigOutput11 (maximum path for magnet1)	DINT				•
96	ConfigOutput12 (maximum path for magnet 2)	DINT				•
100	ConfigOutput13 (maximum speed for magnet 1)	UDINT				•
104	ConfigOutput14 (maximum speed for magnet 2)	UDINT				•
76	ConfigOutput15 (offset position for magnet 3)	DINT				•
80	ConfigOutput16 (offset position for magnet 4)	DINT				•
138	ConfigOutput17 (minimum path for magnet 3)	DINT				•
142	ConfigOutput18 (minimum path for magnet 4)	DINT				•
146	ConfigOutput19 (maximum path for magnet 3)	DINT				•
150	ConfigOutput20 (maximum path for magnet 4)	DINT				•
154	ConfigOutput21 (maximum speed for magnet 3)	UDINT				•
158	ConfigOutput22 (maximum speed for magnet 4)	UDINT				•
42	ConfigOutput23 (dead time 1)	USINT				•
44	ConfigOutput24 (dead time 2)	USINT				•
Read configuration register						
38	ConfigOutput01Read	USINT		•		
40	ConfigOutput02Read	UINT		•		
60	ConfigOutput03Read	UDINT		•		
64	ConfigOutput04Read	UDINT		•		
134	ConfigOutput07Read	DINT		•		
72	ConfigOutput08Read	DINT		•		
84	ConfigOutput09Read	DINT		•		
88	ConfigOutput10Read	DINT		•		
92	ConfigOutput11Read	DINT		•		
96	ConfigOutput12Read	DINT		•		
100	ConfigOutput13Read	UDINT		•		
104	ConfigOutput14Read	UDINT		•		
76	ConfigOutput15Read	DINT		•		
80	ConfigOutput16Read	DINT		•		
138	ConfigOutput17Read	DINT		•		
142	ConfigOutput18Read	DINT		•		
146	ConfigOutput19Read	DINT		•		
150	ConfigOutput20Read	DINT		•		
154	ConfigOutput21Read	UDINT		•		

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
158	ConfigOutput22Read	UDINT		•		
42	ConfigOutput23Read	USINT		•		
44	ConfigOutput24Read	USINT		•		
Status register						
108	StatusInput09	UDINT		•		
112	StatusInput10	UDINT		•		
116	StatusInput11	UDINT		•		
120	StatusInput12	UDINT		•		
162	StatusInput13	UDINT		•		
166	StatusInput14	UDINT		•		
170	StatusInput15	UDINT		•		
174	StatusInput16	UDINT		•		
178	StatusInput17	UDINT		•		
182	StatusInput18	UDINT		•		
186	StatusInput19	UDINT		•		
190	StatusInput20	UDINT		•		
194	StatusInput21	UDINT		•		
198	StatusInput22	UDINT		•		
202	StatusInput23	UDINT		•		
206	StatusInput24	UDINT		•		
210	StatusInput25	UDINT		•		
214	StatusInput26	UDINT		•		
218	StatusInput27	UDINT		•		
222	StatusInput28	UDINT		•		
226	StatusInput29	UDINT		•		
230	StatusInput30	UDINT		•		
234	StatusInput31	UDINT		•		
238	StatusInput32	UDINT		•		
242	StatusInput33	UDINT		•		
246	StatusInput34	UDINT		•		
250	StatusInput35	UDINT		•		
254	StatusInput36	UDINT		•		

8.3 Function model 254 - Bus controller

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Synchronous register							
0	0	Position01	DINT	•			
4	8	Position02	DINT	•			
8	16	Position03	DINT	•			
12	24	Position04	DINT	•			
30	4	Speed01	INT	•			
32	12	Speed02	INT	•			
34	20	Speed03	INT	•			
36	28	Speed04	INT	•			
38	-	LB: Error status of Magnet 1 HB: Module status	UINT	•			
	6	ErrorStatus01	USINT	•			
	7	StatusInput01	USINT	•			
40	14	ErrorStatus02	USINT	•			
42	22	ErrorStatus03	USINT	•			
44	30	ErrorStatus04	USINT	•			
100	0	USSpeed01	UDINT			•	
109	8	USSpeed02	UDINT			•	
150	16	StatusOutput01	USINT			•	
Configuration registers							
2200	-	ConfigOutput01 (module configuration)	USINT				•
2100	-	ConfigOutput02 (channel configuration)	UINT				•
2000	-	ConfigOutput03 (rod length 1)	UDINT				•
2004	-	ConfigOutput04 (rod length 2)	UDINT				•
2008	-	ConfigOutput07 (offset position for magnet 1)	DINT				•
2012	-	ConfigOutput08 (offset position for magnet 2)	DINT				•
2024	-	ConfigOutput09 (minimum path for magnet 1)	DINT				•
2028	-	ConfigOutput10 (minimum path for magnet 2)	DINT				•
2040	-	ConfigOutput11 (maximum path for magnet 1)	DINT				•
2044	-	ConfigOutput12 (maximum path for magnet 2)	DINT				•
2056	-	ConfigOutput13 (maximum speed for magnet 1)	UDINT				•
2060	-	ConfigOutput14 (maximum speed for magnet 2)	UDINT				•
2016	-	ConfigOutput15 (offset position for magnet 3)	DINT				•
2020	-	ConfigOutput16 (offset position for magnet 4)	DINT				•
2032	-	ConfigOutput17 (minimum path for magnet 3)	DINT				•
2036	-	ConfigOutput18 (minimum path for magnet 4)	DINT				•

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
2048	-	ConfigOutput19 (maximum path for magnet 3)	DINT				•
2052	-	ConfigOutput20 (maximum path for magnet 4)	DINT				•
2064	-	ConfigOutput21 (maximum speed for magnet 3)	UDINT				•
2068	-	ConfigOutput22 (maximum speed for magnet 4)	UDINT				•
2201	-	ConfigOutput23 (dead time 1)	USINT				•
2202	-	ConfigOutput24 (dead time 2)	USINT				•
Read configuration register							
2200	-	ConfigOutput01Read	USINT		•		
2100	-	ConfigOutput02Read	UINT		•		
2000	-	ConfigOutput03Read	UDINT		•		
2004	-	ConfigOutput04Read	UDINT		•		
2008	-	ConfigOutput07Read	DINT		•		
2012	-	ConfigOutput08Read	DINT		•		
2024	-	ConfigOutput09Read	DINT		•		
2028	-	ConfigOutput10Read	DINT		•		
2040	-	ConfigOutput11Read	DINT		•		
2044	-	ConfigOutput12Read	DINT		•		
2056	-	ConfigOutput13Read	UDINT		•		
2060	-	ConfigOutput14Read	UDINT		•		
2016	-	ConfigOutput15Read	DINT		•		
2020	-	ConfigOutput16Read	DINT		•		
2032	-	ConfigOutput17Read	DINT		•		
2036	-	ConfigOutput18Read	DINT		•		
2048	-	ConfigOutput19Read	DINT		•		
2052	-	ConfigOutput20Read	DINT		•		
2064	-	ConfigOutput21Read	UDINT		•		
2068	-	ConfigOutput22Read	UDINT		•		
2201	-	ConfigOutput23Read	USINT		•		
2202	-	ConfigOutput24Read	USINT		•		
Status register							
2500	-	StatusInput09	UDINT		•		
2556	-	StatusInput10	UDINT		•		
2504	-	StatusInput11	UDINT		•		
2560	-	StatusInput12	UDINT		•		
2508	-	StatusInput13	UDINT		•		
2564	-	StatusInput14	UDINT		•		
2512	-	StatusInput15	UDINT		•		
2568	-	StatusInput16	UDINT		•		
2516	-	StatusInput17	UDINT		•		
2572	-	StatusInput18	UDINT		•		
2520	-	StatusInput19	UDINT		•		
2524	-	StatusInput20	UDINT		•		
2528	-	StatusInput21	UDINT		•		
2532	-	StatusInput22	UDINT		•		
2536	-	StatusInput23	UDINT		•		
2540	-	StatusInput24	UDINT		•		
2576	-	StatusInput25	UDINT		•		
2580	-	StatusInput26	UDINT		•		
2584	-	StatusInput27	UDINT		•		
2588	-	StatusInput28	UDINT		•		
2592	-	StatusInput29	UDINT		•		
2596	-	StatusInput30	UDINT		•		
2544	-	StatusInput31	UDINT		•		
2548	-	StatusInput32	UDINT		•		
2552	-	StatusInput33	UDINT		•		
2600	-	StatusInput34	UDINT		•		
2604	-	StatusInput35	UDINT		•		
2608	-	StatusInput36	UDINT		•		

1) The offset specifies the position of the register within the CAN object.

The measurements of the module are not synchronized with the X2X Link network in the bus controller function model. The time between 2 measurements corresponds to the set recovery time of the rod (see "Channel configuration" on page 10, but not to the smallest multiple of the X2X Link cycle time, which is greater than the set recovery time, as in the standard function model.

8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see section "Additional information - Using I/O modules on the bus controller" in the X20 user's manual (version 3.50 or later).

8.3.2 CAN I/O bus controller

The module occupies 4 analog logical slots on CAN I/O.

8.4 Commissioning a transducer rod

Two registers need to be configured to initialize an ultrasonic transducer rod and receive valid measurements. The first step is to enter the length of the rod (see "Rod length 1 and 2" on page 10). The wave propagation speed for the rod must then be defined (see "Ultrasonic speed specification" on page 8). This information can usually be found directly on the transducer rod itself or in its data sheet.

If the plausibility limits remain set to 0 (default value), one of the respective ErrorStatus registers will now indicate faulty readings or plausibility errors. If this is the case, plausibility mode can be disabled using the "ConfigOutput01" register (see "Module configuration" on page 9). This will cause the positions of the magnets to be displayed on the rod.

8.5 Reading the magnet position

Name:
Position01 - Position04

These registers contain the position of the individual magnets on the transducer rods.

Data type	Value	Information
DINT	-2,147,483,648 to 2,147,483,647	Resolution 1 µm

8.6 Reading the magnet speed

Name:
Speed01 to Speed04

These registers contain the speed of the individual magnets on the transducer rods. A resolution of 0.1 mm/s is achieved by calculating the speed from 2 position values within a 100 ms interval.

Data type	Value	Information
INT	-32768 to 32767	Resolution 0.1 mm/s

8.7 Error status

Name:
ErrorStatus01 to ErrorStatus04

These registers can be used to indicate the error status for individual channels.

Data type	Values
USINT	See the bit structure.

Bit structure

Bit	Description
0 - 3	Counter for plausibility errors (cyclic)
4 - 7	Counter for mis-measurements (cyclic)

Possible reasons for plausibility errors:

- Configured max. or min. path of a magnet was exceeded
- Configured max. speed was exceeded

Possible reasons for faulty measurements:

- Configured rod length was exceeded
- Rod failure
- Missing measurement magnet

Information:

If the registers "USSpeed01 and USSpeed02" on page 8 are unequal to 0 after the module starts up, the respective error counters on slower fieldbus systems (e.g. CAN I/O) may continue to count until the module configuration is completed. In some cases, this is due problems between the respective rod and the default configuration.

8.8 Status information about the transducer rods

Name:
StatusInput01

This register displays the status information for the transducer rods.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Name	Value	Information
0	Supply voltage too low	0	Supply voltage OK
		1	Supply voltage too low
1	Supply voltage too high	0	Supply voltage OK
		1	Supply voltage too high
2	Transducer Rod 1	0	Ok
		1	Deactivated or not initialized
3	Transducer Rod 2	0	Ok
		1	Deactivated or not initialized
4	Transducer Rod 1	0	Protocol error (invalid data)
		1	Protocol OK (valid data)
5	Transducer Rod 2	0	Protocol error (invalid data)
		1	Protocol OK (valid data)
6 - 7	Reserved		

Comment concerning bits 4 + 5

If this bit is set to "1", configuration data was successfully read from the measurement rod using DPI/IP or EP protocol. This data can now be read into the application using asynchronous access.

8.9 Ultrasonic speed specification

Name:
USSpeed01 to USSpeed02

The module does not perform any measurements on the respective rod while these registers have the value 0. Also disabled:

- Automatic check to determine whether a rod is connected
- Parameter upload via DPI/IP or EP protocol

If a value >0 but <1000cm/s is specified here, the module freezes all measurements and error counters of the corresponding rod, regardless of whether plausibility mode is enabled or not. Based on the default ultrasonic speed of 280,000 cm/s, however, periodic measurement start pulses continue to be generated according to the formula in "Channel configuration" on page 10. In this case the rod check (inserted/not inserted and parameter upload) continues to be active.

As soon as a valid value (≥1000) is specified, the module recalculates the measurement rate (see "Channel configuration" on page 10) and begins the position/speed measurement.

Data type	Value	Information
UDINT	0 to 4,294,967,296	Resolution 1 cm/s

8.10 Applying new magnet offsets

Name:
StatusOutput01

This register makes it easier to more quickly determine new offsets (= zero positions) for the individual magnets. This approach is an alternative or additional method to determining an offset via configuration registers (see "Offset position on the transducer" on page 11).

If the respective bit changes from 0 to 1 in "StatusOutput01" (see following table) then the current mechanical position of the respective magnet becomes the calculated zero position (register "Position0x" = 0).
From that moment, the current mechanical position will be subtracted from all future measured positions. This is essentially a type of referencing. The max. and min. magnet paths (see "Plausibility check configuration" on page 11) are now based on the new zero position.
This process can be repeated at any time by setting the bit again.

Information:

An offset position determined in this manner is *NOT* readable. Only the current contents of ConfigOutput07, ConfigOutput08, ConfigOutput15 and ConfigOutput16 can be read using registers ConfigOutput07Read, ConfigOutput08Read, ConfigOutput15Read and ConfigOutput16Read.

Data type	Values
USINT	See the bit structure.

Bit	Name	Value	Information
0	Magnet 1	0	No effect
		1	Apply offset magnet 1
...		...	
3	Magnet 4	0	No effect
		1	Apply offset magnet 4
4 - 7	Reserved		

8.11 Module configuration

Name:
ConfigOutput01

This register configures the module.

Data type	Values	Bus controller default setting
USINT	See the bit structure.	0

Bit structure:

Bit	Name	Value	Information
0	Plausibility mode	0	The plausibility error counter is incremented with each implausible measurement, and the last plausible measured value is "frozen" (bus controller default setting).
		1	The plausibility error counter is incremented with each implausible measurement and the implausible measurement value is forwarded to the controller
1	Reserved		
2 - 3	Tolerance for monitoring the supply voltage	00	25% (bus controller default setting)
		01	20%
		10	15%
		11	10%
4 - 7	Magnet number	0000	4 magnets on channel 1, channel 2 not available (bus controller default setting)
		0001	3 magnets on channel 1, 1 magnet on channel 2
		0010	2 magnets on channel 1, 2 magnets on channel 2
		0011	1 magnet on channel 1, 0 magnets on channel 2
		0100	2 magnets on channel 1, 0 magnets on channel 2
		0101	3 magnets on channel 1, 0 magnets on channel 2
		0110	2 magnets on channel 1, 1 magnet on channel 2
		0111	1 magnet on channel 1, 1 magnet on channel 2
		1xxx	Reserved

8.12 Channel configuration

Name:
ConfigOutput02

This register can be used to configure the individual channels.

Data type	Values	Bus controller default setting
UINT	See the bit structure.	0

Bit structure:

Bit	Description	Value	Information
0 - 2	Transducer Rod 1	000	User parameter (bus controller default setting)
		001	DPI/IP (Balluf)
		010	EP Start/Stop (MTS)
		011	Reserved
		1xx	Reserved
3 - 4	Rod 1: Start/Stop IF type	00	Start/Stop signal: Rising edge - Rising edge (bus controller default setting)
		01	Start/Stop Signal: Falling edge - falling edge
		10	Start/Stop Signal: Rising edge - falling edge (gate time)
		11	Only Stop Signal: Start when signal is triggered (initialization pulses)
5	Rod 1: Recovery time factor, minimum time between two measurements	0	3 x USW runtime for rod (bus controller default setting)
		1	2 x USW runtime for rod
6 - 7	Reserved		
8 - 10	Transducer Rod 2	000	User parameter (bus controller default setting)
		001	DPI/IP (Balluf)
		010	EP Start/Stop (MTS)
		011	Reserved
		1xx	Reserved
11 - 12	Rod 2: Start/Stop IF type	00	Start/Stop signal: Rising edge - Rising edge (bus controller default setting)
		01	Start/Stop Signal: Falling edge - falling edge
		10	Start/Stop Signal: Rising edge - falling edge (gate time)
		11	Only Stop Signal: Start when signal is triggered (initialization pulses)
13	Rod 2: Recovery time factor, minimum time between two measurements	0	3 x USW runtime for rod (bus controller default setting)
		1	2 x USW runtime for rod
14 - 15	Reserved		

Comment concerning bits 5 + 13

USW transducer rods require a certain recovery time between two measurements to allow the ultrasonic wave to fade. Otherwise there is a risk of interfering with the next measurement (especially when the rod has more than 1 magnet).

Depending on the setting, the module waits at least 2 or 3 times the runtime of the ultrasonic wave for the measurement rod (default = 3x). In the standard function module, the next measurement is then triggered synchronously with the next X2XLink cycle.

The runtime measurement is based on the settings for the rod length (plus a safety margin of 100mm) and the ultrasonic speed:

- USW runtime = (rod length + 100mm) / ultrasonic speed.

For their rods, BALLUFF recommends a recovery time equal to 3 times the maximum runtime of the ultrasonic wave for the measurement rod. This is the default setting for the module.

The setting can be switched to 2 times the runtime if the measurement rate is otherwise too slow. This may only be done after consulting the manufacturer of the transducer rods!

8.13 Rod length 1 and 2

Name:
ConfigOutput03 to ConfigOutput04

These registers are used to configure the length of the respective rod.

- Rod length 1: ConfigOutput03
- Rod length 2: ConfigOutput04

Data type	Value	Information
UDINT	0 to 4,294,967,29	Resolution 1 mm. Bus controller default setting: 0

8.14 Offset position on the transducer

Name:
ConfigOutput07 to ConfigOutput08
ConfigOutput15 to ConfigOutput16

These registers are used to assign the respective magnet an offset position (= zero position) on the transducer. The max. and min. magnet paths refer to these specified offsets (see "Plausibility check configuration" on page 11). If the offset is changed using the StatusOutput01 register, this becomes the new zero position. This does not affect the contents of the offset register.

- Offset magnet 1: ConfigOutput07
- Offset magnet 2: ConfigOutput08
- Offset magnet 3: ConfigOutput15
- Offset magnet 4: ConfigOutput16

Data type	Value	Information
DINT	-2,147,483,648 to 2,147,483,647	Resolution 1 µm. Bus controller default setting: 0

8.15 Plausibility check configuration

These registers are used to configure the plausibility check (also see "Error status" on page 7).

8.15.1 Min. plausible magnet position

Name:
ConfigOutput09 to ConfigOutput10
ConfigOutput17 to ConfigOutput18

These registers are used to assign the min. plausible magnet position based on the applicable offset.

- Min. path - magnet 1: ConfigOutput09
- Min. path - magnet 2: ConfigOutput10
- Min. path - magnet 3: ConfigOutput17
- Min. path - magnet 4: ConfigOutput18

Data type	Value	Information
DINT	-2,147,483,648 to 2,147,483,647	Resolution 1 µm. Bus controller default setting: 0

8.15.2 Max. plausible magnet position

Name:
ConfigOutput11 to ConfigOutput12
ConfigOutput19 to ConfigOutput20

These registers assign the max. plausible magnet position relative to the valid offset.

- Max. path of magnet 1: ConfigOutput11
- Max. path of magnet 2: ConfigOutput12
- Max. path of magnet 3: ConfigOutput19
- Max. path of magnet 4: ConfigOutput20

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Resolution 1 µm. Bus controller default setting: 0

8.15.3 Max. plausible magnet velocity

Name:
ConfigOutput13 to ConfigOutput14
ConfigOutput21 to ConfigOutput22

These registers assign the max. plausible magnet speed.

- Max. speed of magnet 1: ConfigOutput13
- Max. speed of magnet 2: ConfigOutput14
- Max. speed of magnet 3: ConfigOutput21
- Max. speed of magnet 4: ConfigOutput22

Data type	Values	Information
UDINT	0 to 4,294,967,296	Resolution 0.1 mm/s. Bus controller default setting: 0

8.16 Dead time for rods 1 and 2

Name:
ConfigOutput23 to ConfigOutput24

These registers configure the dead time of the respective rod.

- Dead time for rod 1: ConfigOutput23
- Dead time for rod 2: ConfigOutput24

To prevent the multiple pulses that occur with some encoders from affecting the measurement, all pulses received within a configurable timespan from the beginning of the measurement are not evaluated. The range for the dead time is between 0 and 255 µs. The following figure illustrates the effects of defining a dead time:

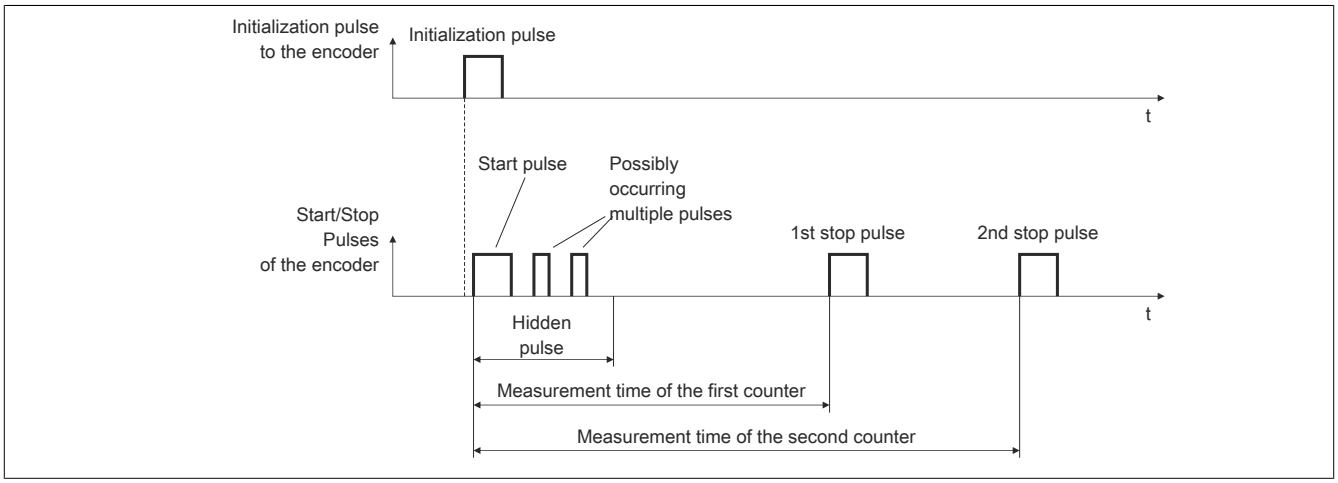


Figure 1: Pulse Ignored after Start Pulse

Data type	Values	Information
USINT	0 to 255	1 µs resolution. Bus controller default setting: 0

8.17 Read configuration register

Name:
ConfigOutput01Read to ConfigOutput04Read
ConfigOutput07Read to ConfigOutput24Read

These registers are used to read the states of the corresponding configuration registers.

8.18 Status register

Name:
StatusInput09 to StatusInput36

These registers are used to store the data read after a parameter upload from transducer rods with DPI/IP protocol or EP protocol. The registers "StatusInput19" to "StatusInput36" remain empty (0x0000) on transducer rods with EP protocol.

8.18.1 Parameter overview

The following parameters are stored in the status registers:

Register	Description	Supported by the protocol	
		DP/IP	EP
StatusInput09	Rod length 1 [mm]	●	●
StatusInput10	Rod length 2 [mm]	●	●
StatusInput11	Ultrasonic speed 1	●	●
StatusInput12	Ultrasonic speed 2	●	●
StatusInput13	Rod 1: Zero point offset [µm]	●	●
StatusInput14	Rod 2: Zero point offset [µm]	●	●
StatusInput15	Rod 1: Vendor ID (see transducer rod data sheet)	●	●
StatusInput16	Rod 2: Vendor ID (see transducer rod data sheet)	●	●
StatusInput17	Rod 1: Serial number (Hex coded)	●	●
StatusInput18	Rod 2: Serial number (Hex coded)	●	●
StatusInput19	Rod 1: Type ID 1 (MSB = letter 1)	●	0x0000
StatusInput20	Rod 1: Type ID 2 (MSB = letter 5)	●	0x0000
StatusInput21	Rod 1: Type ID 3 (MSB = letter 9)	●	0x0000
StatusInput22	Rod 1: Type ID 4 (MSB = letter 13)	●	0x0000
StatusInput23	Rod 1: Type ID 5 (MSB = letter 17)	●	0x0000
StatusInput24	Rod 1: Type ID 6 (MSB = letter 21)	●	0x0000
StatusInput25	Rod 2: Type ID 1 (MSB = letter 1)	●	0x0000
StatusInput26	Rod 2: Type ID 2 (MSB = letter 5)	●	0x0000
StatusInput27	Rod 2: Type ID 3 (MSB = letter 9)	●	0x0000
StatusInput28	Rod 2: Type ID 4 (MSB = letter 13)	●	0x0000
StatusInput29	Rod 2: Type ID 5 (MSB = letter 17)	●	0x0000
StatusInput30	Rod 2: Type ID 6 (MSB = letter 21)	●	0x0000
StatusInput31	Rod 1: Serial number ASCII 1 (MSB = letter 1)	●	0x0000
StatusInput32	Rod 1: Serial number ASCII 2 (MSB = letter 5)	●	0x0000
StatusInput33	Rod 1: Serial number ASCII 3 (MSB = letter 9)	●	0x0000
StatusInput34	Rod 2: Serial number ASCII 1 (MSB = letter 1)	●	0x0000
StatusInput35	Rod 2: Serial number ASCII 2 (MSB = letter 5)	●	0x0000
StatusInput36	Rod 2: Serial number ASCII 3 (MSB = letter 9)	●	0x0000

8.18.2 DPI/IP protocol (BALLUFF) / EP protocol (MTS)

Requirements for a successful upload of the transducer rod parameters to the module:

1. Selection of the communication protocol (DPI/IP or EP). See "Channel configuration" on page 10
2. Transducer rod must support the respective protocol.
3. If the transducer rod does not support the selected protocol, the module will detect this after a timeout of approx. 300 ms and will treat the rod as a "normal" transducer rod.

After the module is started or after a transducer rod is connected, the parameter upload should be complete within 200 to 400 ms.

A communication error causes the data upload to cancel. A new upload attempt can be initiated by the user by deactivating and reactivating the communication protocol using asynchronous access.

All rod parameters can be read to the controller using asynchronous access. The read parameters "rod length" and "ultrasonic speed" are **NOT** automatically uploaded to the module.

It is left up to the application whether the upload values for rod length 1 and rod length 2 or for ultrasonic speed 1 and ultrasonic speed 2 are uploaded.

Information:

Keep in mind that no position measurements can be performed on a rod while parameters are being uploaded. The module freezes all existing position/speed data for all magnets on the rod while the parameters are uploading. Parameters should therefore only be uploaded with the machine stopped, and this should be ensured by the application.

8.19 Minimum cycle time

The minimum cycle time specifies how far the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

Minimum cycle time
250 µs