X20DC2396

Data sheet
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Translation of the original documentation

Publishing information

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Disclaimer

Version history

B&R makes every effort to keep documents as current as possible. The most current versions are available for download on the B&R website (www.br-automation.com).

1 General information

1.1 Other applicable documents

For additional and supplementary information, see the following documents.

Other applicable documents

Document name	Title
MAX20	X20 System user's manual

1.2 Order data

Order number	Short description	Figure
	Counter functions	
X20DC2396	X20 digital counter module, 2 ABR incremental encoder, 24 V, 100 kHz input frequency, 4x evaluation	
	Required accessories	
	Bus modules	
X20BM11	X20 bus module, 24 VDC keyed, internal I/O power supply connected through	
X20BM15	X20 bus module, with node number switch, 24 VDC keyed, internal I/O power supply connected through	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20DC2396 - Order data

1.3 Module description

The module is equipped with two inputs for an ABR incremental encoder with 24 V encoder signal.

Functions:

- ABR incremental encoder
- Monitoring the encoder power supply

ABR incremental encoder

The module provides 2 inputs for ABR incremental encoders. This allows the detection of position (linear) or angular (rotating) changes in ABR encoders.

Monitoring the supply voltage

The encoder power supply voltage is monitored.

2 Technical description

2.1 Technical data

Order number	X20DC2396
Short description	
I/O module	2 ABR incremental encoder 24 V
General information	
Input voltage	24 VDC -15% / +20%
B&R ID code	0x1BAB
Status indicators	I/O function per channel, operating state, module status
Diagnostics	
Module run/error	Yes, using LED status indicator and software
Power consumption	
Bus	0.01 W
Internal I/O	1.5 W
Additional power dissipation caused by actuators (resistive) [W]	-
Type of signal lines	Shielded lines must be used for all signal lines.
Certifications	
CE	Yes
UKCA	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
DNV	Temperature: **B** (0 to 55°C) Humidity: **B** (up to 100%) Vibration: **B** (4 g) EMC: **B** (bridge and open deck)
CCS	Yes
LR	ENV1
KR	Yes
ABS	Yes
BV	**EC33B** Temperature: 5 - 55°C Vibration: 4 g EMC: Bridge and open deck
KC	Yes
Digital inputs	
Quantity	2
Nominal voltage	24 VDC
Input current at 24 VDC	Approx. 3.3 mA
Input circuit	Sink
Input filter	
Hardware	≤2 µs
Software	-
Connection type	3-wire connections
Input resistance	7.19 kΩ
Additional functions	Home enable switch
Switching threshold	
Low	<5 VDC
High	>15 VDC
Insulation voltage between channel and bus	500 V_{eff}
ABR incremental encoder	
Encoder inputs	24 V, asymmetrical
Counter size	16/32-bit
Input frequency	Max. 100 kHz
Evaluation	4x
Encoder power supply	Module-internal, max. 600 mA
Input filter	
Hardware	≤2 µs
Software	-
Input current at 24 VDC	Approx. 1.3 mA

Table 2: X20DC2396 - Technical data

Order number	X20DC2396
Input resistance	18.4 kΩ
Switching threshold	
Low	<5 VDC
High	>15 VDC
Overload characteristics of encoder power supply	Short-circuit proof, overload-proof
Insulation voltage between encoder and bus	500 V_{eff}
Electrical properties	
Electrical isolation	Bus isolated from encoder and reference enable switch Encoder not isolated from reference enable switch and each other
Operating conditions	
Mounting orientation	
Horizontal	Yes
Vertical	Yes
Installation elevation above sea level	
0 to 2000 m	No limitation
>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
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.
Pitch	12.5$^{+0.2}$ mm

Table 2: X20DC2396 - Technical data

2.2 LED status indicators

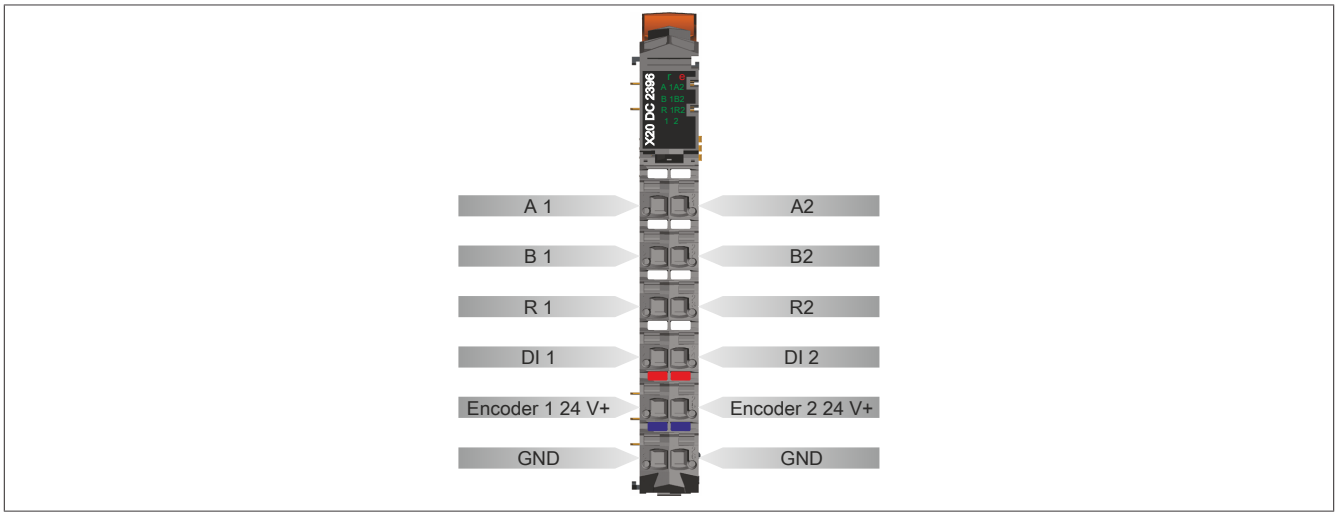
For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" in the X20 System user's manual.

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
	A1, A2	Green		Input state of counter input A1 or A2
	B1, B2	Green		Input state of counter input B1 or B2
	R1, R2	Green		Input state of reference pulse R1 or R2
	1 - 2	Green		Input state of the corresponding digital input

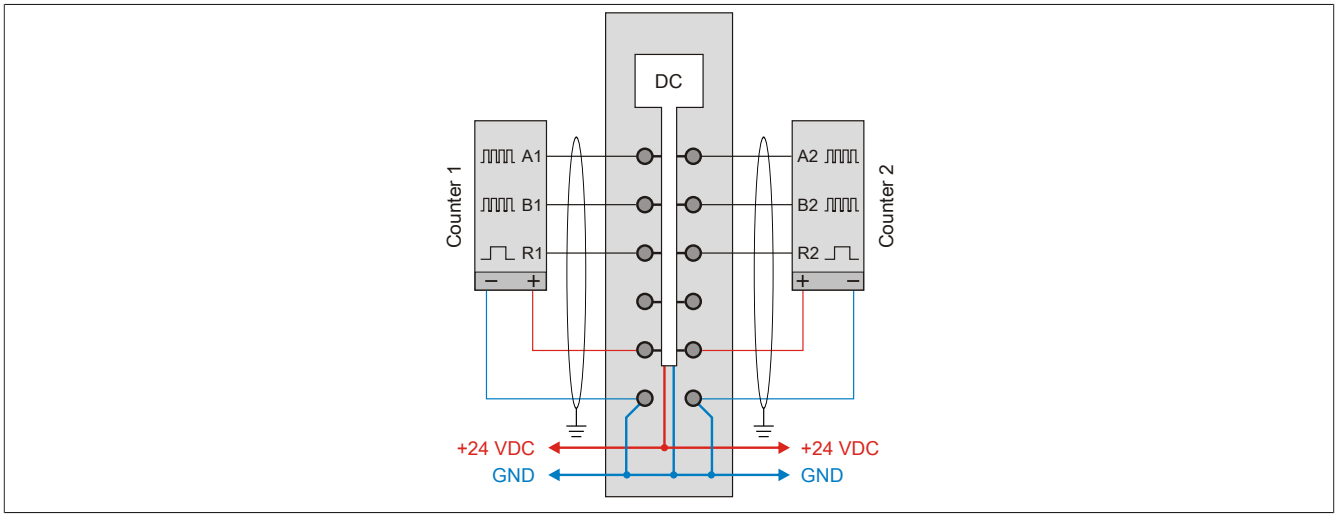
1) Depending on the configuration, a firmware update can take up to several minutes.

2.3 Pinout

Shielded cables must be used for all signal lines.

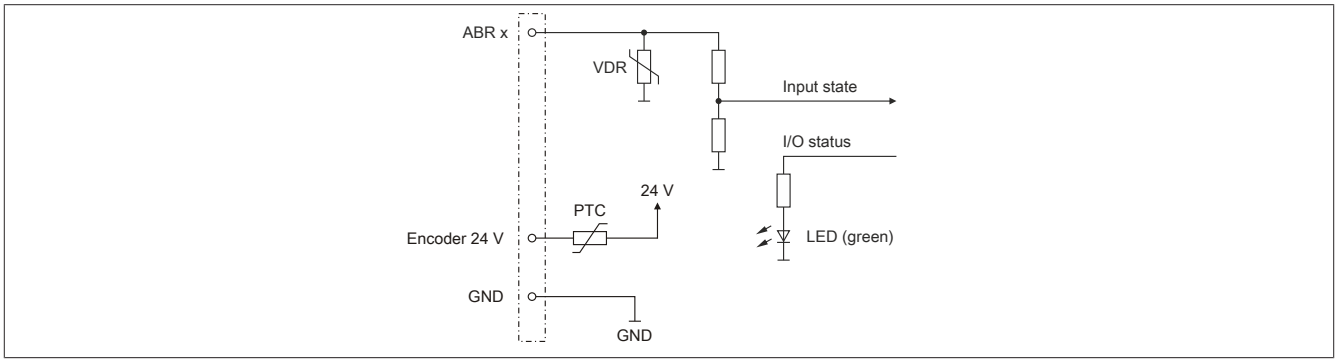


2.4 Connection example

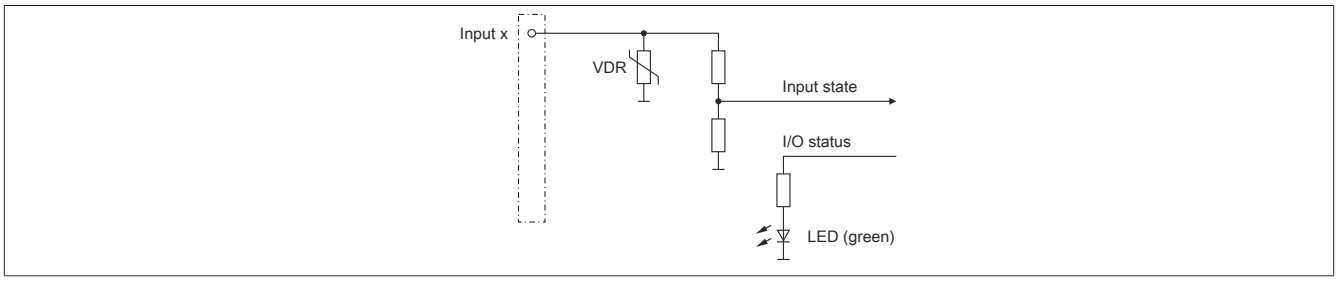


2.5 Input circuit diagram

Counter inputs



Standard inputs



3 Function description

3.1 ABR incremental encoder

This module is equipped with 1 input for ABR incremental encoders.

3.1.1 General information

Incremental encoders are sensors for detecting position (linear) or angular (rotating) changes that can detect distance and direction of travel or an angular change and direction of rotation.

In contrast to continuously operating measuring systems such as servo-potentiometers, incremental encoders have a measurement scale with repeating periodic graduation lines. The measurement is based on the determined direction and a count. Rotating optical encoders are the most commonly used.

Incremental encoders (in contrast to absolute encoders) may need to be homed after switching on since changes in position are not detected when in the switched-off state.

Typical applications are determining position and speed in automation technology.

3.1.2 Signal evaluation

When a movement is performed, the two sensors emit 2 signals (A and B) with an electrical phase shift of 90°.

The module determines the direction from these 2 signals and counts the pulses. This allows direct conclusions to be drawn about the scale of measurement (path or angle).

3.1.3 Homing

After switching on the power supply, the incremental encoder only measures changes compared to the switch-on position. For many applications however, knowledge of the absolute position is required. For this reason, most angular encoders output a reference pulse (zero pulse, reference mark) once per revolution on a third output (reference signal R). After switching on, the encoder must be rotated until the reference pulse has been detected. The absolute angle is then available after one revolution at the latest.

Positioning systems with incremental encoders perform "homing procedures" to an external position sensor (e.g. limit switch) after switching on. From this point, the next reference pulse of the incremental encoder is used as an accurate reference point.

Information:

The registers are described in "Homing" on page 15.

3.1.3.1 Homing mode

2 different homing modes can be set:

- Single-shot homing
- Continuous homing

3.1.3.2 Reference enable input

Independent of the homing mode, application of the home position can be prevented by the corresponding voltage level of the reference input (see "Input state of digital inputs 1 to 2" on page 14: Bit 7). The desired setting can be configured by a one-off acyclic write.

3.1.4 Recording the counter value

The counter value of the incremental encoder is displayed as a 16- or 32-bit counter value.

Information:

The register is described in "Counter state of the encoders" on page 14.

3.2 Monitoring the encoder power supply

Monitoring the encoder power supply

The status of the integrated encoder power supply can be read.

Bit	Description
0	24 VDC encoder supply voltage OK
1	24 VDC encoder supply voltage faulty

Information:

The register is described in "Status of encoder power supply" on page 14.

4 Commissioning

4.1 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).

4.1.1 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

5 Register description

5.1 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.

5.2 Function model 0 - Standard and Function model 1 - Standard with 32-bit encoder counter value

The difference between function model 0 and function model 1 is the size of the data type for some registers.

- Function model 0 uses data type INT
- Function model 1 uses data type DINT and partly extended names (specified in brackets).

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
4104	CfO_EdgeDetectFalling	USINT				•
4106	CfO_EdgeDetectRising	USINT				•
2064	CfO_PresetABR01_1(_32Bit)	(D)INT				•
2068	CfO_PresetABR01_2(_32Bit)	(D)INT				•
2576	CfO_PresetABR02_1(_32Bit)	(D)INT				•
2580	CfO_PresetABR02_2(_32Bit)	(D)INT				•
512	ConfigOutput24	UINT				•
522	ConfigOutput26	USINT				•
520	ConfigOutput27	USINT				•
544	ConfigOutput32	UINT				•
554	ConfigOutput34	USINT				•
552	ConfigOutput35	USINT				•
Communication						
2116	ReferenceModeEncoder01	USINT			•	
2628	ReferenceModeEncoder02	USINT			•	
2080	Encoder01	(D)INT	•			
2592	Encoder02	(D)INT	•			
264	Input state of digital inputs 1 to 2	USINT	•			
	DigitalInput01	Bit 3				
	DigitalInput02	Bit 7				
2118	StatusInput01	USINT	•			
2630	StatusInput02	USINT	•			
40	Status of encoder power supply	USINT	•			
	PowerSupply01	Bit 0				

5.3 Function model 2 - MotionConfiguration

A 16-bit or 32-bit data format can be set in the configuration.

Function model 2 - MotionConfiguration is available starting with hardware upgrade 1.4.0.0.

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
4104	CfO_EdgeDetectFalling	USINT				•
4106	CfO_EdgeDetectRising	USINT				•
2064	CfO_PresetABR01_1	INT				•
2068	CfO_PresetABR01_2	INT				•
2576	CfO_PresetABR02_1	INT				•
2580	CfO_PresetABR02_2	INT				•
2110	CfO_Encoder01Command	USINT				•
2622	CfO_Encoder02Command	USINT				•
512	ConfigOutput24	UINT				•
522	ConfigOutput26	USINT				•
520	ConfigOutput27	USINT				•
544	ConfigOutput32	UINT				•
554	ConfigOutput34	USINT				•
552	ConfigOutput35	USINT				•
Communication						
2096	RefPulsePos01	INT	•			
2100	RefPulsePos01	DINT	•			
2608	RefPulsePos02	INT	•			
2612	RefPulsePos02	DINT	•			
2108	RefPulseCnt01	SINT	•			
2620	RefPulseCnt02	SINT	•			
2104	Encoder01Reset	BOOL			•	
2616	Encoder02Reset	BOOL			•	
0	EncOk01	BOOL	•			
0	EncOk02	BOOL	•			
2088	Encoder01	INT	•			
2092	Encoder01	DINT	•			
2600	Encoder02	INT	•			
2604	Encoder02	DINT	•			
264	Input state of digital inputs 1 to 2	USINT	•			
	DigitalInput01	Bit 3				
	DigitalInput02	Bit 7				
2118	StatusInput01	USINT	•			
2630	StatusInput02	USINT	•			
40	Status of encoder power supply	USINT	•			
	PowerSupply01	Bit 0				

5.4 Function model 254 - Bus controller

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Configuration							
4104	-	CfO_EdgeDetectFalling	USINT				•
4106	-	CfO_EdgeDetectRising	USINT				•
2064	-	CfO_PresetABR01_1	INT				•
2068	-	CfO_PresetABR01_2	INT				•
2576	-	CfO_PresetABR02_1	INT				•
2580	-	CfO_PresetABR02_2	INT				•
512	-	ConfigOutput24	UINT				•
522	-	ConfigOutput26	USINT				•
520	-	ConfigOutput27	USINT				•
544	-	ConfigOutput32	UINT				•
554	-	ConfigOutput34	USINT				•
552	-	ConfigOutput35	USINT				•
Communication							
2116	0	ReferenceModeEncoder01	USINT			•	
2628	1	ReferenceModeEncoder02	USINT			•	
2080	0	Encoder01	INT	•			
2592	4	Encoder02	INT	•			
264	2	Input state of digital inputs 1 to 2	USINT	•			
		DigitalInput01	Bit 3				
		DigitalInput02	Bit 7				
2118	6	StatusInput01	USINT	•			
2630	7	StatusInput02	USINT	•			
40	3	Status of encoder power supply	USINT	•			
		PowerSupply01	Bit 0				

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

5.5 ABR absolute encoder

5.5.1 Counter state of the encoders

Name:
Encoder01 to Encoder02

The encoder values are displayed as 16-bit or 32-bit counter values in this register.

Data type	Value
INT	-32,768 to 32,767
DINT[1)]	-2,147,483,648 to 2,147,483,647

1) Only in function model 1

5.5.2 Input state of digital inputs 1 to 2

Name:
DigitalInput01 to DigitalInput02.

This register displays the input status of the encoders and the digital inputs.

Data type	Value
USINT	See bit structure.

Bit structure:

Bit	Name	Value	Information
0	Encoder 1	0 or 1	Input state - Signal A
1		0 or 1	Input state - Signal B
2		0 or 1	Input state of reference pulse
3	DigitalInput01	0 or 1	Input state - Digital input 1
4	Encoder 2	0 or 1	Input state - Signal A
5		0 or 1	Input state - Signal B
6		0 or 1	Input state of reference pulse
7	DigitalInput02	0 or 1	Input state - Digital input 2

5.5.3 Status of encoder power supply

Name:
PowerSupply01

This register indicates the status of the integrated encoder power supply. A faulty encoder supply voltage is output as a warning.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0	PowerSupply01	0	24 VDC encoder power supply OK
		1	24 VDC encoder power supply faulty
1 - 7	Reserved	-	

5.6 Homing

5.6.1 Reference pulse

The following registers must be configured by a single acyclic write with the listed values so that the homing procedure is completed on the edge of the reference pulse.

The homing procedure can take place on:

- Rising edge
- Falling edge (default configuration)

5.6.1.1 Constant register "CfO_EdgeDetectFalling"

Name:

CfO_EdgeDetectFalling

Data type	Value	Information
USINT	0x00	Configuration value for rising edge
	0x04	Encoder 1 - Configuration value for falling edge
	0x40	Encoder 2 - Configuration value for falling edge
	0x44	Configuration value for falling edge on encoders 1 and 2 (bus controller default setting)

5.6.1.2 Constant register "CfO_EdgeDetectRising"

Name:

CfO_EdgeDetectRising

Data type	Value	Information
USINT	0x00	Configuration value for falling edge (bus controller default setting)
	0x04	Encoder 1 - Configuration value for rising edge
	0x40	Encoder 2 - Configuration value for rising edge
	0x44	Encoders 1 and 2 - Configuration value for rising edge

5.6.1.3 Constant register "ConfigOutput24"

Name:

ConfigOutput24

This register contains the value for ABR encoder 1.

Data type	Value	Information
UINT	0x1012	Configuration value for rising edge
	0x1002	Configuration value for falling edge (bus controller default setting)

5.6.1.4 Constant register "ConfigOutput32"

Name:
ConfigOutput32

This register contains the value for ABR encoder 2.

Data type	Value	Information
UINT	0x1016	Configuration value for rising edge
	0x1006	Configuration value for falling edge (bus controller default setting)

5.6.2 Setting the home position

Name:
CfO_PresetABR01_1 to CfO_PresetABR01_2 (function models 0 and 2)
CfO_PresetABR02_1 to CfO_PresetABR02_2 (function models 0 and 2)

CfO_PresetABR01_1_32Bit to CfO_PresetABR01_2_32Bit (function model 1)
CfO_PresetABR02_1_32Bit to CfO_PresetABR02_2_32Bit (function model 1)

Function model 0 - Standard and function model 1 - Standard with 32-bit encoder counter value

It is possible to specify two home positions for each encoder with these registers through a one-off acyclic write, for example (default = 0). The configured values are applied to the counter values after a completed homing procedure.

Data type	Values	Information
INT	-32768 to 32767	Bus controller default setting: 0
DINT[1)]	-2,147,483,648 to 2,147,483,647	

1) In function model 1 only

Function model 2 - MotionConfiguration

These 4 registers are set to 0 by default in function model MotionConfiguration and cannot be configured.

5.6.3 Homing with reference enable input

5.6.3.1 Voltage level for reference enable activation - ABR encoder 1

Name:

ConfigOutput26

This register is used to configure the active voltage level of digital input 1 for the reference enable.

Data type	Value	Information
USINT	0x00	Reference enable is active at 0 VDC (bus controller default setting).
	0x08	Reference enable is active at 24 VDC

5.6.3.2 Reference enable of the input - ABR encoder 1

Name:
ConfigOutput27

This register can be used to define whether the reference enable is activated.

Data type	Value	Information
USINT	0x00	Reference enable input disabled (bus controller default setting)
	0x08	Reference enable input activated

5.6.3.3 Voltage level for reference enable activation - ABR encoder 2

Name:

ConfigOutput34

This register is used to configure the active voltage level of digital input 2 for the reference enable.

Data type	Value	Information
USINT	0x00	Reference enable is active at 0 VDC (bus controller default setting).
	0x80	Reference enable is active at 24 VDC

5.6.3.4 Reference enable of the input - ABR encoder 2

Name:
ConfigOutput35

This register can be used to define whether the reference enable is activated.

Data type	Value	Information
USINT	0x00	Reference enable input disabled (bus controller default setting)
	0x80	Reference enable input activated

5.6.4 Reading the referencing mode

Name:
ReferenceModeEncoder01 to ReferenceModeEncoder02

This register determines the referencing mode.

Data type	Value
USINT	See bit structure.

Bit structure:

Bit	Name	Value	Information
0 - 1		00	Homing disabled
		01	Single shot referencing
		11	Continuous referencing
2 - 5		0	Bits permanently set = 0
6 - 7		00	Homing disabled
		11	Bits permanently set = 1

This results in the following values:

Binary	Hex	Function
00000000	0x00	Homing disabled
11000001	0xC1	Single shot referencing For a new start after the completed homing procedure: • Write value 0x00 • Wait until bits 0 to 3 of register StatusInput01 apply value 0. Counter bits 4 to 7 are not deleted. • Switch homing procedure on again
11000011	0xC3	Continuous homing Homing takes place automatically with each reference pulse.

It is important to note how the optional reference enable is configured (see "Homing with reference enable input" on page 16).

5.6.5 Status of the homing procedure

Name:
StatusInput01 (for encoder 1) to StatusInput02 (for encoder 2)

This register contains information about the homing procedure.

Data type	Value
USINT	See bit structure.

Bit structure:

Bit	Name	Value	Information
0	Reference pulse without homing[1)]	0	No reference impulse without homing has occurred yet
		1	At least a reference impulse without homing has occurred
1	State change	0 or 1	Changes with each reference pulse without homing
2	Reference pulse with homing[1)]	0	No homing has occurred yet
		1	At least one homing procedure occurred
3	State change	0 or 1	Changes with each homing procedure that has taken place
4	Reference pulse	0	The last reference pulse didn't bring about a homing procedure
		1	The last reference pulse brought about a homing procedure
5 - 7	Counter	x	Free-running counter, increased with each reference pulse

1) Always 1 after the first reference pulse that has occurred

Examples of possible values:

Binary	Hex	Function
0x00000000	0x00	Referencing disabled or homing procedure already active
0x00111100	0x3CE	First homing procedure complete. The reference value was applied to register Encoder01.
0xxxx11100	0xxB	Bits 5 to 7 are subsequently modified with each reference pulse.
0xxxx1x100	0xxx	Continuously changing the bits with setting "Continuous referencing". The reference value is applied to register Encoder01 with each reference pulse.

It is important to note how the optional reference enable is configured (see "Homing with reference enable input" on page 16).

5.7 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
128 µs

5.8 Maximum cycle time

The maximum cycle time specifies the time up to which the bus cycle can be increased without internal counter overflows causing module malfunctions.

Maximum cycle time
16 ms

5.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

Minimum I/O update time
128 µs