

X20(c)AO2437

Data sheet
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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 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



1.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature in a voltage-free state at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.



Information:

It is important to absolutely ensure that there is no forced cooling by air currents in the closed control cabinet, e.g. due to the use of a fan or ventilation slots.

1.3 Order data

Order number	Short description	Figure
	Analog output modules	
X20AO2437	X20 analog output module, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel galvanically isolated	
X20cAO2437	X20 analog output module, coated, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel galvanically isolated	
	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: X20AO2437, X20cAO2437 - Order data

1.4 Module description

The module is equipped with 2 current outputs with 16-bit digital converter resolution. The 2 channels are electrically isolated from each other. The user can select between the 3 output ranges 4 to 20 mA, 0 to 20 mA and 0 to 24 mA.

Functions:

- [Analog outputs](#)
- [OSP mode](#)

Analog outputs

The module is equipped with analog outputs with a configurable current signal.

OSP mode

In mode "OSP" (Operator Set Predefined), the user defines an analog value or 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	X20AO2437	X20cAO2437
Short description		
I/O module	2 analog outputs 4 to 20 mA, 0 to 20 mA or 0 to 24 mA	
General information		
B&R ID code	0xB785	0xE1F2
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	
Power consumption		
Bus	0.05 W	
Internal I/O	1.6 W	
Additional power dissipation caused by actuators (resistive) [W]	-	
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	-
Analog outputs		
Output	4 to 20 mA, 0 to 20 mA or 0 to 24 mA configurable using software	
Digital converter resolution	16-bit	
Settling time on output change over entire range	2 ms to 20 s, configurable using software	
Data output rate	1 ms without ramp	
Max. error ¹⁾		
Gain		
4 to 20 mA	±0.025% ²⁾	
0 to 20 mA	±0.022% ²⁾	
0 to 24 mA	±0.02% ²⁾	
Offset		
4 to 20 mA	±0.025% ³⁾	
0 to 20 mA	±0.022% ³⁾	
0 to 24 mA	±0.02% ³⁾	
Output protection	Short-circuit proof, overvoltage protection (up to 30 VDC)	
Open-circuit detection	Yes, using hardware and software	
Data format	INT	
Output format		
4 to 20 mA	INT 0x0000 to 0x7FFF / 1 LSB = 0x0001 = 488.281 nA	
0 to 20 mA	INT 0x0000 to 0x7FFF / 1 LSB = 0x0001 = 610.352 nA UINT 0x0000 to 0xFFFF / 1 LSB = 0x0001 = 305.176 nA	
0 to 24 mA	INT 0x0000 to 0x5DC0 / 1 LSB = 0x0001 = 1000 nA	
Load per channel	Max. 600 Ω	
Short-circuit proof	Yes, continuous	

Table 2: X20AO2437, X20cAO2437 - Technical data

Technical description


Order number	X20AO2437	X20cAO2437
Output filter	Active second-order low-pass filter / Cutoff frequency 4 kHz Configurable slew rate	
Max. gain drift		
4 to 20 mA	±0.0055%/°C ²⁾	
0 to 20 mA	±0.005%/°C ²⁾	
0 to 24 mA	±0.005%/°C ²⁾	
Max. offset drift		
4 to 20 mA	±0.0035%/°C ³⁾	
0 to 20 mA	±0.002%/°C ³⁾	
0 to 24 mA	±0.002%/°C ³⁾	
Error caused by load change ⁴⁾		
4 to 20 mA	0.14%	
0 to 20 mA	0.1%	
0 to 24 mA	0.1%	
Nonlinearity	<0.003% ⁵⁾	
Test voltage		
Channel - Channel	1000 VAC	
Channel - Bus	1000 VAC	
Channel - Ground	1000 VAC	
Electrical properties		
Electrical isolation	Channel isolated from channel and bus	
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".	
Starting temperature	-	Yes, -40°C
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: X20AO2437, X20cAO2437 - Technical data

- 1) At 25°C
- 2) Based on the current output value.
- 3) Based on the respective output range.
- 4) Load change from 1 Ω → 600 Ω, resistive
- 5) Based on the entire output range.

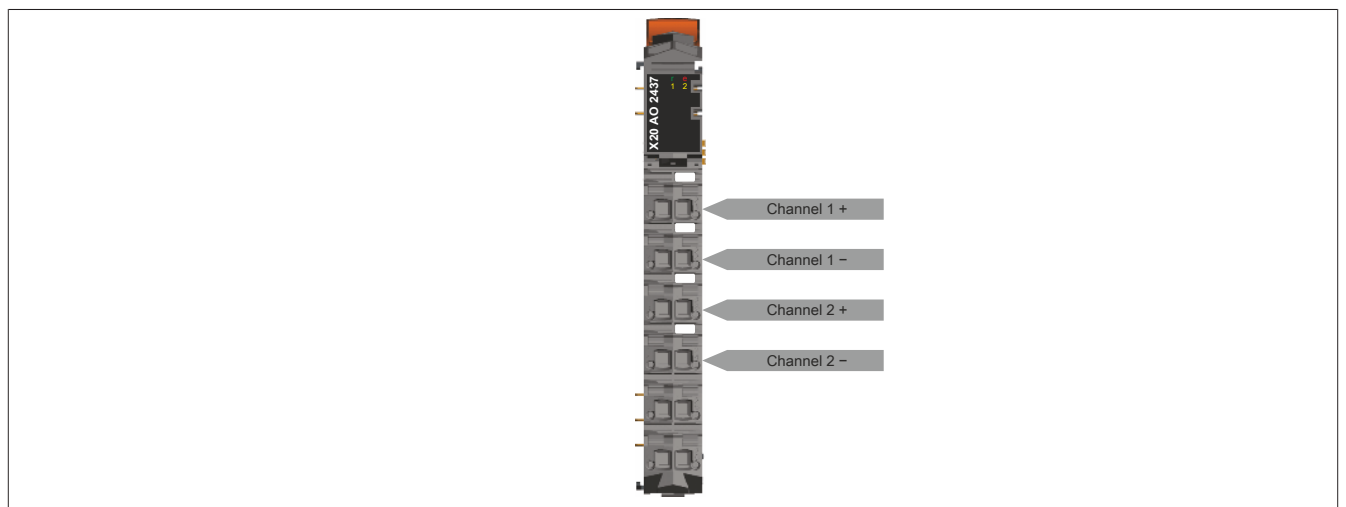
2.2 LED status indicators

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

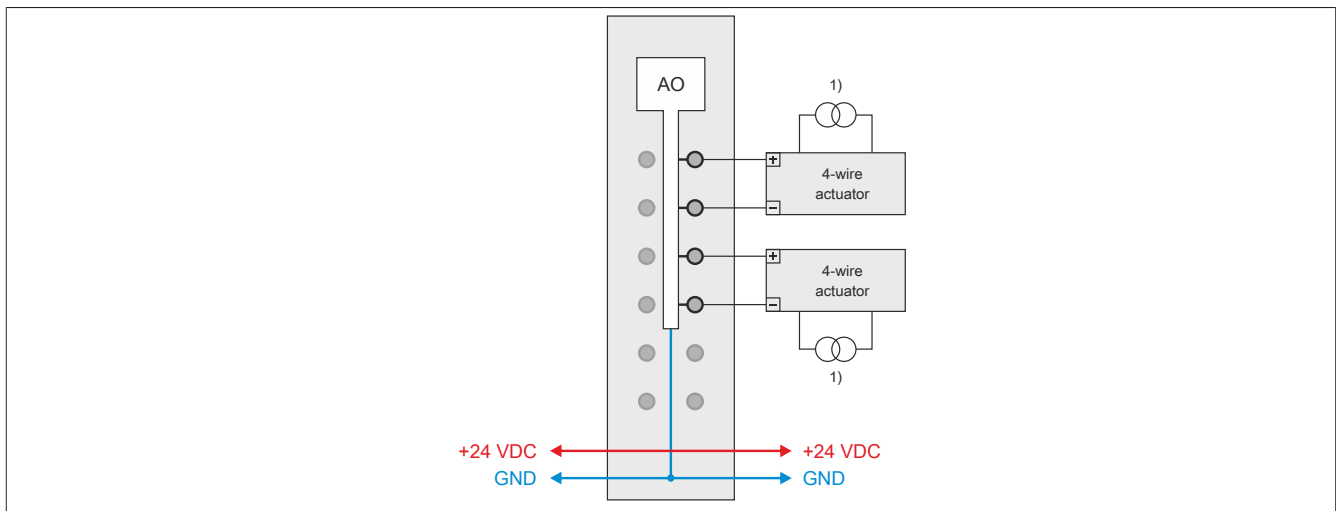
Figure	LED	Color	Status	Description
	Operating status			
	r	Green	Off	No power to module
			Single flash	UNLINK mode
			Double flash	BOOT mode (during firmware update) ¹⁾
			Blinking quickly	SYNC mode
			Blinking slowly	PREOPERATIONAL mode
			On	RUN mode
			Flickering (approx. 10 Hz)	Module is in OSP mode
	Module status			
	e	Red	Off	No power to module or everything OK
			Single flash	A conversion error has occurred. When an error occurs, the LED of the faulty analog output channel begins to double flash and this status is output.
			On	Error or reset status
	Analog output			
	1 - 2	Orange	Off	Indicates one of the following cases: <ul style="list-style-type: none">No power to moduleChannel disabled
			Single flash	Open line
			Double flash	A conversion error has occurred. A single flash is output on the red "e" module status LED.
			On	Digital/analog converter running, value OK

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

2.3 Pinout



2.4 Connection example

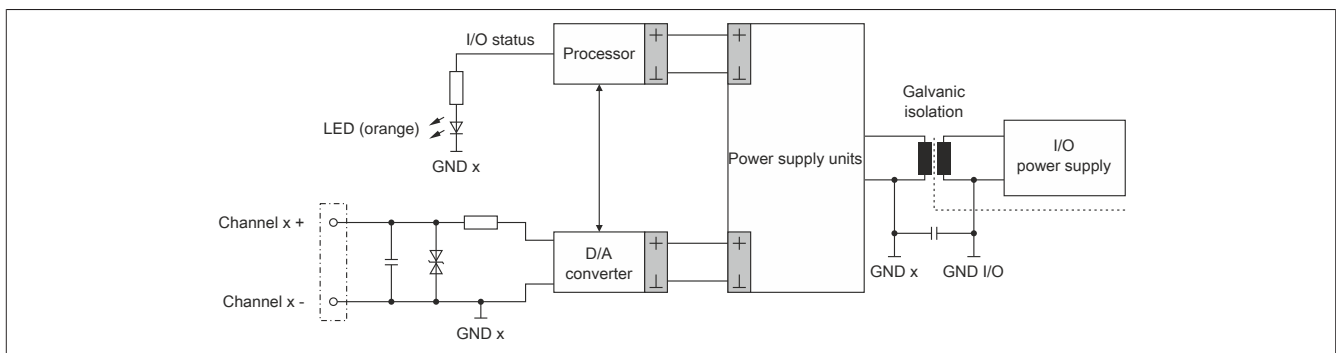


1) With external power supply.

2.5 OSP 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.

2.6 Output circuit diagram



2.7 Derating

To ensure proper operation, the derating values listed below must be adhered to:

Horizontal installation

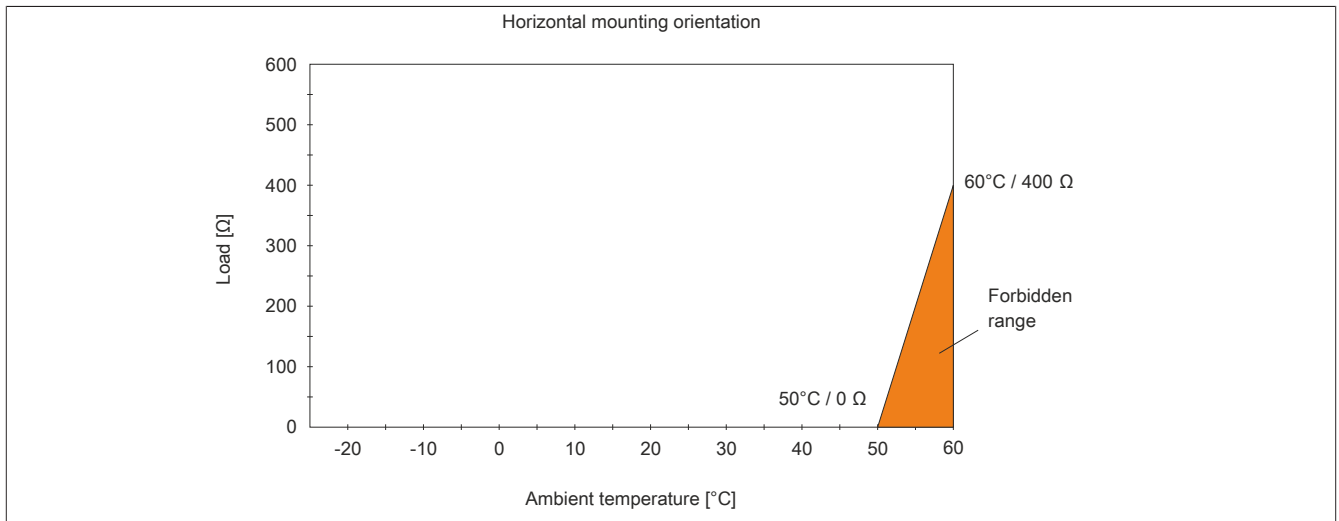


Figure 1: Derating the load with horizontal mounting

Vertical installation

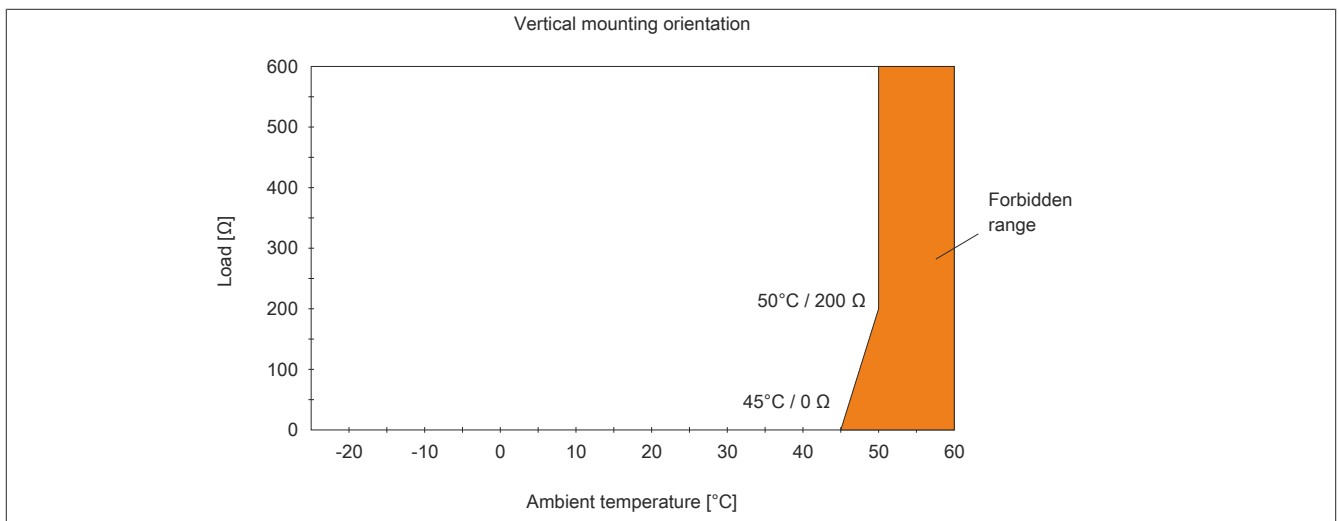


Figure 2: Derating the load with vertical mounting

3 Function description

3.1 Analog outputs

The module has 2 electrically isolated channels. All registers have a dual design. Channels can be configured and operated independently of one another.

Setting the current signal

In order to output the desired current signal (default: 4 to 20 mA), the module must be provided with a normalized output value (default: 0 to 32767).



Information:

Selecting operating mode "Scaling 0 to 20 mA (resolution 0 to 65535)" means that the corresponding "AnalogOutput" register is no longer interpreted internally as INT, but as UINT. A rebuild of the entire program is required to change the data type. The data type cannot be modified at runtime (e.g. via library).

Adjustable slew rate output ramp

The slew rate of the analog signal can be limited. In this way, a kind of upper cutoff frequency can be defined.

The following formula applies: $f(\text{analog}) = f(\text{output clock}) * \text{Permissible change} / \text{Max. } \Delta(\text{normalized output value})$



Information:

The registers are described in "[Analog signal - Configuration](#)" on page 14.

3.2 OSP mode

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

3.2.1 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.

3.2.2 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.



Mise en garde !

Si le bit OSPValid est remis à « 0 » par le module, l'état de la sortie ne dépend plus de la tâche responsable dans le contrôleur principal. Néanmoins, la sortie est effectuée en fonction de la configuration de la valeur de remplacement OSP.



Information:

The registers are described in "[Function model "OSP"](#)" on page 17.

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	Non-cyclic	Cyclic	Non-cyclic
Analog signal - Configuration						
386 394	AnalogMode01 AnalogMode02	UINT				•
390 398	DACSlewrate01 DACSlewrate02	UINT				•
Analog signal - Communication						
0 2	AnalogOutput01 AnalogOutput02	(U)INT			•	
30 31	AnalogStatus01 AnalogStatus02	USINT	•			
	OpenLineAnalogOutput01 or OpenLineAnalogOutput02	Bit 2				
	ConversionErrorAnalogOutput01 or ConversionErrorAnalogOutput02	Bit 3				
	IoSuppErrorAnalogOutput01 or IoSuppErrorAnalogOut- put02	Bit 7				

5.3 Function model 1 - OSP

Register	Name	Data type	Read		Write	
			Cyclic	Non-cyclic	Cyclic	Non-cyclic
Analog signal - Configuration						
386 394	AnalogMode01 AnalogMode02	UINT				•
390 398	DACSlewrate01 DACSlewrate02	UINT				•
Analog signal - Communication						
0 2	AnalogOutput01 AnalogOutput02	(U)INT			•	
30 31	AnalogStatus01 AnalogStatus02	USINT	•			
	OpenLineAnalogOutput01 or OpenLineAnalogOutput02	Bit 2				
	ConversionErrorAnalogOutput01 or ConversionErrorAnalogOutput02	Bit 3				
	IoSuppErrorAnalogOutput01 or IoSuppErrorAnalogOut- put02	Bit 7				
The OSP function model						
32	OSPComByte	USINT			•	
	OSPValid	Bit 0				
401 403	CfgOSPMODE01 CfgOSPMODE02	USINT				•
34 36	CfgOSPValue01 CfqOSPValue02	INT				•

5.4 Function model 254 - Bus controller

Register	Offset ¹⁾	Name	Data type	Read		Write	
				Cyclic	Non-cyclic	Cyclic	Non-cyclic
Analog signal - Configuration							
386 394	-	AnalogMode01 AnalogMode02	UINT				•
390 398	-	DACSlewrate01 DACSlewrate02	UINT				•
Analog signal - Communication							
0 2	0 2	AnalogOutput01 AnalogOutput02	(U)INT			•	
30 31	-	AnalogStatus01 AnalogStatus02	USINT		•		
		OpenLineAnalogOutput01 or OpenLineAnalogOutput02	Bit 2				
		ConversionErrorAnalogOutput01 or ConversionErrorAnalogOutput02	Bit 3				
		IoSuppErrorAnalogOutput01 or IoSuppErrorAnalogOutput02	Bit 7				

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

5.5 Analog signal - Configuration

The module has 2 galvanically isolated channels. All registers are duplicated. The channels are configured and operated independently of each other.

5.5.1 Operating parameters

Name:

AnalogMode01 to AnalogMode02

These registers are used to predefine the operating parameters that the module will be using for the respective channel. Each channel must be activated and configured separately.

Data type	Values	Bus controller default setting
UINT	See the bit structure.	33

Bit structure:

Bit	Name	Value	Information
0	Channel	0	Disabled
		1	Enabled (bus controller default setting)
1	Check - D/A converter configuration/status	0	Enabled (bus controller default setting)
		1	Disabled
2 - 3	Reserved	-	
4	Scaling 0 to 20 mA (Resolution 0 to 32767)	0	Disabled
		1	Enabled
5	Scaling 4 to 20 mA (Resolution 0 to 32767)	0	Disabled
		1	Enabled (bus controller default setting)
6	Scaling 0 to 24 mA (Resolution 0 to 24000)	0	Disabled
		1	Enabled
7	Scaling 0 to 20 mA (Resolution 0 to 65535)	0	Disabled
		1	Enabled
8 - 15	Reserved	-	

5.5.2 Slew rate of the analog signal

Name:

DACSlewrates01 to DACSlewrates02

These registers limit the rate at which the analog signal is modified. This makes it possible to define a sort of upper limit frequency.

The following formula applies: $f(\text{Analog}) = f(\text{Output rate}) * \text{Permitted change} / \text{max. } \Delta(\text{standardized output value})$

Data type	Values	Bus controller default setting
UINT	See the bit structure.	514

Bit structure:

Bit	Name	Value	Information
0 - 2	Permitted change per rate	000	1-bit
		001	2-bit
		010	4-bit (bus controller default setting)
		011	8-bit
		100	16-bit
		101	32-bit
		110	64-bit
		111	128-bit
3 - 7	Reserved	-	
8 - 11	Output rate	0000	257730 Hz
		0001	198410 Hz
		0010	152440 Hz (bus controller default setting)
		0011	131580 Hz
		0100	115740 Hz
		0101	69440 Hz
		0110	37590 Hz
		0111	25770 Hz
		1000	20160 Hz
		1001	16030 Hz
		1010	10290 Hz
		1011	8280 Hz
		1100	6900 Hz
		1101	5530 Hz
		1110	4240 Hz
		1111	3300 Hz
12 - 14	Reserved	-	
15	Slewrates enable (ramp functionality)	0	Disabled (undefined jump behavior)
		1	Enabled (defined transitions)

5.6 Analog signal - Communication

In order to output the desired current signal (default: 4 to 20 mA), the module must be provided with the normalized output value (default: 0 to 32767).

5.6.1 Output value

Name:

AnalogOutput01 to AnalogOutput02

The normalized output values are specified via these registers. Depending on the choice of scaling (see register "[AnalogMode](#)" on page 14), the range of values and data type can be adapted to the requirements of the application. After a permissible value is transferred, the module outputs the corresponding current.



Information:

The value "0" disables the channel status LED.

Data type	Value
INT	0 to 32767
Optional: UINT	0 to 65535

5.6.2 Channel status

Name:

AnalogStatus01 to AnalogStatus02

The status register gives the user feedback about whether the respective channel is functioning properly.

Data type	Value
USINT	See bit structure

Bit structure:

Bit	Name	Value	Information
0 - 1	Reserved	-	
2	OpenLineAnalogOutput01, 02	0	Line OK
		1	Open line
3	ConversionErrorAnalogOutput01, 02	0	Conversion temperature OK
		1	Conversion temperature too high
4 - 6	Reserved	-	
7	IoSuppErrorAnalogOutput01, 02	0	Module supply OK
		1	Module supply error

5.7 Function model "OSP"

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

5.7.1 Activating the OSP output in the module

Name:
OSPValid

This data point offers the possibility to start module output and request OSP operation during running operation.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Name	Value	Information
0	OSPValid	0	Request OSP operation (after initial start or module in Standby)
		1	Request normal operation
1 - 7	Reserved	0	

There is one OSPValid bit on the module, which is managed by the user task. It must be set when the enabled channels are started. As long as the OSPValid bit remains set in the module, the module behaves the same as the "Standard" function model.

5.7.2 Setting the OSP mode

Name:
CfgOSPMode01 to CfgOSPMode02

This register essentially controls a channel's behavior when OSP is being used.

Data type	Value	Description
USINT	0	Replace with static value
	1	Retain last valid value

5.7.3 OSP replacement value

Name:
CfgOSPValue01 to CfgOSPValue02

This register contains the analog output value, which is output in "Replace with static value" mode during OSP operation.

Data type	Value
Corresponds to AnalogOutput0x	Corresponds to AnalogOutput0x



Warning!

The OSP replacement value is only applied by the module if bit "OSPValid" has been set in the module.



Mise en garde !

La valeur de remplacement OSP est uniquement appliquée par le module si le bit « OSP-Valid » a été défini dans le module.

5.8 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
200 µs

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
200 μ s