X20(c)DO4332-1

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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
MAEMV	Installations / EMV guide

1.2 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

1.3 Order data

Order number	Short description	Figure
	Digital outputs	
X20DO4332-1	X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections, PWM output	
X20cDO4332-1	X20 digital output module, coated, 4 outputs, 24 VDC, 2 A, source, 3-wire connections, PWM output	
	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	
X20cBM11	X20 bus module, coated, 24 VDC keyed, internal I/O power supply connected through	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20DO4332-1, X20cDO4332-1 - Order data

1.4 Module description

The module is equipped with 4 outputs with 3-wire connections as well as 24 VDC and GND for the actuator power supply. The outputs are designed for a source circuit. The nominal output current is 2 A.

Functions:

- Digital outputs
- PWM
- OSP mode

Monitoring status of the digital outputs

The output signal of the digital outputs is monitored for short circuit or overload, as is the state of the power supply.

PWM

The module is equipped with a PWM mode. This can be used to control valves, for example. To prevent the valves from sticking, a dither can be configured exactly according to the specifications of the valve manufacturer.

OSP mode

In mode "OSP" (Operator Set Predefined), the user defines a digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

2 Technical description

2.1 Technical data

Order number	X20DO4332-1	X20cDO4332-1
Short description		
I/O module	4 digital outputs 24 VDC for 3-wire connections	
General information		
B&R ID code	0xF5F9	0x2A01
Status indicators	I/O function per channel, operating state, module status	
Diagnostics		
Module run/error	Yes, using LED status indicator and software	
Outputs	Yes, using LED status indicator and software (output error status)	
Power consumption		
Bus	0.1 W (Rev. <D0: 0.16 W)	
Internal I/O	0.49 W	
Additional power dissipation caused by actuators (resistive) [W] [1]	+1 (Rev. <D0: +1.6)	
Certifications		
CE	Yes	
UKCA	Yes	
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	
ABS	Yes	
BV	**EC33B** Temperature: 5 - 55°C Vibration: 4 g EMC: Bridge and open deck	
Digital outputs		
Variant	Current-sourcing FET	
Nominal voltage	24 VDC	
Switching voltage	24 VDC -15% / +20%	
Nominal output current	2 A	
Total nominal current	8 A	
Connection type	3-wire connections	
Output circuit	Source	
Output protection	Thermal shutdown in the event of overcurrent or short circuit (see value "Short-circuit peak current") Internal freewheeling diode for switching inductive loads	
Actuator power supply	0.5 A in total for output-independent actuator power supply	
Diagnostic status	Output monitoring with 10 ms delay	
Leakage current when the output is switched off	5 µA	
$R_{DS(on)}$	60 mΩ (Rev. <D0: 100 mΩ)	
Peak short-circuit current	<4 A	
Switch-on in the event of overload shutdown or short-circuit shutdown	Approx. 10 ms (depends on the module temperature)	
Switching delay [2]		
0 → 1	<300 µs	
1 → 0	<300 µs	
Switching frequency		
Resistive load [2]	Max. 500 Hz	
Braking voltage when switching off inductive loads	0.6 V [3]	
Insulation voltage between channel and bus	500 V_{eff}	
Additional functions	Outputs can be connected in parallel to increase the output current. [4]	
PWM output		
Quantity	4	
Nominal voltage	24 VDC	
Nominal current	2 A	
PWM frequency	15.25 to 1000 Hz	
Output protection	Thermal shutdown in the event of overcurrent or short circuit (see value "Short-circuit peak current") Internal freewheeling diode for switching inductive loads	
Variant	Current-sourcing FET	

Table 2: X20DO4332-1, X20cDO4332-1 - Technical data

Technical description

Order number	X20DO4332-1	X20cDO4332-1
Configurable dither	0 to 250 Hz, 1 to 25% of the period duration	
Period duration resolution	1000 to 65535 μs in 1 μs steps	
Insulation voltage between channel and bus	500 V_{eff}	
Actuator power supply		
Voltage	Module power supply minus voltage drop for short-circuit protection	
Voltage drop for short-circuit protection at 500 mA	Max. 2 V	
Short-circuit proof	Yes	
Power consumption		
Actuator power supply	Max. 12 W [5]	
Electrical properties		
Electrical isolation	Channel isolated from bus Channel not isolated from channel and I/O power supply	
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	See section "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: X20DO4332-1, X20cDO4332-1 - Technical data

1) Number of outputs x $R_{DS(on)}$ x Nominal output current[2]. For a calculation example, see section "Mechanical and electrical configuration" in the X20 system user's manual.
2) At loads ≤ 1 kΩ
3) Due to the freewheeling diode integrated in the module.
4) A parallel connection is not possible in PWM mode.
5) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

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	Mode RESET
			Blinking	Mode PREOPERATIONAL
			On	Mode RUN
			Flickering (approx. 10 Hz)	The module is in the OSP state.
	e	Red	Off	Module not supplied with power or everything OK
			Single flash	Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered.
	e + r	Solid red / Single green flash		Invalid firmware
	1 - 4	Orange		Output state of the corresponding digital output.[1]

1) Die Helligkeit der Anzeige kann sich im PWM-Modus abhängig von Frequenz und Tastverhältnis ändern.
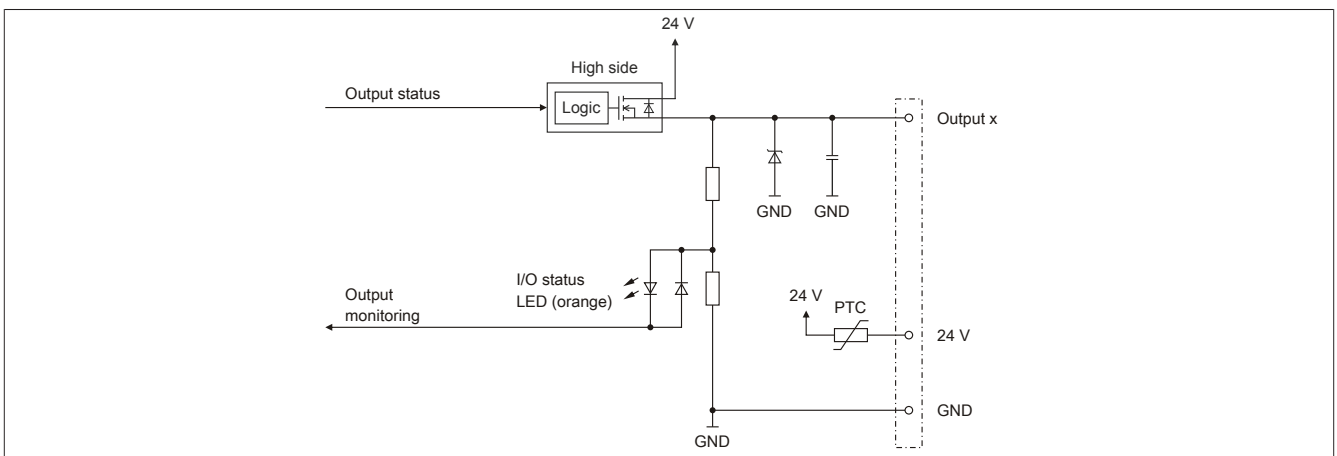
2.3 Pinout
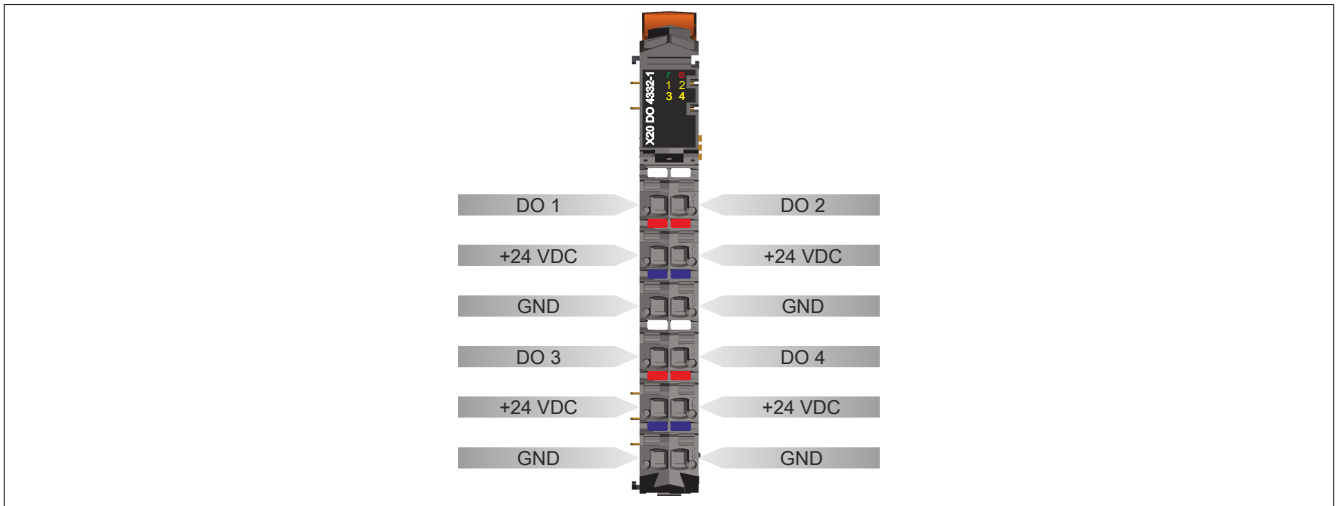
## 2.4 Connection example
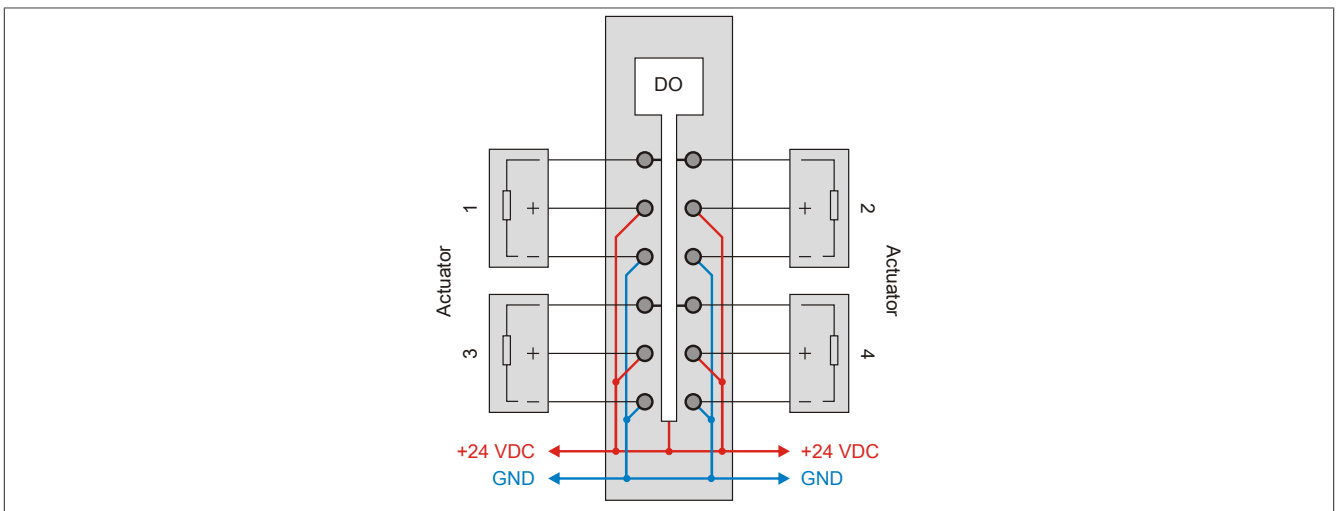
2.5 Output circuit diagram

2.6 Derating

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "Mechanical and electrical configuration - Power dissipation of I/O modules" in the X20 user's manual.
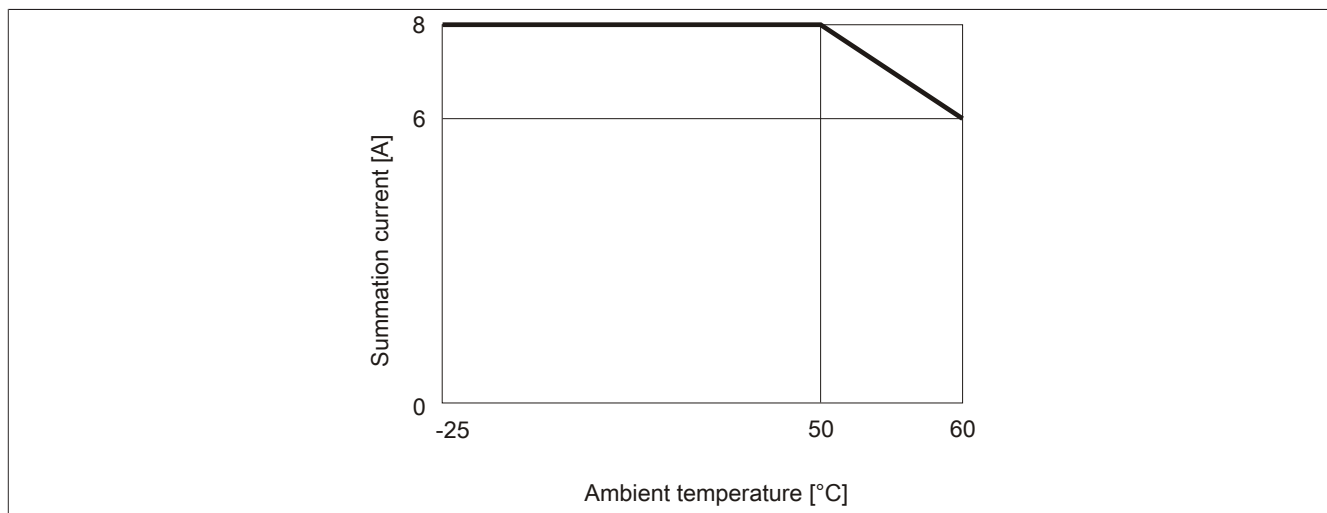
3 Function description

3.1 Digital outputs

The module is equipped with 4 digital outputs.

The output state is transferred to the output channels with a fixed offset (<60 µs) in relation to the network cycle (SyncOut).

Packed outputs (only function model 0 - Standard)

Setting "Packed outputs" in the Automation Studio I/O configuration can be used to determine whether all bits of the register should be applied as individual data points in the Automation Studio I/O mapping (e.g. "DigitalOutput01 to DigitalOutputxx") or whether the register should be displayed as a single USINT data point (e.g. "DigitalOutput").

> **Information:**
>
> **The register is described in "Switching state of digital outputs 1 to 4" on page 13.**

3.1.1 Monitoring status of the outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read out. A change in the monitoring status is actively transmitted as an error message.

Supervision status	Description
0	Digital output channel: No error
1	Digital output channel: • Short circuit or overload • Channel switched on and missing I/O power supply • Channel switched off and external voltage applied to channel

> **Information:**
>
> **The register is described in "Status of digital outputs 1 to 4" on page 14.**

3.2 PWM

The module is equipped with a PWM mode. This can be used to control valves, for example. To prevent the valves from sticking, a dither can be configured exactly according to the specifications of the valve manufacturer.

At the beginning of each period, the output is switched on for the percentage of time set in the PWM pulse width register.
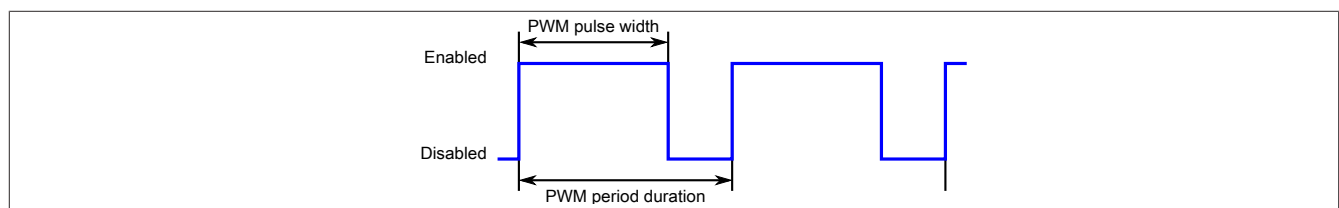
> **Information:**
>
> **The registers are described in "Function model "PWM"" on page 15.**

3.2.1 Dither

When the position setpoint for valves remains constant for a long period of time, especially in fluids, there is a risk that a valve will stick. This is normally prevented using "dithering". When doing so, the value is permitted to slightly oscillate around the position setpoint.

By default, dither is active for all outputs as soon as the following conditions are met:

- Dither amplitude and dither frequency are set to a value greater than 0.
- Pulse width is set to a value greater than 0 and less than 32767.

Dither is enabled or disabled for all outputs together.

3.3 OSP mode

In function model "OSP" (Operator Set Predefined), the user defines a digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

3.3.1 Hardware requirements

In order to use OSP mode sensibly, it should be ensured when setting up the application that the power supply of the output module and controller are designed to be independent of each other.

3.3.2 Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

If an OSP event occurs, e.g. communication between the module and master controller aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register OSPMode.

> **The following generally applies:**
>
> **Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.**
>
> **When the master controller is restarted, bit OSPValid bit is reinitialized in the master controller. It must be set once more by the application and transferred via the bus.**
> **In the event of brief communication errors between the module and master controller (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the controller, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal mode.**

If the task in the master controller needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

> ⚠️ **Warning!**
>
> **If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master controller. Nevertheless, output is made depending on the configuration of the OSP replacement value.**

> ⓘ **Information:**
>
> **The registers are described in "Function model "OSP"" 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

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Communication						
2	DigitalOutput	USINT			●	
	DigitalOutput01	Bit 0				
	...	...				
	DigitalOutput04	Bit 3				
30	StatusInput01	USINT	●			
	StatusDigitalOutput01	Bit 0				
	...	...				
	StatusDigitalOutput04	Bit 3				

5.3 Function model 1 - OSP

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
32	CfgOSPMode	USINT		(●)		●
36	CfgOSPValue	USINT		(●)		●
Communication						
2	Switching state of digital outputs 1 to 4	USINT			●	
	DigitalOutput01	Bit 0				
	...	...				
	DigitalOutput04	Bit 3				
30	Status of digital outputs 1 to 4	USINT	●			
	StatusDigitalOutput01	Bit 0				
	...	...				
	StatusDigitalOutput04	Bit 3				
34	Enabling OPS output in the module	USINT			●	
	OSPValid	Bit 0				

5.4 Function model 3 - PWM

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
26	CfgDitherFrequency	USINT				●
28	CfgDitherAmplitude	USINT				●
Communication						
2 * N + 2	PwmOutput0N (index N = 1 to 4)	INT			●	
12	PwmPeriode	UINT			●	
30	Status of digital outputs 1 to 4	USINT	●			
	StatusDigitalOutput01	Bit 0				
	...	...				
	StatusDigitalOutput04	Bit 3				

5.5 Function model 254 - Bus controller

Register	Offset[1]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Configuration							
12	-	PwmPeriode	UINT				●
26	-	CfgDitherFrequency	USINT				●
28	-	CfgDitherAmplitude	USINT				●
Communication							
2 * N + 2	2 * N	PwmOutput0N (index N = 1 to 4)	INT			●	
30	-	Status of digital outputs 1 to 4	USINT		●		
		StatusDigitalOutput01	Bit 0				
		…	…				
		StatusDigitalOutput04	Bit 3				

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

5.6 Digital outputs

The output status is transferred to the output channels with a fixed offset in relation to the network cycle (SyncOut).

5.6.1 Switching state of digital outputs 1 to 4

Name:
DigitalOutput
DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Data type	Values	Information[1]
USINT	0 to 15	Packed outputs = On Data point: "DigitalOutput"
	See the bit structure.	Packed outputs = Off or function model ≠ 0 - Standard. Data points: "DigitalOutput01" to "DigitalOutput04"

1) See "Digital outputs" on page 9.

Bit structure:

Bit	Description	Value	Information
0	DigitalOutput01	0	Digital output 01 reset
		1	Digital output 01 set
…		…	
3	DigitalOutput04	0	Digital output 04 reset
		1	Digital output 04 set

5.7 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states.

5.7.1 Status of digital outputs 1 to 4

Name:
StatusInput01
StatusDigitalOutput01 to StatusDigitalOutput04

This register contains the state of digital outputs 1 to 4.

Data type	Values	Information[1]
USINT	0 to 15	Packed outputs = On Data point: "StatusInput01"
	See the bit structure.	Packed outputs = Off or function model ≠ 0 - Standard. Data points: "StatusDigitalOutput01" to "StatusDigitalOutput04"

1)   See "Digital outputs" on page 9.

Bit structure:

Bit	Name	Value	Information
0	StatusDigitalOutput01	0	Channel 01: No error
		1	Channel 01: • Short circuit or overload • Channel switched on and missing I/O power supply • Channel switched off and external voltage applied to channel
...		...	
3	StatusDigitalOutput04	0	Channel 04: No error
		1	Channel 04: For an error description, see channel 01.

5.8 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines a digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

5.8.1 Enabling OPS output in the module

Name:
OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0	OSPValid	0	Request OSP operation (after initial startup or module in standby)
		1	Request normal operation
1 - 7	Reserved	0	

5.8.2 Setting OSP mode

Name:
CfgOSPMode

This register controls the behavior of a channel when using OSP.

Data type	Values	Explanation
USINT	0	Replace with static value
	1	Retain last valid value

5.8.3 Defining an OSP-digital output value

Name:
CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP mode.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0		0 or 1	OSP output value for channel DigitalOutput00
...		...	
x		0 or 1	OSP output value for channel DigitalOutput0x

⚠️ **Warning!**

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

5.9 Function model "PWM"

5.9.1 Pulse width

Name:
PwmOutput01 to PwmOutput04

In this register, the PWM pulse width is specified as a percentage of the period duration. At the beginning of each period, the output is switched on for the percentage of time set in this register.

Data type	Values	Information
INT	0 to 32767	Corresponds to 0 to 100% of the period duration

5.9.2 Period duration

Name:
PwmPeriode

In this register, the PWM period duration is specified in µs.

Data type	Values	Information
UINT	0	PWM disabled
	1000 to 65535	Period duration in µs

5.9.3 Dither

When the position setpoint for valves remains constant for a long period of time, especially in fluids, there is a risk that a valve will stick. This is normally prevented using "dithering". When doing so, the value is permitted to slightly oscillate around the position setpoint.

5.9.3.1 Dither frequency

Name:
CfgDitherFrequency

The dither frequency for all 4 channels can be specified together in this register.

Data type	Values	Information
USINT	0 to 250	Corresponds to 0 to 250 Hz

5.9.3.2 Dither amplitude

Name:
CfgDitherAmplitude

In this register, the change of the pulse width caused by the dither can be specified for all 4 channels together as a percentage. The change takes place in both the positive and negative direction.

If the pulse width is adjusted, the dithering is reset and reapplied in the direction of the change.

Example

Set period duration: 2000 µs
DitherAmplitude: 10%
Result: The set pulse width oscillates by ±100 µs (200 µs / 2).

Data type	Values	Information
USINT	0	No dither
	1 to 25	1 to 25% of the period duration

5.10 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

5.11 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
Equal to the minimum cycle time