



Expansion Module EM-SinCos-01

Frequency Inverter 230 V / 400 V

ACTIVE Cube



BONFIGLIOLI

General points on the documentation

The present supplement of the documentation is valid for the frequency inverter series ACU. The information necessary for assembly and application of the EM-SinCos-01 expansion module is documented in this guidance.

For better clarity, the user documentation is structured according to the customer-specific demands made of the frequency inverter.

Quick Start Guide

The Quick Start Guide describes the basic steps required for mechanical and electrical installation of the frequency inverter. The guided commissioning supports you in the selection of necessary parameters and the configuration of the frequency inverter by the software.

Operating instructions

The operating instructions document the complete functionality of the frequency inverter. The parameters necessary for specific applications for adaptation to the application and the extensive additional functions are described in detail.

Application manual

The application manual supplements the documentation for purposeful installation and commissioning of the frequency inverter. Information on various subjects connected with the use of the frequency inverter is described specific to the application.

Installation instructions

The installation instructions describe the mechanical installation and use of devices which differ from those described in the brief instructions and the operating instructions.

The documentation and additional information can be requested via your local representation of the company BONFIGLIOLI.

The following pictograms and signal words are used in the documentation:



Danger!

Danger refers to an immediate threat. Non-compliance with the precaution described may result in death, serious injury or material damage.



Warning!

Warning refers to a possible threat. Non-compliance with the warning may result in death, serious injury or material damage.



Caution!

Caution refers to an indirect threat. Non-compliance may result in personal or material damage.

Attention!

Attention refers to a possible operational behavior or an undesired condition that can occur in accordance with the reference text.

Note

Note marks information that facilitates handling for you and supplements the corresponding part of the documentation.



Warning! In installation and commissioning, comply with the information in the documentation. You as a qualified person must have read the documentation carefully and understood it. Comply with the safety instructions. For the purposes of the instructions, "qualified person" designates a person acquainted with the erection, assembly, commissioning and operation of the frequency inverters and possessing the qualification corresponding to the activity.

TABLE OF CONTENTS

1	General safety and application information	4
1.1	General information.....	4
1.2	Proper use.....	5
1.3	Transport and storage	5
1.4	Handling and positioning.....	5
1.5	Electrical connection.....	6
1.6	Operation information	6
1.7	Maintenance and service	6
2	Introduction	7
3	Technical data	8
4	Installation.....	10
4.1	General	10
4.2	Mechanical installation	10
4.3	Electrical installation	12
4.3.1	Circuit diagram	12
4.3.2	Control terminals	14
4.3.3	External voltage supply	17
5	System bus interface.....	18
5.1	Bus termination	18
5.2	Cables	19
5.3	Socket X410B.....	19
5.4	Baud rate setting/line length	20
5.5	Setting node address	20
5.6	Functional overview	21
5.7	Network management	21
5.7.1	SDO channels (parameter data)	22
5.7.2	PDO channels (process data).....	22
5.8	Master functionality.....	23
5.8.1	Control boot-up sequence, network management.....	23
5.8.2	SYNC telegram, generation.....	25
5.8.3	Emergency message, reaction.....	26
5.8.4	Client SDO (system bus master).....	27
5.9	Slave functionality	28
5.9.1	Implement boot-up sequence, network management.....	28
5.9.1.1	Boot-up message	28
5.9.1.2	Status control	28
5.9.2	Process SYNC telegram	29
5.9.3	Emergency message, fault switch-off.....	30
5.9.4	Server SDO1/SDO2	31
5.10	Communication channels, SDO1/SDO2.....	33
5.10.1	SDO telegrams (SDO1/SDO2)	33
5.10.2	Communication via field bus connection (SDO1).....	35
5.10.2.1	Profibus-DP	35
5.10.2.2	RS232/RS485 with VECTRON bus protocol	35

5.11	Process data channels, PDO	37
5.11.1	Identifier assignment process data channel	37
5.11.2	Operation modes process data channel	38
5.11.3	Timeout monitoring process data channel	39
5.11.4	Communication relationships of the process data channel	40
5.11.5	Virtual links	41
5.11.5.1	Input parameters of the TxPDO's for data to be transmitted	44
5.11.5.2	Source numbers of the RxPDO's for received data	46
5.11.5.3	Examples of virtual links	47
5.12	Control parameters	48
5.13	Handling of the parameters of the system bus	49
5.14	Ancillaries	51
5.14.1	Definition of the communication relationships	52
5.14.2	Production of the virtual links	53
5.14.3	Capacity planning of the system bus	54
6	Control inputs and outputs	56
6.1	Analog input EM-S1INA	56
6.1.1	General	56
6.1.2	Characteristic	56
6.1.3	Operation modes	57
6.1.3.1	Examples	57
6.1.4	Scaling	60
6.1.5	Tolerance band and hysteresis	61
6.1.6	Error and warning behavior	62
6.1.7	Adjustment	63
6.1.8	Filter time constant	63
6.2	Digital outputs EM-S1OUTD and EM-S2OUTD	64
6.2.1	General	64
6.2.2	Operation modes	64
6.2.3	Repetition frequency output via EM-S1OUTD and EM-S2OUTD	64
6.3	Digital inputs EM-SxIND	65
6.3.1	Fixed reference values and fixed value switch-over	65
6.4	Encoder input EM-SinCos	66
6.4.1	Division Marks	66
6.4.2	Track signals	66
6.4.3	Voltage supply	67
6.4.4	Supply voltage	69
6.4.5	Speed filter	70
6.4.6	Offset	70
6.4.7	Actual speed source	72
6.5	Frequency and percentage reference channel	73
6.6	Actual value display	73
6.7	Status of the digital signals	74
6.8	Motor temperature	75
7	Parameter list	76
7.1	Actual value menu (VAL)	76
7.2	Parameter menu (PARA)	76
8	Annex	78
8.1	Error messages	78

1 General safety and application information

This documentation has been created with greatest care and has been extensively and repeatedly checked. For reasons of clarity, we have not been able to take all detailed information on all the types of the products and also not every imaginable case of positioning, operation or maintenance into account. If you require further information or if particular problems not treated extensively enough in the operating instructions occur, you can obtain the necessary information via the local representation of the company BONFIGLIOLI.

In addition, we would point out that the contents of these operating instructions are not part of an earlier or existing agreement, assurance or legal relationship, nor are they intended to amend them. All manufacturer's obligations result from the purchase contract in question, which also contains the completely and solely valid warranty regulation. These contractual warranty provisions are neither extended nor limited by the implementation of these operating instructions.

The manufacturer reserves the right to correct or amend the contents and product information as well as omissions without specific announcement and assumes no kind of liability for damage, injuries or expenditure to be put down to the aforementioned reasons.

1.1 General information



Warning! BONFIGLIOLI VECTRON frequency inverters have high voltage levels during operating, depending on their protection class, drive moving parts and have hot surfaces.

In the event of inadmissible removal of the necessary covers, improper use, wrong installation or operation, there is the risk of serious damage to persons or property.

To avoid the damage, only qualified staff may carry out the transport, installation, setup or maintenance work required. Comply with the standards EN 50178, IEC 60364 (Cenelec HD 384 or DIN VDE 0100), IEC 60664-1 (Cenelec HD 625 or VDE 0110-1), BGV A2 (VBG 4) and national provisions. Qualified persons within the meaning of this principal safety information are people acquainted with the erection, fitting, commissioning and operating of frequency inverters and the possible hazards and in possession of qualifications matching their activities.

1.2 Proper use



Warning! The frequency inverters are electrical drive components intended for installation in industrial plant or machines. Commissioning and start of intended operation are not allowed until it has been established that the machine corresponds to the provisions of the EC machine directive 98/37/EEC and EN 60204. According to the CE sign, the frequency inverters additionally fulfill the requirements of the low-voltage directive 2006/95/EC and standards EN 50178/DIN VDE 0160 and EN 61800-2. Responsibility for compliance with the EMC directive 89/336/EEC is with the user. Frequency inverters are available in a limited way and as components exclusively intended for professional use within the meaning of the standard EN 61000-3-2.

With the issue of the UL certificate according to UL508c, the requirements of the CSA Standard C22.2-No. 14-95 have also been fulfilled.

The technical data and the information on connection and ambient conditions stated on the rating plate and the documentation must be complied with. The instructions must have been read and understood before starting work at the device.

1.3 Transport and storage

Transport and storage are to be done appropriate in the original packing. Store the units only in dry rooms, which are protected against dust and moisture and are subjected to little temperature deviations only. Observe the climatic conditions according to standard EN 50178 and to the information on the label of the original packing. The duration of storage without connection to the admissible reference voltage may not exceed one year.

1.4 Handling and positioning



Warning! Damaged or destroyed components may not be put into operation because they may be a health hazard.

The frequency inverters are to be used according to the documentation, the directives and the standards. Handle carefully and avoid mechanical overload. Do not bend the components or change the isolation distances. Do not touch electronic components or contacts. The devices contain construction elements with a risk of electrostatic, which can easily be damaged by improper handling. Any use of damaged or destroyed components shall be considered as a non-compliance with the applicable standards. Do not remove any warning signs from the device.

1.5 Electrical connection



Warning! Before any assembly or connection work, de-energize the frequency inverter. Make sure that the frequency inverter is de-energized. Do not touch the sockets, because the capacitors may still be charged. Comply with the information given in the operating instructions and on the frequency inverter label.

While working on the frequency inverters, obey the applicable standards BGV A2 (VBG 4), VDE 0100 and other national directives. Comply with the information in the documentation on electrical installation and the relevant directives. Responsibility for compliance with and examination of the limit values of the EMC product standard EN 61800-3 for variable-speed electrical drive mechanisms is with the manufacturer of the industrial plant or machine.

The documentation contains information on installation correct for EMC. The cables connected to the frequency inverters may not be subjected to an isolation test with a high test voltage without previous circuit measures.

1.6 Operation information



Warning! Before commissioning and the start of the intended operation, attach all the covers and check the sockets. Check additional monitoring and protective devices pursuant to EN 60204 and the safety directives applicable in each case (e.g. Working Machines Act, Accident Prevention Directives etc.).

No connection work may be performed, while the system is in operation.

1.7 Maintenance and service



Warning! Unauthorized opening and improper interventions can lead to physical injury or damage to property. Repairs on the frequency inverters may only be done by the manufacturer or persons authorized by the latter.

2 Introduction

This document describes the possibilities and the properties of the EM-SinCos-01 expansion module for the frequency inverters of the ACU device series.

Note: This document exclusively describes the EM-SinCos-01 expansion module. It is not to be understood as fundamental information for the operation of the frequency inverters of the ACU device series.

The EM-SinCos-01 expansion module is an optional hardware component to extend the functionality of the frequency inverter. It enables the data exchange within the network between the components which have been directly connected, for example control elements.

At the EM-SinCos-01 module a SinCos-encoder and a voltage supply can be connected. By means of the connected voltage supply the SinCos-encoder can be supplied with voltage. For that the voltage supply must be set to "external" via a parameter (*Voltage supply 1186*, refer to chapter 6.4.3 "Voltage supply"). The voltage value can be set via a parameter (*Supply voltage 1187*, refer to chapter 6.4.4 "Supply voltage"). The voltage value can be monitored and controlled via a sense measuring line.

The EM-SinCos-01 module extends the functionality of the frequency inverters of the ACU device series by the following functions:

- CAN system bus
(CAN interface ISO-DIS 11898; CAN High Speed; max. 1 Mbaud).
Refer to chapter 5 "System bus interface".
- Analog input.
Refer to chapter 6.1 "Analog input EM-S1INA".
- SinCos-encoder input including PTC evaluation via HD-Sub-D connection.
Refer to chapter 6.4 "Encoder input EM-SinCos".
- Three digital inputs.
Refer to chapter 6.3 "Digital inputs EM-SxIND".
- Two digital outputs, also usable as repetition frequency outputs.
Refer to chapter 6.2 "Digital outputs EM-S1OUTD and EM-S2OUTD".
- Adjustable voltage output for encoder voltage supply.
Refer to chapters 6.4.3 "Voltage supply" and 6.4.4 "Supply voltage".
- Voltage input 24 VDC for connection of external voltage supply. It can be used as voltage supply for a connected SinCos-encoder. Refer to chapters 4.3.3 "External voltage supply" and 6.4.3 "Voltage supply".

Note: The EM-SinCos-01 expansion module has been enclosed with the frequency inverter as a separate component and must be fitted by the user. This is described in detail in the chapter "Mechanical Installation".

To assemble the expansion module it can be simply plugged into the frequency inverter of the ACU device series.



Caution! Assemble the module at the frequency inverter before the frequency inverter is put into operation, and only in a voltage-free state.

The pluggable sockets of the expansion module enable economical overall fitting with a safe function.

3 Technical data

For usage of the expansion module comply with the technical data of the frequency inverter.

Terminal X410A		Terminal X410B	
X410A.1	Voltage input 24 VDC	X410B.1	Ground
X410A.2	Ground 24 VDC	X410B.2	Digital input EM-S1IND ¹⁾
X410A.3	Digital output EM-S1OUTD ^{1), 2)}	X410B.3	Digital input EM-S2IND ¹⁾
X410A.4	Digital output EM-S2OUTD ^{1), 2)}	X410B.4	Digital input EM-S3IND ¹⁾
X410A.5	Voltage output 0...10 VDC ³⁾	X410B.5	System bus, CAN-Low
X410A.6	Analog input EM-S1INA ¹⁾	X410B.6	System bus, CAN-High
X410A.7	Ground 10 VDC	X410B.7	Ground

¹⁾ The control electronics can be freely parameterized.

²⁾ Can be used as repetition frequency output. The repetition frequency output is interference voltage proof in the range -5 V ... +10 V.

³⁾ The maximum power available will be reduced by the further control outputs of the frequency inverter and expansion module.



Caution! The input for the external 24VDC-voltage supply can withstand external voltage up to 30 VDC. Avoid higher voltage levels. Higher voltages may destroy the unit.



Caution! The voltage output at terminal X410A.5 may be loaded with a maximum power of 2 Watt. Higher load may damage components of the module.

Encoder- and PTC-input X412 (HD-Sub-D)	
Encoder	PTC input
Internal impedance of source <100 Ω	Tripping resistance = 2.4 kΩ acc. DIN 44081
A/B- and C/D-track: sinusoidal difference signal, DC component: $V_{DC} = 2.5 \text{ V} \pm 0.5 \text{ V}$, Peak value: 0.6 V	Hysteresis = 1.3 kΩ
R-track: difference signal, DC component: $V_{DC} = 2.5 \text{ V} \pm 0.5 \text{ V}$, Differential mode voltage: 1.8 V	PTC thermistor respectively bimetallic temperature sensor (normally closed contact)



Warning! The PTC input is not insulated. Only PTC thermistors with safe insulation from the motor winding acc. to EN61800-5-1 may be connected.

Note: BONFIGLIOLI servomotors of types BCR and BTM are designed with safe insulation against the motor winding.

Note: BONFIGLIOLI VECTRON recommends the connection of an external voltage supply to the voltage input. This provides an auxiliary voltage for the encoder voltage supply. Comply with the power requirement of the encoder according to the manufacturer's data.

Technical data of the control terminals**Digital inputs (X410B.2) ... (X210B.4):**

Low signal: 0 V ... 3 V, High signal: 12 V ... 30 V, Input resistance: 2.3 k Ω ,

Response time: 4 ms, PLC compatible

Frequency signal: 0 ... 30 V, 10 mA at 24 V, $f_{\max} = 150$ kHz

Digital outputs (X410A.3), (X410A.4):

Low signal: 0 V ... 3 V,

High signal: 12 V ... 30 V, output current: 40 mA, PLC compatible,

Repetition Frequency Output: Frequency signal, $F_{\max} = 150$ kHz, overload and short-circuit proof, $I_{\max} = \pm 60$ mA at min. permissible line termination 150 Ω , according to specification EIA485

Analog input (X410A.6):

Analog signal: input voltage: -10 V ... 10 V / 0 V ... 10 V ($R_i = 100$ k Ω),

Resolution 10 Bit

Voltage output 0 ... 10 VDC for encoder voltage supply (X410A.5):

$P_{\max} = 2$ W. This value can be lower dependent on the load at the digital outputs of the frequency inverter and expansion module.

Voltage input 24 VDC for external voltage supply (X410A.1)

Input voltage range: 24 VDC $\pm 10\%$, $U_{\max} = 30$ VDC,

rated input current: max. 1.0 A (typical 0.45 A),

peak inrush current: typical: < 20 A,

external fuse: via standard fuse elements for rated current, characteristic: slow,

safety: safety extra low voltage (SELV) according to EN 61800-5-1

Conductor cross section:

Suitable cross sections of the control terminals are:

With wire end ferrule: 0.25...1.0 mm²

Without wire end ferrule: 0.14...1.5 mm²

4 Installation

4.1 General

The mechanical and electrical installation of the EM-SinCos-01 expansion module is to be carried out by qualified personnel according to the general and regional safety and installation directives. Safe operation of the frequency inverter requires that the documentation and the device specification be complied with during installation and start of operation. For specific areas of application further provisions and guidelines must be complied with where applicable.

The frequency inverters are designed according to the requirements and limit values of product standard EN 61800-3 with an interference immunity factor (EMI) for operation in industrial applications. The electromagnetic interference is to be avoided by expert installation and observation of the specific product information.

For further information, refer to the chapter "Electrical Installation" in the operating instructions of the frequency inverter.



Warning! All connection sockets where dangerous voltage levels may be present (e.g. motor connection sockets, mains sockets, fuse connection sockets, etc.) must be protected against direct contact.

4.2 Mechanical installation



Danger! If the following instructions are not complied with, there is direct danger with possible consequences of death or severe injury by electrical current. To disregard the instructions can lead to destruction of the frequency inverter and/or of the expansion module.

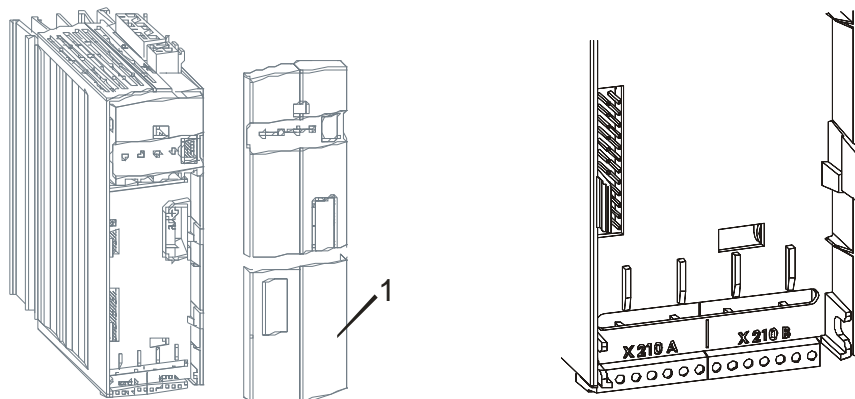
- Before assembly or disassembly of the EM-SinCos-01 expansion module, the frequency inverter must be de-energized. Take appropriate measures to make sure it is not energized unintentionally.
- Make sure that the frequency inverter is de-energized.



Danger! The mains, direct voltage and motor terminals can be live with dangerous voltage after disconnection of the frequency inverter. Work may only be done on the device after a waiting period of some minutes until the DC link capacitors have been discharged.

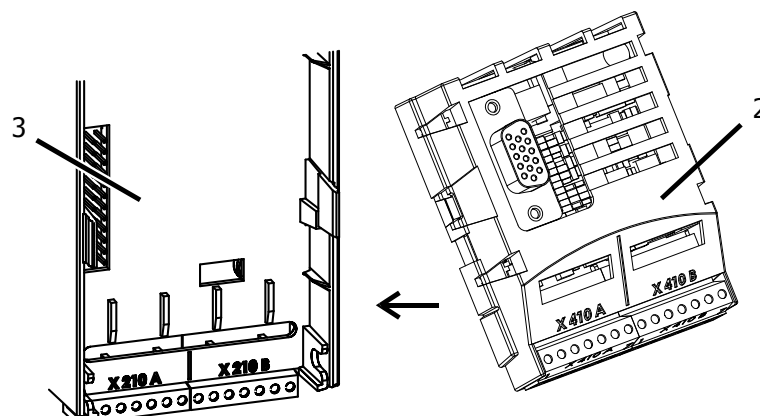
The EM-SinCos-01 expansion module is supplied in a housing for assembly on the lower slot of the frequency inverter.

- Remove the lower cover (1) of the frequency inverter.
The slot for the EM-SinCos-01 expansion module becomes accessible.



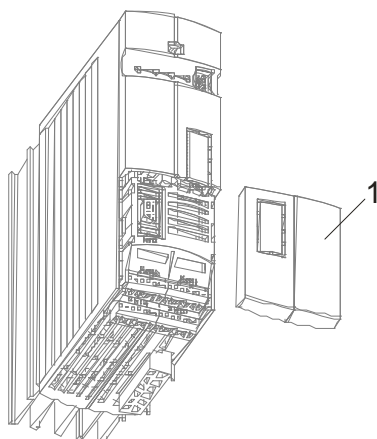
Caution! The EM-SinCos-01 expansion module (2) is pre-fitted in a housing. Do NOT touch the PCB visible on the back, as modules may be damaged.

- Plug the EM-SinCos-01 expansion module (2) onto the slot (3).



- Re-install the lower cover (1).
This completes the assembly procedure.

When the supply voltage of the frequency inverter is switched on, the EM-SinCos-01 expansion module is ready for operation.



4.3 Electrical installation



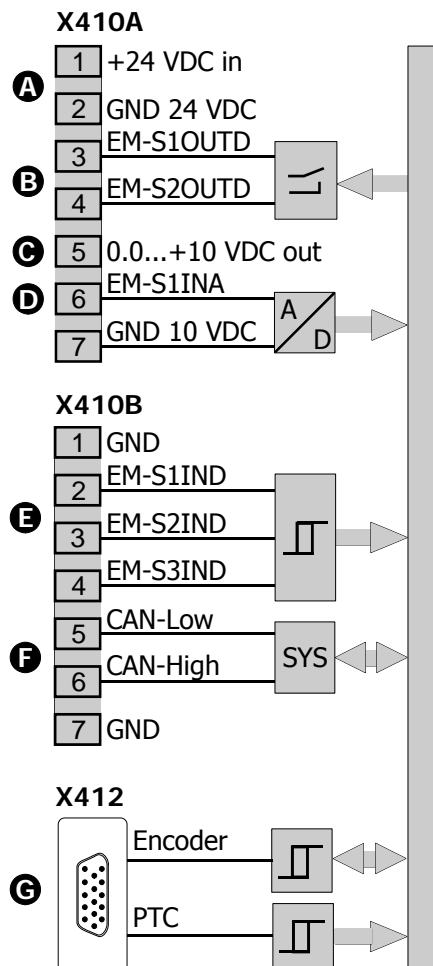
Danger! If the following instructions are not complied with, there is direct danger with the possible consequences of death or severe injury by electrical current. Further, failure to comply can lead to destruction of the frequency inverter and/or of the expansion module.

- Before electrical installation of the EM-SinCos-01 expansion module, the frequency inverter must be de-energized. Take appropriate measures to make sure it is not energized unintentionally.
- Make sure that the frequency inverter is de-energized.



Danger! The mains, direct voltage and motor sockets can have dangerous voltages even after disconnection of the frequency inverter. Work may only be done on the device after a waiting period of some minutes until the DC link capacitors have been discharged.

4.3.1 Circuit diagram





Caution! The digital inputs and the 24 VDC input terminal of the electronic control equipment can withstand external voltage up to 30 VDC. Avoid higher voltage levels. Higher voltages may destroy the unit.

A Voltage input, connection of external voltage supply for encoder

Input voltage range: 24 VDC $\pm 10\%$, $U_{\max} = 30$ VDC,
 rated input current: max. 1.0 A (typical 0.45 A),
 peak inrush current: typical: < 20 A,
 external fuse: via standard fuse elements for rated current, characteristic: slow,
 safety: safety extra low voltage (SELV) according to EN 61800-5-1

B Digital outputs EM-S1OUTD, EM-S2OUTD

Digital signal, 24 VDC, $I_{\max} = 40$ mA, PLC compatible, overload and short-circuit proof

C Voltage output for encoder voltage supply

0.0 V ... 10 VDC, according to setting of parameter *Supply voltage 1187* (factory setting: 5.0 V), $P_{\max} = 2$ W



Caution! The voltage output at terminal X410A.5 may be loaded with a maximum power of 2 Watt. Higher load might damage components of the module.

D Analog input EM-S1INA

Analog signal, resolution 10 Bit, $U_{\max} = \pm 10$ V ($R_i = 100$ k Ω)

E Digital inputs EM-S1IND ... EM-S3IND

Digital signal, response time approx. 16 ms, $U_{\max} = 30$ V, 10 mA at 24 V,
 PLC compatible,
 Frequency signal, 0 ... 30 V, 10 mA at 24 V, $f_{\max} = 150$ kHz

F Communication interface system bus

CAN actuation of the system bus according to ISO-DIS 11898 (CAN High Speed), bus termination can be activated via switch

G SinCos-encoder input and PTC thermistor input (15-pole HD-Sub-D)

The encoder interface is suitable for the connection of standard SinCos-encoders.
 Evaluation of:

- A/B-track
 - C/D-track (commutating track)
 - R-track (reference track)
 - Sense measuring line for monitoring and control of encoder supply voltage
- Input: incremental sine signal, internal impedance of source <100 Ω ,
 A/B- and C/D-track: DC component $V_{DC} = 2.5$ V ± 0.5 V, Peak value: 0.6 V,
 R-track: $V_{DC} = 2.5$ V ± 0.5 V, Differential mode voltage: 1.8 V.

The supply voltage for the encoder provided at contact X412.6 (V_{Enc}) and X412.15 (0VL) is adjustable in the range of 0.0 ... 10 VDC via parameter *Supply voltage 1187*.

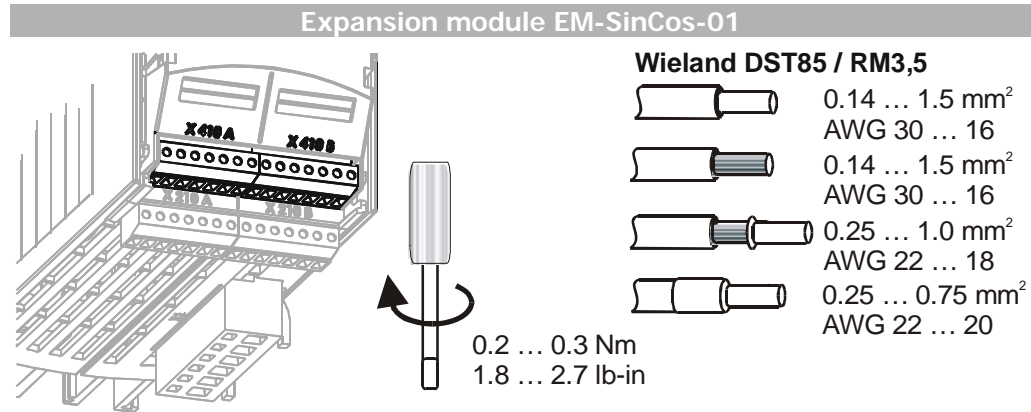
PTC thermistor input:

Tripping resistance = 2.4 k Ω (PTC) acc. DIN 44081,
 PTC thermistor or bimetal temperature sensor (normally closed contact)

Use PTC thermistors with safe insulation from the motor winding according to EN 61800 5-1.

4.3.2 Control terminals

The control and software functionality can be freely configured for economical operation with a safe function.



Caution! The control inputs and outputs must be connected and disconnected free of electrical power. Otherwise components may be damaged.

Attention! In order to minimize electromagnetic interference and to obtain a good signal quality, connect the line screen to PE on a plane at both ends.

Control terminal X410A	
Terminal	Description
1	24 VDC input
2	Ground 24 VDC
3	Digital output EM-S1OUTD ¹⁾
4	Digital output EM-S2OUTD ¹⁾
5	0 ... 10 VDC output ²⁾
6	Analog input EM-S1INA ¹⁾
7	Ground 10 VDC

Control terminal X410B	
Terminal	Description
1	Ground
2	Digital input EM-S1IND ¹⁾
3	Digital input EM-S2IND ¹⁾
4	Digital input EM-S3IND ¹⁾
5	System bus, CAN-Low
6	System bus, CAN-High
7	Ground

¹⁾ The control electronics is freely programmable.

²⁾ The maximum power available will be reduced by the further used control outputs of the frequency inverter and expansion module. For sufficient power connect an external power supply at the 24 VDC input.

The voltage value can be set via parameter *Supply voltage* **1187**.

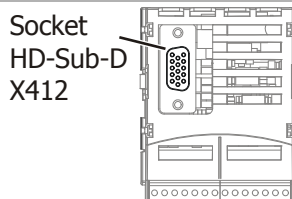


Caution! The input for the external 24VDC-voltage supply can withstand external voltage up to 30 VDC. Avoid higher voltage levels. Higher voltages may destroy the unit.



Caution! The voltage output at terminal X410A.5 may be loaded with a maximum power of 2 Watt. Higher load might damage components of the frequency inverter.

Socket X412



Encoder input and PTC input X412 (socket HD-Sub-D)

Contact	Designation	Function
	socket	Shielding connected with PE
1	D-	0.6 V ... 1.2 V _{pp} incremental signal
2	D+	
3	B-	
4	B+	
5	TM _{PTC} -	Motor PTC thermistor connection
6	V _{Enc}	Encoder voltage supply (0 ... 10 VDC) ¹⁾
7	R-	0.2 ... 1.7 V _{pp} analog signal
8	C-	0.6 V ... 1.2 V _{pp} incremental signal
9	A-	
10	TM _{PTC} +	Motor PTC thermistor connection
11	V _{Enc S}	Sense measuring line for monitoring V _{Enc} ²⁾
12	R+	0.2 ... 1.7 V _{pp} analog signal
13	C+	0.6 V ... 1.2 V _{pp} incremental signal
14	A+	
15	0VL	Encoder voltage supply

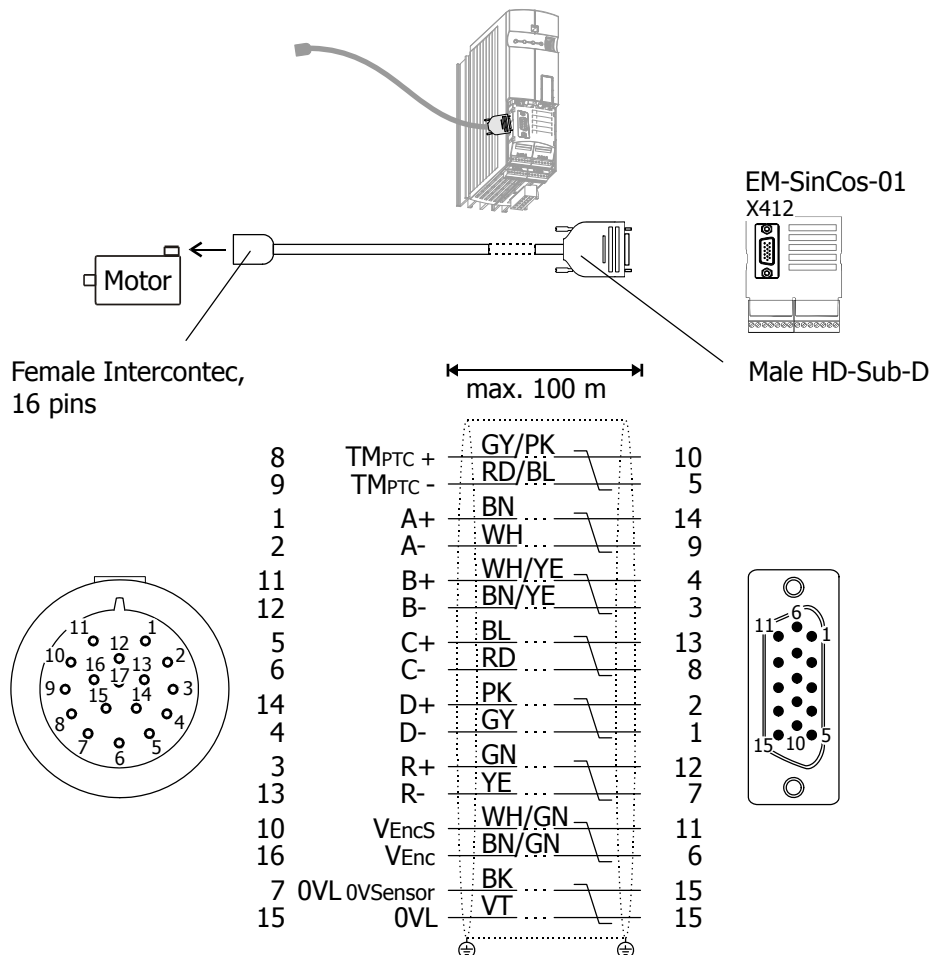
V_{pp}: peak-to-peak voltage

¹⁾ The voltage value can be set via parameter *Supply voltage 1187*. Refer to chapter 6.4.4 "Supply voltage".

²⁾ The voltage control via the sense measuring line can be activated optionally via parameter *Voltage supply 1186*. Refer to chapter 6.4.3 "Voltage supply".

BONFIGLIOLI VECTRON ready-made cable

Encoder cable	8 twisted pair-cables
Cross section	0.14 mm ²
Length	3 m, 5 m or 10 m

Pin-assignment of BONFIGLIOLI VECTRON ready-made cable


- Use PTC thermistors with safe insulation from the motor winding acc. to EN 61800-5-1.
- Use shielded twisted pair.
- The encoder cable must be kept physically separate from the motor cable.
- Place the cable shield of the encoder cable on both sides with large area contact.
- BONFIGLIOLI VECTRON recommends ready-made cable for the connection of synchronous motors of types BCR and BTB.

4.3.3 External voltage supply

An external voltage supply can be connected to the terminals X410A.1 (24 VDC) and X410A.2 (GND). By means of this voltage supply a connected SinCos-encoder can be supplied with voltage. Alternatively the internal voltage source of the frequency inverter can be used for encoder voltage supply. BONFIGLIOLI VECTRON recommends the connection of an external voltage supply.

Requirements to be met by external power supply

Input voltage range	24 VDC $\pm 10\%$
Rated input current	Max. 1.0 A (typical 0.45 A)
Peak inrush current	Typical: < 20 A
External fuse	Standard fuse elements for rated current, characteristic: slow
Safety	Safety extra low voltage (SELV) according to EN 61800-5-1



Caution! The inputs for the external voltage supply can withstand external voltage up to 30 VDC. Avoid higher voltage levels. Higher voltages may destroy the unit.

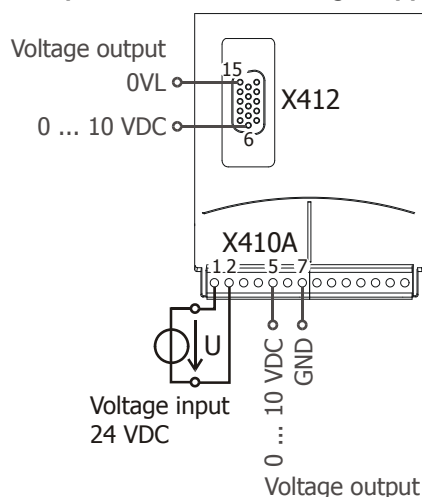
The parameter *Voltage supply* **1186** enables the selection of the internal or an external voltage supply for the SinCos-encoder. Refer to chapter 6.4.3 "Voltage supply". Via Parameter *Supply voltage* **1187** the voltage value for encoder voltage supply can be set. Refer to chapter 6.4.4 "Supply voltage".

The SinCos-encoder can be supplied with voltage:

- via control terminals X410A.5 (0 ... 10 VDC) and X410A.7 (GND) or
- via HD-Sub-D socket contacts X412.6 (V_{Enc}) and X412.15 (0VL)

Refer to chapter 4.3.2 "Control terminals".

Voltage input and voltage outputs for encoder voltage supply



5 System bus interface

The CAN connection of the system bus is physically designed according to **ISO-DIS 11898** (CAN High Speed). The bus topology is the line structure.

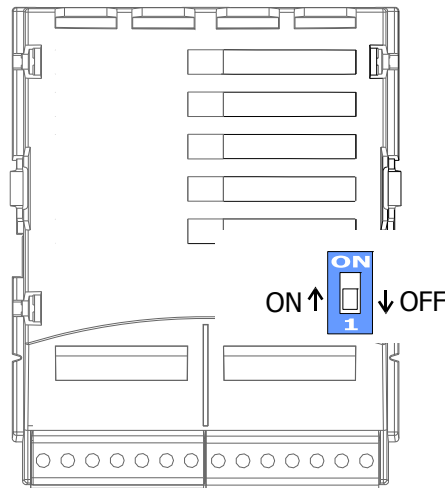
The frequency inverter supports a CAN protocol controller, which may exist in **either** the CM-CAN communication module with CANopen interface **OR** in an expansion module for the system bus, such as the EM-SinCos-01 expansion module.

Attention! Installation of two optional components with CAN-Protocol controller results in a deactivation of the system bus interface in the EM-SinCos-01 expansion module.

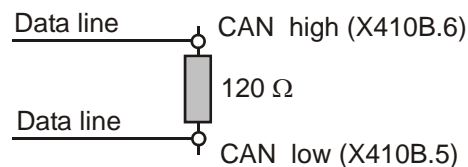
5.1 Bus termination

The necessary bus terminator at the physically first and last node can be activated via the DIP switch on the EM-SinCos-01 expansion module.

- Switch to **ON** (upper position) for a passive termination.



Attention! The factory setting of the bus termination is "1" (OFF, switch in lower position).



passive

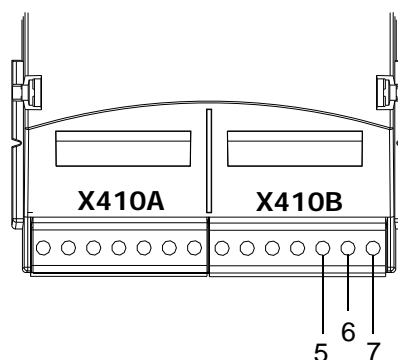
5.2 Cables

For the bus line, use twisted a cable with harness shield (**no foil shield**).

Attention: The control and communication lines are to be laid physically separate from the power lines. The harness screen of the data lines is to be connected to ground (PE) on both sides on a large area and with good conductivity.

5.3 Socket X410B

The system bus is connected via three sockets of the plug **X410B** on the EM-SinCos-01 expansion module.



Socket X410B		
Socket	Input/Output	Description
X410B.5	CAN-Low	CAN-Low (System bus)
X410B.6	CAN-High	CAN-High (System bus)
X410B.7	GND	CAN-GND (System bus)

5.4 Baud rate setting/line length

The setting of the baud rate must be identical in all subscribers on the system bus. The maximum possible baud rate is based on the necessary overall line length of the system bus. The baud rate is set via the parameter *Baud-Rate* **903** and thus defines the possible line length.

Operation mode	Function	max. line length
3 - 50 kBaud	Transmission rate 50 kBaud	1000 meters
4 - 100 kBaud	Transmission rate 100 kBaud	800 meters
5 - 125 kBaud	Transmission rate 125 kBaud	500 meters
6 - 250 kBaud	Transmission rate 250 kBaud	250 meters
7 - 500 kBaud	Transmission rate 500 kBaud	100 meters
8 - 1000 kBaud	Transmission rate 1000 kBaud	25 meters

A baud rate under 50 kBaud, as defined according to CANopen, is not sensible for the system bus as the data throughput is too low.

The maximum line lengths stated are guidelines. If they are made complete use of, the admissible length is to be calculated on the basis of the line parameters and the bus driver (PCA82C250T)

5.5 Setting node address

A maximum of 63 slaves or frequency inverters with system bus can be operated on the system bus. Each frequency inverter is given a node ID, which may only exist once in the system, for its unambiguous identification. The setting of the system bus node ID is done via the parameter *Node-ID* **900**.

Parameter		Setting		
No.	Description	Min.	Max.	Factory setting
900	Node-ID	-1	63	-1

Thus, the system bus possesses a maximum number of 63 subscribers (Network nodes), plus one frequency inverter as a master.

Note: With the factory setting of parameter *Node-ID* **900** = -1, the system bus is deactivated for this frequency inverter.
If the *Node-ID* **900** = 0 is set, the frequency inverter is defined as a master. Only one frequency inverter on the system bus may be defined as a master.

5.7.1 SDO channels (parameter data)

Each frequency inverter possesses two SDO channels for the exchange of parameter data. In a slave device, these are two server SDO's, in a device defined as a master a client SDO and a server SDO. Attention must be paid to the fact that only one master for each SDO channel may exist in a system.

Note: Only one master can initiate by the system bus an exchange of data via its client SDO.

The identifier assignment for the SDO channels (Rx/Tx) is done according to the Pre-defined Connection Set.

This assignment can be amended by parameterization, in order to solve identifier conflicts in a larger system in which further devices are on the CAN bus alongside the frequency inverters.

Attention: If a system in which an frequency inverter works as a master is produced, the identifier allocations for the SDO channel may not be altered. In this way, an addressing of individual subscribers via the field bus/system bus path of the master frequency inverter is possible.

Parameters are read/written via the SDO channels. With the limitation to the SDO Segment Protocol Expedited, which minimizes the requirements of the parameter exchange, the transmittable data are limited to the uint / int / long types. This permits complete parameterization of the frequency inverters via the system bus, as all the settings and practically all the actual values are displayed via these data types.

5.7.2 PDO channels (process data)

Each frequency inverter possesses three PDO channels (Rx/Tx) for the exchange of process data.

The identifier assignment for the PDO channel (Rx/Tx) is done by default according to the Predefined Connection Set. This assignment corresponds to an alignment to a central master control.

In order to produce the logical channels between the devices (transverse movement) on the system bus, the amendment of the PDO identifiers for Rx/Tx is necessary.

Each PDO channel can be operated with time or SYNC control. In this way, the operation behavior can be set for each PDO channel:

The setting of the operation mode is done via the following parameters:

TxPDO1 Function 930, TxPDO2 Function 932 und TxPDO3 Function 934

RxPDO1 Function 936, RxPDO2 Function 937 und RxPDO3 Function 938

Operation mode	Function
0 - deactivated	no exchange of data via the PDO channel (Rx and/or Tx)
1 - time-controlled	Tx-PDO's cyclically transmit according to the time specification Rx-PDO's are read in with $T_a = 1$ ms and forward the data received to the application
2 - SYNC controlled	Tx-PDO's transmit the data from the application that are then current after the arrival of the SYNC telegram. Rx-PDO's forward the last data received to the application after the arrival of the SYNC telegram.

For synchronous PDO's, the master (PC, PLC or frequency inverter) generates the SYNC telegram. The identifier assignment for the SYNC telegram is done by default according to the Predefined Connection Set. This assignment can be altered by parameterization.

5.8 Master functionality

An external control or an frequency inverter defined as a master (node ID = 0) can be used as a master. The fundamental tasks of the master are controlling the start of the network (boot-up sequence), generating the SYNC telegram and evaluating the emergency messages of the slaves.

Further, there can be access to the parameterization of all the frequency inverters on the system bus by means of a field bus connection via the client SDO of the master frequency inverter.

5.8.1 Control boot-up sequence, network management

The Minimum Capability Boot-Up method defined according to CANopen is used for the state control of the subscribers (nodes).

This method knows the pre-operational, operational and stopped states.

After the initialization phase, all the subscribers are in the pre-operational state. The system bus master transmits the NMT command **Start-Remote-Node**. With this command, individual nodes or all the nodes can be started together. An frequency inverter defined as a master starts **all** the nodes with **one** command. After receipt of the Start Remote Node command, the subscribers change into the Operational state. From this time on, process data exchange via the PDO channels is activated.

A master in the form of a PLC/PC can start the subscribers on the system bus individually and also stop them again.

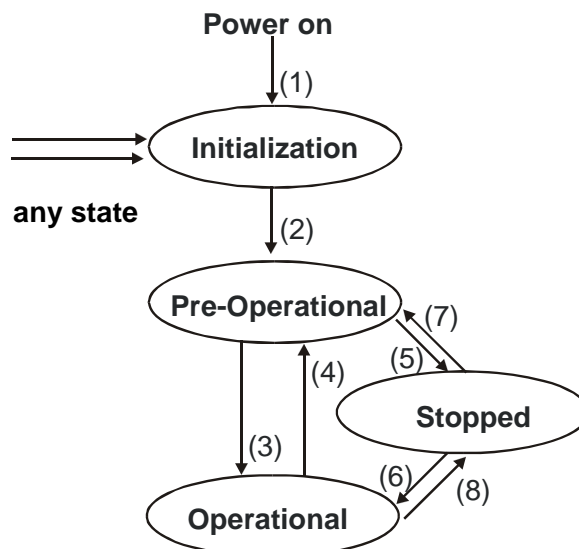
As the slaves on the system bus need different lengths of time to conclude their initialization phases (especially if external components exist alongside the frequency inverters), an adjustable delay for the change to Operational is necessary. The setting is done in an frequency inverter defined as a system bus master via *Boot-Up Delay* **904**.

Parameter		Setting		
No.	Description	Min.	Max.	Factory setting
904	Boot-Up Delay	3500 ms	50000 ms	3500 ms

Properties of the states:

State	Properties
Pre-Operational	Parameterization via SDO channel possible Exchange of process data via PDO channel not possible
Operational	Parameterization via SDO channel possible Exchange of process data via PDO channel possible
Stopped	Parameterization via SDO channel not possible Exchange of process data via PDO channel not possible

Note: Start-Remote-Node is cyclically transmitted with the set delay time by an frequency inverter defined as a system bus master, in order to put slaves added with a delay or temporarily separated from the network back into the Operational state.



After Power On and the initialization, the slaves are in the Pre-Operational state. The transition (2) is automatic. The system bus master (frequency inverter or PLC/PC) triggers the transition (3) to Operational state. The transitions are controlled via NMT telegrams.

The identifier used for the NMT telegrams is "0" and may only be used by the system bus master for NMT telegrams. The telegram contains two data bytes.

Byte 0	Byte 1
CS (Command Specifier)	Node-ID

Identifier = 0

With the statement of the node ID $\neq 0$, the NMT command acts on the subscriber selected via the node ID. If node ID = 0, **all** the subscribers are addressed. If Node-ID = 0, **all** nodes are addressed.

Transition	Command	Command Specifier
(3) , (6)	Start Remote Node	1
(4) , (7)	Enter Pre-Operational	128
(5) , (8)	Stop Remote Node	2
-	Reset Node	129
-	Reset Communication	130

Note: A frequency inverter defined as a system bus master only transmits the command "Start Remote Node" with node ID = 0 (for all subscribers). Transmission of the command is done after completion of the initialization phase and the time delay *Boot-Up Delay* **904** following it.

5.8.2 SYNC telegram, generation

If synchronous PDO's have been created on the system bus, the master must send the SYNC telegram cyclically. If an frequency inverter has been defined as a system bus master, the latter must generate the SYNC telegram. The interval for the SYNC telegram of an frequency inverter defined as the system bus master is adjustable. The SYNC telegram is a telegram without data.

The default identifier = 128 according to the Predefined Connection Set.

If a PC or PLC is used as a master, the identifier of the SYNC telegrams can be adapted by parameterization on the frequency inverter.

The identifier of the SYNC telegram must be set identically in all subscribers on the system bus.

The setting of the identifier of the SYNC telegram is done via the parameter *SYNC-Identifier* **918**.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
918	SYNC-Identifier	0	2047	0

The setting "0" results in identifier assignment according to the Predefined Connection Set.

Attention: The identifier range 129...191 may not be used as the emergency telegrams can be found there.

The temporal cycle for the SYNC is set on an frequency inverter defined as a system bus master via the parameter *SYNC-Time* **919**.

Note: A setting of 0 ms for the parameter *SYNC-Time* 919 means "no SYNC telegram".

5.8.3 Emergency message, reaction

If a slave on the system bus suffers a fault, it transmits the emergency telegram. The emergency telegram marks the node ID for the identification of the failed node via its identifier and the existing fault message via its data contents (8 bytes).

After a fault has been acknowledged on the slave, the latter again transmits an emergency telegram with the data content zero.

The emergency telegram has the identifier 128 + node ID (= 129 ... 191)

The system bus master evaluates the emergency telegrams of the slaves. Its reaction to an emergency telegram can be set with *Emergency Reaction* **989**.

Operation mode	Function
0 - Error	The system bus master receives the emergency telegram and switches-off
1 - No Error	Das Emergency Telegram is displayed as a warning

Operation mode - parameter 989 = 0 – Error

Behavior of the system bus master in *Emergency Reaction* **989** = 0 / Error:

As soon as the system bus master receives an emergency telegram, it also switches to failure mode and reports the failed subscriber on the basis of its ID via the kind of error. Only the subscriber is reported, not the cause of the error.

The fault message on the system bus master via *Current error* **260** is **21nn** with **nn** = **node ID** (hexadecimal) of the slave in which a fault switch-off exists.

In addition, the system bus master reports the warning Sysbus (0x2000) via the parameter *Warnings* **270** Bit 13.

If a fault switch-off occurs on a number of slaves, the first slave to transmit its emergency telegram is displayed on the system bus master.

Operation mode - parameter 989 = 1 – No Error

Behavior of system bus master in the case of *Emergency Reaction* **989** = 1 / No Error:

As soon as the system bus master receives an emergency telegram, it reports the warning Sysbus (0x2000) via the parameter *Warnings* **270** Bit 13.

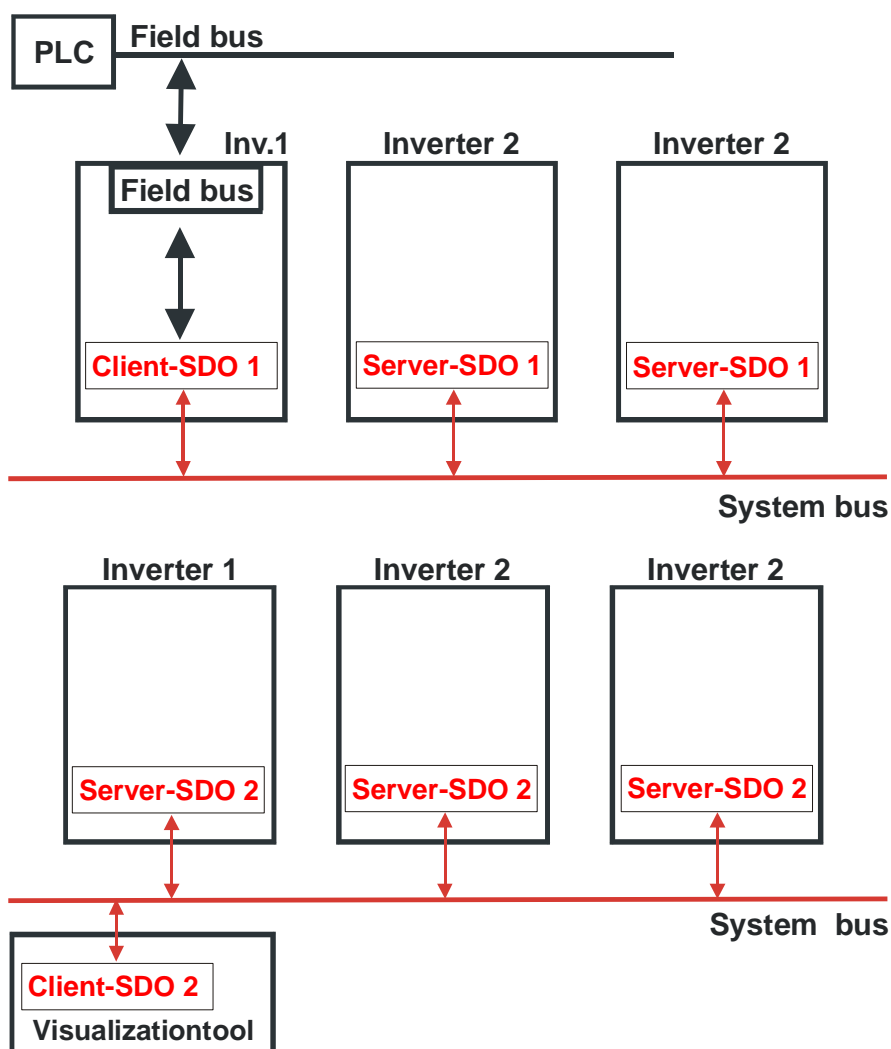
Note: In both cases, the Boolean variable SysbusEmergency with source number 730 is set to TRUE in the system bus master. It can be used in the system bus master and (in transmission via a TxPDO) in the slaves for a defined shutdown.
SysbusEmergency is also set if the system bus master breaks down.
Resetting of SysbusEmergency is done with the fault acknowledgment.

5.8.4 Client SDO (system bus master)

Each subscriber on the system bus can be addressed via the SDO channels. In this way, each subscriber can be addressed and parameterized by one master via its client SDO1. All the parameters of the data types uint/int/long are accessible. String parameters can **not** be processed. If an frequency inverter has been defined as a system bus master, each subscriber on the system bus in this frequency inverter can be addressed by means of a field bus connection (RS232, RS485, Profibus-DP) via its client SDO1.

Note: The second SDO channel SDO2 of the frequency inverters is planned for the parameterization of the frequency inverters via a visualization tool on the system bus.

The service used is SDO Segment Protocol Expedited according to CANopen. An frequency inverter defined as a system bus master automatically generates the correct telegrams. If the SDO channel is operated via a PLC/PC on the system bus, the telegrams must be generated according to the specification.



5.9 Slave functionality

5.9.1 Implement boot-up sequence, network management

5.9.1.1 Boot-up message

After the initialization, each slave on the system bus transmits its boot-up message (heartbeat message).

Note: The boot-up telegram has the identifier 1792 + node ID and a data byte with contents = 0x00.

This telegram is of importance if a PLC/PC with CANopen functionality is used as a master. An frequency inverter defined as a system bus master does **not** evaluate the boot-up message.

5.9.1.2 Status control

The identifier used for the NMT telegrams is "0" and may only be used by the system bus master for NMT telegrams. The telegram contains two data bytes.

Byte 0	Byte 1
CS (Command Specifier)	Node-ID

Identifier = 0

With the statement of the node ID $\neq 0$, the NMT command acts on the subscriber selected via the node ID. If node ID = 0, **all** the subscribers are addressed. If Node-ID = 0, **all** nodes are addressed.

Transition	Command	Command Specifier
(3),(6)	Start Remote Node	1
(4),(7)	Enter Pre-Operational	128
(5),(8)	Stop Remote Node	2
-	Reset Node	129
-	Reset Communication	130

Attention: The reset node and reset communication command specified according to DS 301 lead to a change to Pre-Operational via Initialization in the frequency inverters. There is a new boot-up message.

After a slave has received the command "Start Remote Node", it activates the PDO channels and is ready for the exchange of process data.

5.9.2 Process SYNC telegram

If synchronous PDO's have been created in an frequency inverter, their processing is synchronized with the SYNC telegram. The SYNC telegram is generated by the system bus master and is a telegram without data.

The identifier is 128 according to the Predefined Connection Set.

If a PC or PLC is used as a master, the identifier of the SYNC telegrams can be adapted by parameterization on the frequency inverter. The identifier of the SYNC telegram must be set identically in all subscribers on the system bus.

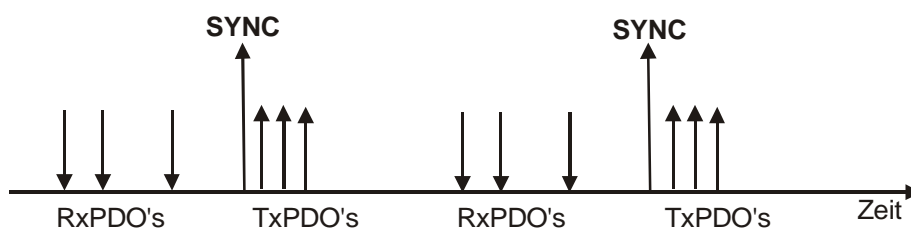
Attention: The identifier range 129 ... 191 may not be used as the emergency telegrams can be found there.

The setting of the identifier of the SYNC telegram is done via the parameter *SYNC-Identifier* **918**.

Parameter		Setting		
No.	Description	Min.	Max.	Factory setting
918	SYNC-Identifier	0	2047	0

The setting "0" results in identifier assignment according to the Predefined Connection Set.

The data of the Rx-PDO's are forwarded to the application after the arrival of the SYNC telegram. At the same time, the Tx-PDO's with the currently available data from the application are sent.



This method enables pre-occupancy of set points in the system bus subscribers and a synchronous / parallel take-over of the data.

5.9.3 Emergency message, fault switch-off

As soon as a fault switch-off occurs in a slave frequency inverter, the emergency telegram is transmitted. The emergency telegram marks the node ID for the identification of the failed node via its identifier and the existing fault message via its data contents (8 bytes).

The emergency telegram has the identifier 128 + node ID.

After a fault acknowledgment, another emergency telegram is transmitted, with the data content (Byte 0 ...7) being set to "0" this time. This identifies the subscriber's repeated readiness for operation. If a further fault occurs subsequently, it is transmitted in a new emergency telegram.

The acknowledgment sequence is based on the definitions according to CANopen.

Data contents of the emergency telegram:

Emergency telegram		
Byte	Value	Meaning
0	0x00	low-byte Error-Code
1	0x10	high-byte Error-Code
2	0x80	Error-Register
3	0x00	-
4	0x00	-
5	0x00	-
6	0xnn	internal Error-Code, low-byte
7	0xmm	internal Error-Code, high-byte

Bytes 0, 1 and 2 are firmly defined and compatible with CANopen.

Bytes 6/7 contain the product specific VECTRON error code.

Error-Code	= 0x1000	= general error
Error-Register	= 0x80	= manufacturer-specific error

The explanation and description of the product-specific VECTRON error code can be found in the annex "Error messages".

5.9.4 Server SDO1/SDO2

The communication channel for the exchange of parameter data is the SDO channel. Communication works according to the client/server model. The server is the subscriber holding the data (here the frequency inverter), the client the subscriber requesting or wanting to alter the data (PLC, PC or frequency inverter as system bus master).

For the frequency inverter, two server SDO channels have been implemented. The first SDO channel **SDO1** is used for the parameterization of the PLC/PC as a master or frequency inverter with field bus connection as a system bus master. The second SDO channel **SDO2** is reserved for a visualization tool for parameterization. An exchange of data can only be implemented by the master via a client SDO.

The SDO channels are stipulated for the server SDO's via identifiers according to the Predefined Connection Set to CANopen. As CANopen only provides for and defines one SDO channel in the Predefined Connection Set, the second SDO channel can be deactivated.

In addition, the number of system bus subscribers and the adjustable node ID are limited to 63.

Identifier assignment according to the Predefined Connection Set:

Identifier Rx-SDO = 1536 + Node-ID (Node-ID = 1 ... 127, Identifier = 1537 ... 1663)

Identifier Tx-SDO = 1408 + Node-ID (Node-ID = 1 ... 127, Identifier = 1409 ... 1535)

Identifier assignment for SDO1/SDO2 compatible with the Predefined Connection Set:

Identifier Rx-SDO1 = 1536 + Node-ID (Node-ID = 1 ... 63, Identifier = 1537 ... 1599)

Identifier Tx-SDO1 = 1408 + Node-ID (Node-ID = 1 ... 63, Identifier = 1409 ... 1471)

Identifier Rx-SDO2 = 1600 + Node-ID (Node-ID = 0 ... 63, Identifier = 1600 ... 1663)

Identifier Tx-SDO2 = 1472 + Node-ID (Node-ID = 0 ... 63, Identifier = 1472 ... 1535)

This corresponds to the factory settings of the frequency inverters for the SDO's. The node ID = 0 for SDO2 is the system bus master.

Attention: The SDO2 must be deactivated in a CANopen system in order not to generate any compatibility problems.

If a frequency inverter has been defined as the system bus master, the above settings for the SDO1 must be maintained in all the frequency inverters. In this way, access to the parameterization of the frequency inverters via a field bus connection on the master frequency inverter is possible.

The client SDO1 in the master frequency inverter addresses the server SDO1 of the slaves via the above identifiers.

Attention: The identifiers for a visualization tool on the second SDO channel SDO2 cannot be changed.

If a PC or a PLC is used as a master, the identifiers of the **Rx/Tx-SDO1** can be adapted by parameterization on the frequency inverter.

Attention: In free assignment of identifiers, there may not be any double occupancy !

The identifier range 129...191 may not be used as the emergency telegrams can be found there.

The setting of the identifiers of the RxSDO1 is done via the parameter *RxSDO1-Identifier* **921**.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
921	RxSDO1-Identifier	0	2047	0

The setting of the identifiers of the TxSDO1 is done via parameter number **922**.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
922	TxSDO1-Identifier	0	2047	0

The setting "0" results in identifier assignment according to the Predefined Connection Set.

The second SDO channel can be deactivated via the *SDO2 Set Active* **923**.

Operation mode	Function
0 - SDO2 deactivated	Communication channel deactivated
1 - SDO2 activated	Communication channel activated for the visualization tool

The identifier assignment for the second SDO channel is always to the specification:

Identifier Rx-SDO2 = 1600 + Node-ID
 Identifier Tx-SDO2 = 1472 + Node-ID

Note: In this way, firm identifiers via which communication takes place are available for the visualization tool.

5.10 Communication channels, SDO1/SDO2

5.10.1 SDO telegrams (SDO1/SDO2)

The service used for the exchange of parameter data is **SDO Segment Protocol Expedited**. The data (type uint, int, long) are exchanged in a telegram.

Access to the parameters in the frequency inverters with a statement of parameter number and data set is displayed via the addressing defined for object access pursuant to the specifications of CANopen via Index/Sub-Index.

Index = parameter number / Sub index = data set.

The data to be transmitted have a length of 2 bytes for uint/int and 4 bytes for long. As standardization and simplification, 4 bytes are always transmitted.

The data are on bytes 4...7 of the SDO telegram.

- uint/int variables are transmitted in bytes 4 and 5 with bytes 6 und 7 = 0.
- long variables are transmitted in bytes 4...7.

Writing parameters:

Client → Server SDO Download (expedited)

0	1	2	3	4	5	6	7
Ctrl. byte	Parameter number		Data set	Data			
0x22	LSB	MSB	0xnn	LSB			MSB
uint/int				LSB	MSB	0x00	0x00
long				LSB	...	...	MSB

Server → Client Download Response → Writing process free of errors

0	1	2	3	4	5	6	7
Ctrl. byte	Parameter number		Data set	Data			
0x60	LSB	MSB	0xnn	0			

Server → Client Abort SDO Transfer → Writing process faulty

0	1	2	3	4	5	6	7
Ctrl. byte	Parameter number		Data set	Data			
0x80	LSB	MSB	0xnn	Code	0	0	0

The error code is stated in byte 4 in a faulty reading process.
(see Table, failure codes).

Attention: Control byte 0x22 for the identification "SDO Download expedited" does not consider the bits "s" (data size indicated) and "n" (number of bytes not containing data). If set, they are ignored. The user is responsible for the number of bytes matching the type of data.

Reading parameters:

Client → Server SDO Upload (expedited)

0	1	2	3	4	5	6	7
Ctrl. byte	Parameter number		Data set	Data			
0x40	LSB	MSB	0xnn	0			

Server → Client Upload Response → Reading process free of errors

0	1	2	3	4	5	6	7
Ctrl. byte	Parameter number		Data set	Data			
0x42	LSB	MSB	0xnn	LSB			MSB
uint/int				LSB	MSB	0x00	0x00
long				LSB	...	...	MSB

Server → Client Abort SDO Transfer → Reading process faulty

0	1	2	3	4	5	6	7
Ctrl. byte	Parameter number		Data set	Data			
0x80	LSB	MSB	0xnn	Code	0	0	0

The error code is stated in byte 4 in a faulty reading process.
(see Table, failure codes).

failure codes	
Code	Description
1	inadmissible parameter figure
2	inadmissible data set
3	parameter not readable
4	parameter not writable
5	reading error EEPROM
6	writing error EEPROM
7	checksum error EEPROM
8	parameter cannot be written during running drive
9	values of the data sets differ
10	parameter of wrong type
11	unknown parameter
12	BCC error in VECTRON bus protocol
15	unknown error
20	system bus subscriber not available only in access via field bus connection
21	string parameter not admissible only in access via VECTRON bus protocol

Errors marked in the table are generated by the field bus side, not in the Abort SDO Transfer of the system bus.

5.10.2 Communication via field bus connection (SDO1)

If an frequency inverter has been defined as the system bus master and equipped with a field bus interface, access to the parameterization of all the subscribers in existence on the system bus is possible by means of this field bus interface via the first SDO channel (SDO1). An extension has been created in the protocol frame of the field buses for this purpose.

Attention: The prerequisite for this mechanism is that the identifier setting for the first SDO channel (SDO1) corresponds to the Predefined Connection Set. The parameter addressed must also be existent in the system bus master.

5.10.2.1 Profibus-DP

If an object with communication channel (PKW) is used in Profibus-DP, access to all the other subscribers on the system bus can be done via it. The structure of the communication channel permits an additional addressing of a system bus subscriber. This is done by the use of an unused byte in the communication channel.

Communication channel PKW

0	1	2	3	4	5	6	7
PKE		Index	-	Data			
AK/SPM	Parameter number	Data set	Node-ID system bus				

Byte 3 is used to transmit the node ID of the required subscriber on the system bus. If byte 3 = 0, the master inverter of the system bus is addressed. The display is binary (0...63).

5.10.2.2 RS232/RS485 with VECTRON bus protocol

In the VECTRON bus protocol, there is a byte in the telegram header that is always transmitted with 0 as a standard feature.

ENQUIRY

0	1	2	3	4	5	6
Address	0	p	n	n	n	ENQ
	Node-ID system bus	Data set	Parameter number			

SELECT

0	1	2	3	4			
Address	STX	0	p	n	n	n	...
		Node-ID System bus	Data set	Parameter number			

Byte 1 in the enquiry and byte 2 in the select telegram are not defined and are used to transmit the node ID of the required subscriber on the system bus. If this byte = 0, the master inverter of the system bus is addressed. The display is ASCII corresponding to the conventions for the display of the address in the VECTRON bus protocol.

Note: If there is an NAK fault message, the error is to be read out from the system bus master with node ID = 0 via parameter 11.

Display of node ID system bus in the VECTRON bus protocol:

System bus Node-ID					
System bus address	(ASCII-) character	HEX value	System bus address	(ASCII-) character	HEX value
1	A	41	31	—	5F
2	B	42	32	,	60
3	C	43	33	a	61
4	D	44	34	b	62
5	E	45	35	c	63
6	F	46	36	d	64
7	G	47	37	e	65
8	H	48	38	f	66
9	I	49	39	g	67
10	J	4A	40	h	68
11	K	4B	41	i	69
12	L	4C	42	j	6A
13	M	4D	43	k	6B
14	N	4E	44	l	6C
15	O	4F	45	m	6D
16	P	50	46	n	6E
17	Q	51	47	o	6F
18	R	52	48	p	70
19	S	53	49	q	71
20	T	54	50	r	72
21	U	55	51	s	73
22	V	56	52	t	74
23	W	57	53	u	75
24	X	58	54	v	76
25	Y	59	55	w	77
26	Z	5A	56	x	78
27	[	5B	57	y	79
28	\	5C	58	z	7A
29	]	5D	59	{	7B
30	^	5E	60	|	7C
			61	}	7D
			62	~	7E
			63	□	7F

5.11 Process data channels, PDO

5.11.1 Identifier assignment process data channel

The process channel for the exchange of process data under CANopen is the PDO channel. Up to three PDO channels with differing properties can be used in one device.

The PDO channels are defined via identifiers according to the Predefined Connection Set to CANopen:

Identifier 1. Rx-PDO = 512 + Node-ID
 Identifier 1. Tx-PDO = 384 + Node-ID

Identifier 2. Rx-PDO = 768 + Node-ID
 Identifier 2. Tx-PDO = 640 + Node-ID

Identifier 3. Rx-PDO = 1024 + Node-ID
 Identifier 3. Tx-PDO = 896 + Node-ID

This corresponds to the factory settings of the frequency inverters for the Rx/Tx-PDO's. This occupancy is aligned to an external master (PLC/PC) serving all the channels.

If the PDO channels are used for a connection of the frequency inverters amongst one another, the identifiers are to be set accordingly by parameterization.

Attention: In free assignment of identifiers, there may not be any double occupancy!

The identifier range 129...191 may not be used as the emergency telegrams can be found there.

Setting of the identifiers of the Rx/TxPDO's:

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
924	RxPDO1 Identifier	0	2047	0
925	TxPDO1 Identifier	0	2047	0
926	RxPDO2 Identifier	0	2047	0
927	TxPDO2 Identifier	0	2047	0
928	RxPDO3 Identifier	0	2047	0
929	TxPDO3 Identifier	0	2047	0

The setting "0" results in identifier assignment according to the Predefined Connection Set.

5.11.2 Operation modes process data channel

The transmit/receive behavior can be time controlled or controlled via a SYNC telegram. The behavior can be parameterized for each PDO channel.

Tx-PDO's can work time controlled or SYNC controlled. A time controlled TxPDO transmits its data at the interval of time set. A SYNC controlled TxPDO transmits its data after the arrival of a SYNC telegram.

RxPDO's in the time controlled setting forward the received data to the application immediately. If an RxPDO has been defined as SYNC controlled, its forwards its received data to the application after the arrival of a SYNC telegram.

Settings TxPDO1/2/3

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
931	TxPDO1 Time	1 ms	50000 ms	8 ms
933	TxPDO2 Time	1 ms	50000 ms	8 ms
935	TxPDO3 Time	1 ms	50000 ms	8 ms

The setting of the operation mode is done via the following parameters:

TxPDO1 Function 930, TxPDO2 Function 932 und TxPDO3 Function 934

Operation mode	Function
0 - Not Active	No data are sent.
1 - Controlled by time	In the cycle of the adjusted time interval the data are sent.
2 - Controlled by SYNC	To arrival of a SYNC telegram the data are sent.

Settings RxPDO1/2/3

The setting of the operation mode is done via the following parameters:

RxPDO1 Function 936, RxPDO2 Function 937 und RxPDO3 Function 938

Operation mode	Function
0 - Controlled by time	The received data are passed on immediately.
1 - Controlled by SYNC	After arrival of a SYNC telegram the received data are passed on.

Note: In the "controlled by time" operation mode, there is a polling of the received data with the trigger cycle of $T_a = 1$ ms.

5.11.3 Timeout monitoring process data channel

Each frequency inverter monitors its received data for whether they are updated within a defined time window.

The monitoring is done onto the SYNC telegram and the RxPDO channels.

Monitoring SYNC / RxPDO's

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
939	SYNC Timeout	0 ms	60000 ms	0 ms
941	RxPDO1 Timeout	0 ms	60000 ms	0 ms
942	RxPDO2 Timeout	0 ms	60000 ms	0 ms
945	RxPDO3 Timeout	0 ms	60000 ms	0 ms

Setting "0" means no timeout monitoring.

Attention: There is only monitoring for the SYNC telegram if at least one RxPDO or one TxPDO channel is defined as SYNC controlled.

If a timeout period is exceeded, the frequency inverter switches to failure mode and reports one of the faults:

- F2200** **System bus Timeout SYNC**
- F2201** **System bus Timeout RxPDO1**
- F2202** **System bus Timeout RxPDO2**
- F2203** **System bus Timeout RxPDO3**

5.11.4 Communication relationships of the process data channel

Regardless of the process data to be transmitted, the communication relationships of the process data channels must be defined. The connection of PDO channels is done via the assignment of the identifiers. The identifiers of Rx-/Tx-PDO must match in each case.

There are two principal possibilities:

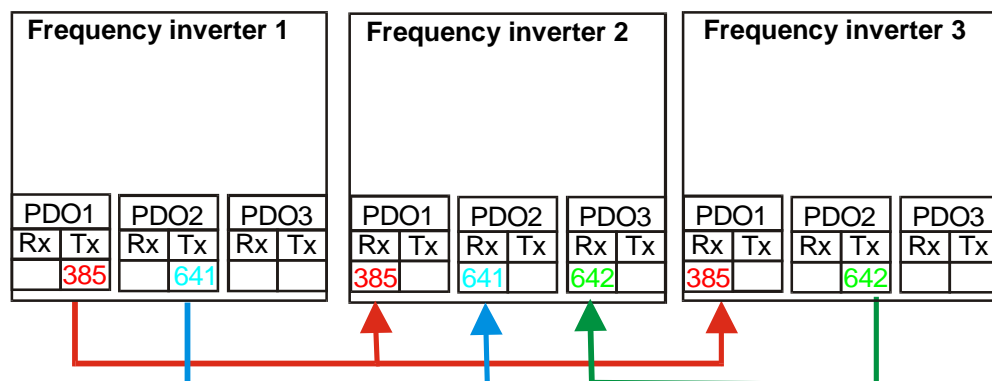
- **one** Rx-PDO to **one** Tx-PDO (one to one)
- connect **several** Rx-PDO's to **one** TxPDO (one to many)

This process is documented in a tabular form via a **communication relationship list**.

Example:

Frequency inverter 1		Frequency inverter 2		Frequency inverter 3	
PDO	Identifier	PDO	Identifier	PDO	Identifier
TxPDO1	385	TxPDO1		TxPDO1	
RxPDO1		RxPDO1	385	RxPDO1	385
TxPDO2	641	TxPDO2		TxPDO2	642
RxPDO2		RxPDO2	641	RxPDO2	
TxPDO3		TxPDO3		TxPDO3	
RxPDO3		RxPDO3	642	RxPDO3	

Attention: All the TxPDO's used must have different identifiers !!!
The Identifier must be clear in the system bus network.



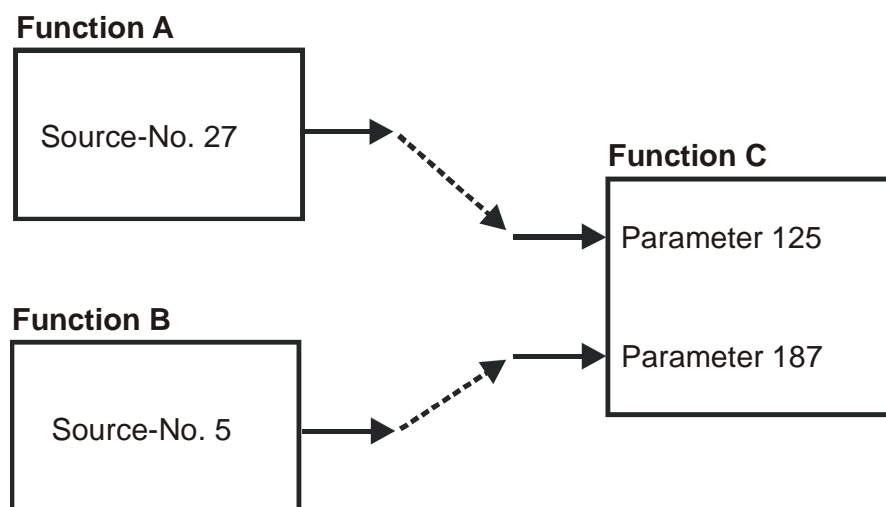
5.11.5 Virtual links

A PDO telegram contains 0 ...8 data bytes according to CANopen. A mapping for any kind of objects can be done in these data bytes.

For the system bus, the PDO telegrams are firmly defined with 8 data bytes. The mapping is not done via mapping parameters as with CANopen, but via the method of sources and links.

Each function provides its output data via a source. These sources are defined via source numbers. The input data of functions are defined via parameters. The link of a data input to a data output is done via the assignment of parameters to source numbers.

Example 1:

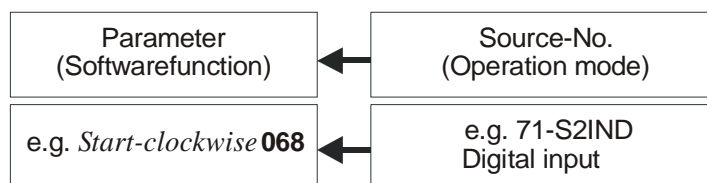


In example 1, the two inputs of function C are connected to the outputs of functions A and B. The parameterization for this connection is thus:

Function C

Parameter 125 = Source-No. 27
 Parameter 187 = Source-No. 5

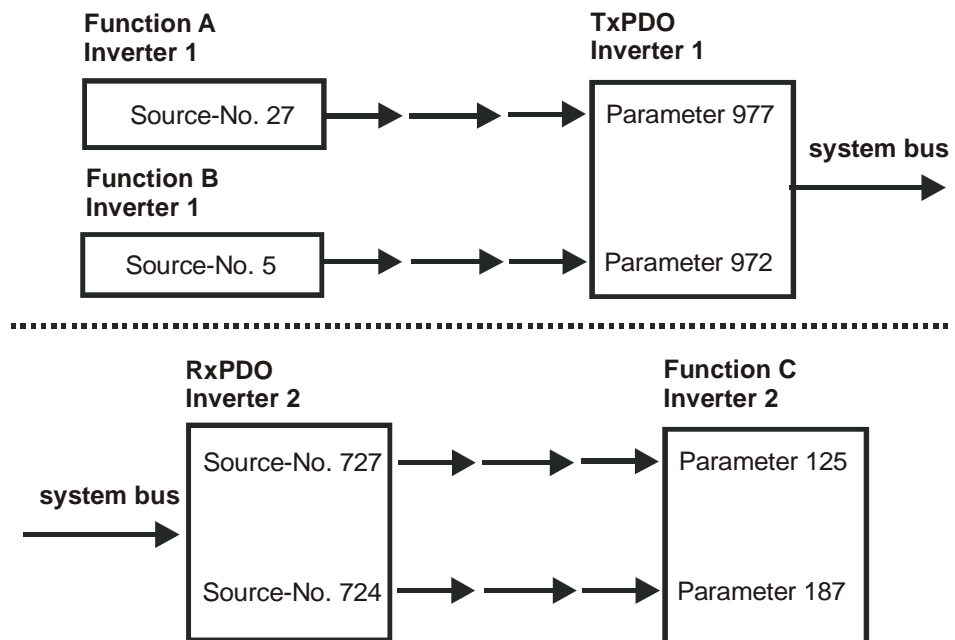
Example of a virtual connection in VPlus:



The assignment of the operation modes to the software functions available can be adapted to the application in question.

For the system bus, the input data of the TxPDO's are also displayed as input parameters and the output data of the RxPDO's as sources.

Example 2:



Example 2 displays the same situation as Example 1. But now, the functions A and B are in frequency inverter 1 and function C in frequency inverter 2. The connection is done via a TxPDO in frequency inverter 1 and a RxPDO in frequency inverter 2. Thus, the parameterization for this connection is:

Frequency inverter 1

Parameter 977 = Source-No. 27
Parameter 972 = Source-No. 5

Frequency inverter 2

Parameter 125 = Source-No. 727
Parameter 187 = Source-No. 724

As the links with the system used exceed the device limits, they are termed "virtual links".

The virtual links with the possible sources are related to the Rx/TxPDO channels. For this purpose, the eight bytes of the Rx-/TxPDO's are defined structured as inputs and sources. This exists for each of the three PDO channels.

Each transmit PDO and receive PDO can be occupied as follows:

4 Boolean variables

or

4 uint/int variables

or

2 long variables

or

a mixture paying attention to the eight bytes available

Assignment data type / number of bytes:

Assignment	
Data type	Length
Boolean	2 Bytes
uint/int	2 Bytes
long	4 Bytes

5.11.5.1 Input parameters of the TxPDO's for data to be transmitted

The listed parameters can be used to stipulate the data that are to be transported there for each position in the TxPDO telegrams. The setting is done in such a way that a source number is entered for the required data in the parameters.

TxPDO1	P. No.	TxPDO1	P. No.	TxPDO1	P. No.
Byte	Boolean input	Byte	uint/int input	Byte	long input
0	946	0	950	0	954
1	Boolean1	1	Word1	1	
2	947	2	951	2	
3	Boolean2	3	Word2	3	Long1
4	948	4	952	4	955
5	Boolean3	5	Word3	5	
6	949	6	953	6	
7	Boolean4	7	Word4	7	Long2

TxPDO2	P. No.	TxPDO2	P. No.	TxPDO2	P. No.
Byte	Boolean input	Byte	uint/int input	Byte	long input
0	956	0	960	0	964
1	Boolean1	1	Word1	1	
2	957	2	961	2	
3	Boolean2	3	Word2	3	Long1
4	958	4	962	4	965
5	Boolean3	5	Word3	5	
6	959	6	963	6	
7	Boolean4	7	Word4	7	Long2

TxPDO3	P. No.	TxPDO3	P. No.	TxPDO3	P. No.
Byte	Boolean input	Byte	uint/int input	Byte	long input
0	966	0	972	0	976
1	Boolean1	1	Word1	1	
2	967	2	973	2	
3	Boolean2	3	Word2	3	Long1
4	968	4	974	4	977
5	Boolean3	5	Word3	5	
6	969	6	975	6	
7	Boolean4	7	Word4	7	Long2

Note: Depending on the selected data information the percentages values are displayed via the uint/int inputs.

With this method, there are up to three possibilities for a meaning of the contents of the individual bytes. Each byte may only be used for one possibility.

To ensure this, the processing of the input links is derived from the setting. If an input link has been set to the fixed value of zero, it is **not** processed.

The settings for the fixed value zero are:

Source = 7 (FALSE) for Boolean variables
 Source = 9 (0) for uint, int, long variables

This is simultaneously the factory setting.

Examples Boolean source

Boolean source	
Source	Data
6	TRUE
7	FALSE
70	Contact input 1
71	Contact input 2
72	Contact input 3
161	Running message
163	Nominal figure reached
164	Set frequency reached (P. 510)

Examples uint/int source

unit/int source	
Source	Data
9	0
63	Reference percentage 1
64	Reference percentage 2
52	Percentage MFI1
133	Output percentage ramp
137	Output reference percentage channel
138	Output actual percentage channel
740	Control word
741	State word

Examples long source

long source	
Source	Data
9	0
0	Output frequency ramp
1	Fixed frequency 1
5	Reference line value
62	Output frequency reference value channel
50	Reference frequency MFI1

5.11.5.2 Source numbers of the RxPDO's for received data

Equivalent to the input links of the TxPDO's, the received data of the RxPDO's are displayed via sources or source numbers. The sources existing in this way can be used in the frequency inverter via the local input links for the data targets.

RxPDO1 Byte	Source No. Boolean value	RxPDO1 Byte	Source No. uint/int value	RxPDO1 Byte	Source No. long- Value
0	700	0	704	0	708
1	Boolean1	1	Word1	1	
2	701	2	705	2	
3	Boolean2	3	Word2	3	Long1
4	702	4	706	4	709
5	Boolean3	5	Word3	5	
6	703	6	707	6	
7	Boolean4	7	Word4	7	Long2

RxPDO2 Byte	Source No. Boolean value	RxPDO2 Byte	Source No. uint/int value	RxPDO2 Byte	Source No. long value
0	710	0	714	0	718
1	Boolean1	1	Word1	1	
2	711	2	715	2	
3	Boolean2	3	Word2	3	Long1
4	712	4	716	4	719
5	Boolean3	5	Word3	5	
6	713	6	717	6	
7	Boolean4	7	Word4	7	Long2

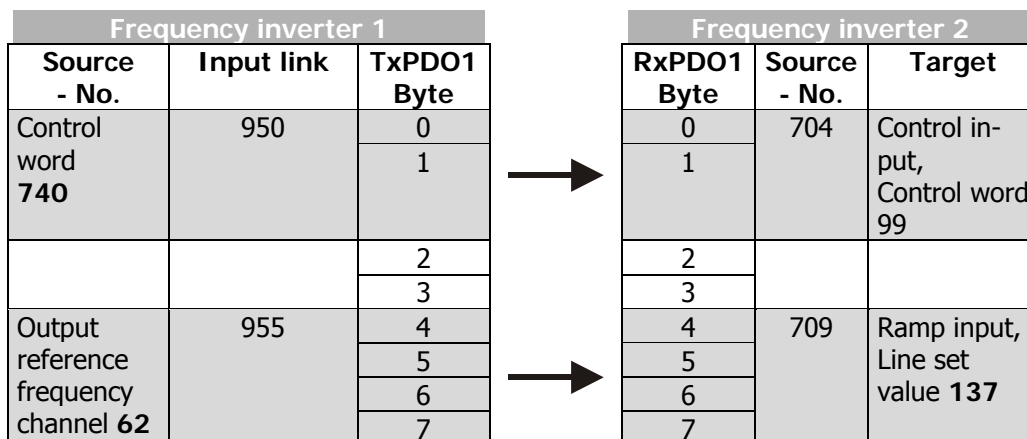
RxPDO3 Byte	Source No. Boolean value	RxPDO3 Byte	Source No. uint/int value	RxPDO3 Byte	Source No. long value
0	720	0	724	0	728
1	Boolean1	1	Word1	1	
2	721	2	725	2	
3	Boolean2	3	Word2	3	Long1
4	722	4	726	4	729
5	Boolean3	5	Word3	5	
6	723	6	727	6	
7	Boolean4	7	Word4	7	Long2

With this method, there are up to three possibilities for a meaning of the contents of the individual bytes. Each byte may only be used for one possibility.

Note: Depending on the selected data information the percentages values are displayed via the uint/int inputs.

5.11.5.3 Examples of virtual links

Example 1:



Parameter 950 = Source-No. 740
 Parameter 955 = Source-No. 62

Parameter 99 = Source-No. 704
 Parameter 137 = Source-No. 709

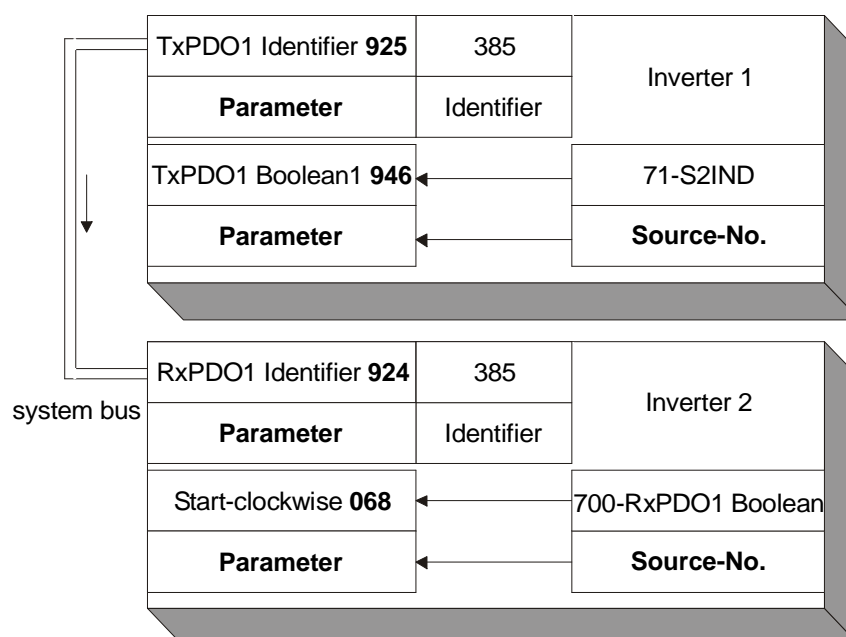
The control word of frequency inverter 1 is linked with the control word of frequency inverter 2. In this way, both frequency inverters can be operated synchronously via the remote control. The output of the reference value channel of frequency inverter 1 is laid onto the output of the ramp of frequency inverter 2. In this way, both frequency inverters have a joint source of reference values and are given reference values in the internal notation.

As an extension, a number of frequency inverters can also exist on the receive side (Rx), these then being supplied with data parallel and simultaneously.

The input link not used in the TxPDO1 of frequency inverter 1 is on ZERO and is thus not served.

Example 2:

Example of a virtual link with transmission via the system bus:



5.12 Control parameters

For the monitoring of the system bus and the display of the internal states, two control parameters are provided. There is a report of the system bus state and a report of the CAN state via two actual value parameters.

The parameter *Node-State* **978** gives information about the Pre-Operational, Operational, Stopped state. A PDO transfer is only possible in the Operational state. The state is controlled by the system bus master (PLC / PC / frequency inverter) via NMT telegrams.

The parameter *CAN-State* **979** gives information about the state of the physical layer. If there are transmission errors, the state changes from OKAY to WARNING until the cancellation of the communication with BUS-OFF. After BUS-OFF, the CAN controller is automatically re-initialized and the system bus started again.

Note: If the BUS-OFF state occurs, the frequency inverter breaks down with "F2210 BUS-OFF".

After Bus-OFF, the system bus in the frequency inverter is completely reinitialized. There is a new boot-up message from the subscriber and an emergency telegram with the Bus-OFF message is transmitted. The change of state of the subscriber to Operational is done by the Start-Remote-Node telegram cyclically sent by the system bus master.

Actual values of the system bus		
No.	Description	Display
978	Node-State	1 - Pre-Operational 2 - Operational 3 - Stopped
979	CAN-State	1 - OKAY 2 - WARNING 3 - BUS-OFF

5.13 Handling of the parameters of the system bus

As soon as the system bus expansion module EM-SYS exists in an frequency inverter, the actual value parameters for system state and bus state are activated and can be observed in the actual value menu **VAL** of the control unit KP500 or with the VPlus PC program in the menu **Actual values \ Systembus**.

Note: The actual value parameters are on control level 3 and are thus available for the user at any time.

All the setting parameters for the configuration of the system bus are not directly accessible for the user. For defined customer applications, pre-defined XPI files can be generated by VECTRON for the VPlus PC program, with which the necessary parameters are visible for the user. The application-relevant variables are then available in these XPI files.

Note: XPI files can be read in addition to the loaded parameter information of the frequency inverter into the VPlus PC program.
In the menu of the software under the point "Edit" you find the command "Read in XPI file".

The method of working via an XPI file has its reasoning in the fact that deep interventions in the system are possible via the system bus and can lead to serious problems in the application with an untrained user. Via the XPI files, a user is given a selection list pre-defined by VECTRON.

Attention: The configuration of the necessary parameters for the system bus is accessible by a XPI file with the help of the VPlus PC program.
The control unit KP500 does not support this functionality.
If the expansion module system bus EM-SYS is installed additionally to a communication module for the field bus connection (CM-232, CM-485 or CM-PDP) in the frequency inverter, the parameterization can be made with the interface adapter KP232.

Experienced users have complete access to all the existing sources and possible input links with the XPI file of the active functions. The selection depends on the selected configuration and control procedure.

The display of the parameters when using the XPI file is according to the following structure:

System bus

Basic Settings	900	Node-ID
	903	Baud-Rate
Master Functions	904	Boot-Up Delay
	919	SYNC-Time
SYNC-Identifier	918	SYNC-Identifier
SDO1-Identifier	921	RxSDO1-Identifier
	922	TxSDO1-Identifier
SDO2 Set Active	923	SDO2 Set Active
PDO-Identifier	924	RxPDO1-Identifier
	925	TxPDO1-Identifier
	926	RxPDO2-Identifier
	927	TxPDO2-Identifier
	928	RxPDO3-Identifier
	929	TxPDO3-Identifier
TxPDO-Function	930	TxPDO1 Function
	931	TxPDO1 Time
	932	TxPDO2 Function
	933	TxPDO2 Time
	934	TxPDO3 Function
	935	TxPDO3 Time
RxPDO-Function	936	RxPDO1 Function
	937	RxPDO2 Function
	938	RxPDO3 Function
Timeout	939	SYNC Timeout
	941	RxPDO1 Timeout
	942	RxPDO2 Timeout
	945	RxPDO3 Timeout
TxPDO1 Objects	946	TxPDO1 Boolean1
	947	TxPDO1 Boolean2
	948	TxPDO1 Boolean3
	949	TxPDO1 Boolean4
	950	TxPDO1 Word1
	951	TxPDO1 Word2
	952	TxPDO1 Word3
	953	TxPDO1 Word4
	954	TxPDO1 Long1
	955	TxPDO1 Long2
TxPDO2 Objects	956	TxPDO2 Boolean1
	957	TxPDO2 Boolean2
	958	TxPDO2 Boolean3
	959	TxPDO2 Boolean4
	960	TxPDO2 Word1
	961	TxPDO2 Word2
	962	TxPDO2 Word3
	963	TxPDO2 Word4
	964	TxPDO2 Long1
	965	TxPDO2 Long2
TxPDO3 Objects	966	TxPDO3 Boolean1
	967	TxPDO3 Boolean2
	968	TxPDO3 Boolean3
	969	TxPDO3 Boolean4
	972	TxPDO3 Word1
	973	TxPDO3 Word2
	974	TxPDO3 Word3
	975	TxPDO3 Word4
	976	TxPDO3 Long1
	977	TxPDO3 Long2

Actual values

System bus	978	Node-State
	979	CAN-State

5.14 Ancillaries

For the planning of the system bus according to the drive tasks in question, there are ancillaries in the form of tables.

The planning of the system bus is done in three steps:

1. Definition of the communication relationships
2. Production of the virtual links
3. Capacity planning of the system bus

The priority assignment of the identifiers is relevant for the definition of the communication relationships. Data that are to be transmitted with a higher priority must be given low identifiers. This results in the message with the higher priority being transmitted first with a simultaneous access of two subscribers to the bus.

Note: The recommended identifier range for the communication relationships via the PDO channels is 385 ...

The identifiers below 385 are used for the NMT telegrams (boot-up sequence, SYNC telegram) and emergency message.

The identifiers above 1407 are used for the SDO channel for parameterization.

5.14.1 Definition of the communication relationships

The communication relationships are planned and documented with the help of the table. The table is available as a Microsoft Word document "kbl.doc" on the VECTRON product CD or upon request.

Inverter: _____	Inverter: _____	Inverter: _____	Inverter: _____	Inverter: _____
Node-ID: _____	Node-ID: _____	Node-ID: _____	Node-ID: _____	Node-ID: _____
PDO	PDO	PDO	PDO	PDO
Identifier	Identifier	Identifier	Identifier	Identifier
TxPDO1	TxPDO1	TxPDO1	TxPDO1	TxPDO1
RxPDO1	RxPDO1	RxPDO1	RxPDO1	RxPDO1
TxPDO2	TxPDO2	TxPDO2	TxPDO2	TxPDO2
RxPDO2	RxPDO2	RxPDO2	RxPDO2	RxPDO2
TxPDO3	TxPDO3	TxPDO3	TxPDO3	TxPDO3
RxPDO3	RxPDO3	RxPDO3	RxPDO3	RxPDO3

5.14.2 Production of the virtual links

The virtual links are planned and documented with the help of the table. The table is available as a Microsoft Word document "vvk.doc" on the VECTRON product CD or upon request.

<div>Inverter: _____</div>	<div>Identifier: _____ (Tx/RxPDO)</div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></</div>
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5.14.3 Capacity planning of the system bus

Each PDO telegram possesses a constant useful data content of 8 Bytes. According to worst case, this results in a maximum telegram length of 140 bits. The maximum telegram run time of the PDO's is thus stipulated via the set baud rate.

Capacity planning	
Baud rate / kBaud	Telegram run time / µs
1000	140
500	280
250	560
125	1120
100	1400
50	2800

As a function of the set baud rate and the transmission interval of the TxPDO's selected, the following bus loads results:

Capacity of the system bus										
Baud rate / kBaud	Bus load as a function of the transmission for one TxPDO in %									
	1ms	2ms	3ms	4ms	5ms	6ms	7ms	8ms	9ms	10ms
1.000	14	7	4.7	3.5	2.8	2.3	2	1.8	1.6	1.4
500	28	14	9.3	7	5.6	4.7	4	3.5	3.1	2.8
250	56	28	18.7	14	11.2	9.3	8	7	6.2	5.6
125	112	56	37.3	28	22.4	18.7	16	14	12.4	11.2
100	140	70	46.7	35	28	23.3	20	17.5	15.6	14
50	280	140	93.3	70	56	46.7	40	35	31.1	28

Attention: A bus load >100% means that a telegram cannot be dispatched completely between two transmission times.

Such a setting is not admissible!

This observation must be done for each TxPDO. The sum of all the TxPDO's decides on the entire bus load. The bus load must be designed in such a way that any telegram repetitions for transmission errors are possible without exceeding the bus capacity.

Note: To facilitate capacity planning, a Microsoft Excel file with the name "Load_Systembus.xls" is available.

The capacity planning are planned and documented with the help of the table. The work sheet is available as a Microsoft Excel document "Load_Systembus.xls" on the VECTRON product CD or by request.

Load system bus			
Baud rate [kBaud]: 50, 100, 125, 250, 500, 1000			1000
Frequency inverter	TxPDO Number	Ta [ms]	Workload [%]
1	1	0	0
	2	0	0
	3	0	0
2	1	0	0
	2	0	0
	3	0	0
3	1	0	0
	2	0	0
	3	0	0
4	1	0	0
	2	0	0
	3	0	0
5	1	0	0
	2	0	0
	3	0	0
6	1	0	0
	2	0	0
	3	0	0
7	1	0	0
	2	0	0
	3	0	0
8	1	1	14
	2	1	14
	3	1	14
9	1	1	14
	2	1	14
	3	0	0
10	1	0	0
	2	0	0
	3	0	0
Total workload [%]			70

In the table, the set baud rate is entered from the parameter *Baud-Rate 903* in kBaud. For each frequency inverter, the set time for the transmission interval (e. g. *TxPDO1 Time 931*) in ms is entered for the TxPDO being used at the time. In the column **Load** the bus load caused by the individual TxPDO appears, under **Total Load** the entire bus load.

For the bus load (Total load) the following limits have been defined:

≤ 80 % → OKAY
 80 ... 90 % → CRITICAL
 %
 > 90 % → NOT POSSIBLE

6 Control inputs and outputs

6.1 Analog input EM-S1INA

6.1.1 General

The analog input of the EM-SinCos-01 expansion module can be used as voltage input. Parameterization of the input signal is done by the definition of a linear characteristic and assignment as a

- reference value source
(can be selected via the parameter *Reference frequency source* **475**),
- reference percentage source
(can be selected via the parameter *Reference percentage source* **476**),
- actual percentage source
(can be selected via the parameter *Actual percentage source* **478**, in configuration **x11**) or
- limit value sources
(can be selected via the parameters **734...737**).

6.1.2 Characteristic

The mapping of the analog input signals onto a frequency or percentage reference value is possible for various demands. The parameterization is to be done via two points of the linear characteristic of the reference channel.

The characteristic point 1, with the coordinates X1 and Y1, and the characteristic point 2, with the coordinates X2 and Y2, can be set in four parameters.

The characteristic points X1 and X2 are stated as percentages, as the analog input can be switched as a current or voltage input via switch S3.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
564	Point X1	-100.00%	100.00%	-98.00%
565	Point Y1	-100.00%	100.00%	-100.00%
566	Point X2	-100.00%	100.00%	98.00%
567	Point Y2	-100.00%	100.00%	100.00%

The coordinates of the characteristic points are related as a percentage to the analog signal, with 10 V or 20 mA, and the parameter *Maximum Frequency* **419** or parameter *Maximum reference percentage* **519**. The change of direction of rotation can be done via the digital inputs of the frequency inverter and/or by selecting the characteristic points.

The definition of the analog input characteristic can be calculated via the two-point form of the straight-line equation. The speed Y of the drive mechanism is controlled according to the analog control signal X.

$$Y = \frac{Y2 - Y1}{X2 - X1} \cdot (X - X1) + Y1$$

Attention! Monitoring of the analog input signal via the parameter *Error/Warning Behavior* **563** demands a check of the characteristic parameters. Sensible use is only possible if the *Point X1* **564** is in the positive range.

6.1.3 Operation modes

The operation modes of the analog input characteristic enable application-related scaling as a supplement to the characteristic points stated. One of the four linear types of characteristic is selected for adaptation of the signal for the analog input signal via the parameter *Operation mode 562*.

If the characteristic points are not suited for the type of characteristic selected, the characteristic points are corrected internally.

<i>Operation mode 562</i>	Function
1 - bipolar	The analog input signal is mapped onto the reference figure according to the characteristic points (X1/Y1) and (X2/Y2). Factory setting.
11 - unipolar	With a negative parameter value of the characteristic points X1 or X2, they are mapped to the reference value zero.
21 - unipolar 2-10V/ 4-20mA	If the characteristic points X1 or X2 have been set to a negative parameter value or smaller than 0%, the input characteristic is mapped to the reference value 20%.
101 - bipolar Absolute value	Negative parameter values of the characteristic points Y1 or Y2 are mapped as a positive reference value in the characteristic.

Further information on the operation modes stated in the table can be found in the following chapter "Examples".

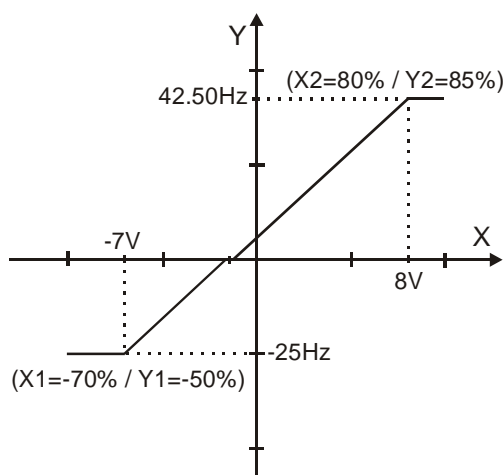
6.1.3.1 Examples

The analog input signal is mapped onto a reference value as a function of the characteristic. The following examples show the operation modes for an analog voltage signal. The parameter *Minimum Frequency 418* is set to the value 0.00 Hz. The characteristic point 100% for the Y-axis corresponds to the parameter *Maximum Frequency 419* of 50.00 Hz in the examples.

Attention! The various operation modes change the input characteristic as a function of the parameterized characteristic points. In the following examples, the areas of the coordinate system from which a characteristic point is displaced are marked.

Operation mode "1 – bipolar"

In operation mode "1 – bipolar", the characteristic of the analog input can be freely set by stating two characteristic points.



Characteristic point 1:

$$X1 = -70.00\% \cdot 10 \text{ V} = -7.00 \text{ V}$$

$$Y1 = -50.00\% \cdot 50.00 \text{ Hz} = -25.00 \text{ Hz}$$

Characteristic point 2:

$$X2 = 80.00\% \cdot 10 \text{ V} = 8.00 \text{ V}$$

$$Y2 = 85.00\% \cdot 50.00 \text{ Hz} = 42.50 \text{ Hz}$$

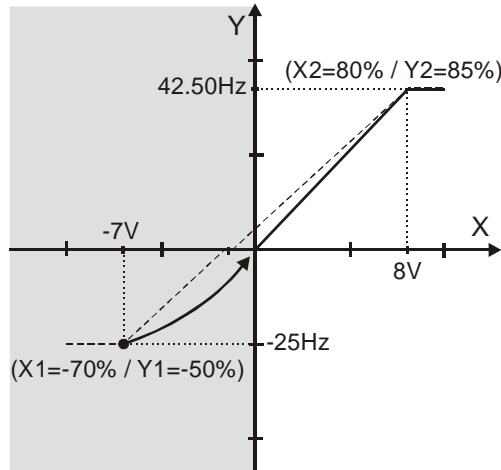
Tolerance band:

$$\Delta X = 2.00\% \cdot 10 \text{ V} = 0.20 \text{ V}$$

The change of direction of rotation is done in the example at an analog input signal of -1.44 V, with a tolerance band of $\pm 0.20 \text{ V}$.

Operation mode "11 – unipolar"

In operation mode "11 – unipolar", the characteristic points are displaced to the origin of the characteristics with a negative value for the X-axis.



Characteristic point 1:

$$X1 = -70.00\% \cdot 10 \text{ V} = -7.00 \text{ V}$$

$$Y1 = -50.00\% \cdot 50.00 \text{ Hz} = -25.00 \text{ Hz}$$

Characteristic point 2:

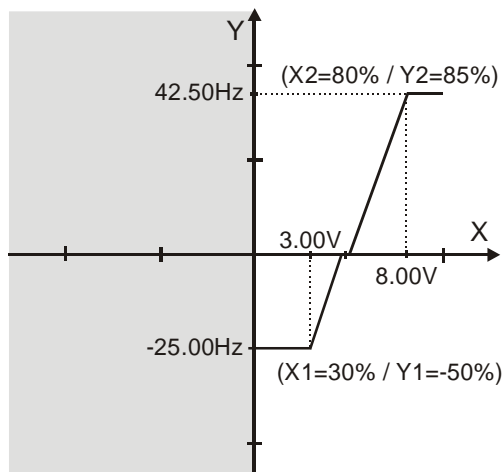
$$X2 = 80.00\% \cdot 10 \text{ V} = 8.00 \text{ V}$$

$$Y2 = 85.00\% \cdot 50.00 \text{ Hz} = 42.50 \text{ Hz}$$

Tolerance band:

$$\Delta X = 2.00\% \cdot 10 \text{ V} = 0.20 \text{ V}$$

The characteristic point 1 has been displaced to the origin. The parameter *Tolerance band* 560 is not taken into account in this example, as no change of sign of the reference frequency value takes place.



Characteristic point 1:

$$X1 = 30.00\% \cdot 10 \text{ V} = 3.00 \text{ V}$$

$$Y1 = -50.00\% \cdot 50.00 \text{ Hz} = -25.00 \text{ Hz}$$

Characteristic point 2:

$$X2 = 80.00\% \cdot 10 \text{ V} = 8.00 \text{ V}$$

$$Y2 = 85.00\% \cdot 50.00 \text{ Hz} = 42.50 \text{ Hz}$$

Tolerance band:

$$\Delta X = 2.00\% \cdot 10 \text{ V} = 0.20 \text{ V}$$

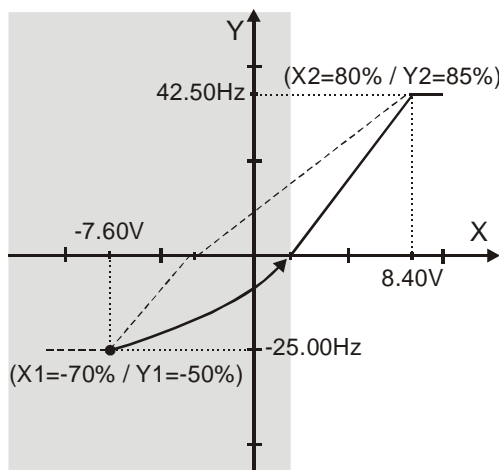
The change of direction of rotation is done in the example at an analog input signal of 4.85 V, with a tolerance band of $\pm 0.20 \text{ V}$.

Operation mode "21 – unipolar 2...10 V / 4...20 mA"

This operation mode limits the input characteristic to the range between 20% and 100% of the analog signal. If the value for a characteristic point of the X-axis is outside 0%, it is mapped to the characteristic point (2 V / 0 Hz).

The characteristic point on the X-axis is calculated according to the following formula:

$$\text{characteristic point } X = \text{parameter value } X \cdot (100.00\% - 20.00\%) + 20.00\%$$



Characteristic point 1:

$$\begin{aligned} X1 &= [-70.00\% \cdot (100.00\% - 20.00\%) \\ &\quad + 20.00\%] \cdot 10 \text{ V} = -7.60 \text{ V} \\ Y1 &= -50.00\% \cdot 50.00 \text{ Hz} = -25.00 \text{ Hz} \end{aligned}$$

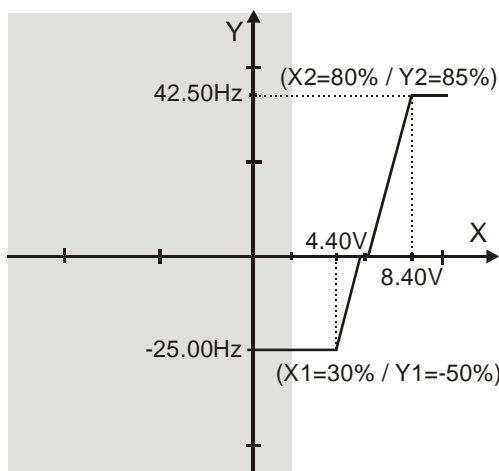
Characteristic point 2:

$$\begin{aligned} X2 &= [80.00\% \cdot (100.00\% - 20.00\%) \\ &\quad + 20.00\%] \cdot 10 \text{ V} = 8.40 \text{ V} \\ Y2 &= 85.00\% \cdot 50.00 \text{ Hz} = 42.50 \text{ Hz} \end{aligned}$$

Tolerance band:

$$\begin{aligned} \Delta X &= [2.00\% \cdot (100.00\% - 20.00\%) \\ &\quad \cdot 10 \text{ V}] = 0.16 \text{ V} \end{aligned}$$

The characteristic point 1 has been displaced to the point (2.00 V / 0.00 Hz). The parameter *Tolerance band 560* is not used in this example, as no change of sign of the reference frequency value takes place.



Characteristic point 1:

$$\begin{aligned} X1 &= [30.00\% \cdot (100.00\% - 20.00\%) \\ &\quad + 20.00\%] \cdot 10 \text{ V} = 4.40 \text{ V} \\ Y1 &= -50.00\% \cdot 50.00 \text{ Hz} = -25.00 \text{ Hz} \end{aligned}$$

Characteristic point 2:

$$\begin{aligned} X2 &= [80.00\% \cdot (100.00\% - 20.00\%) \\ &\quad + 20.00\%] \cdot 10 \text{ V} = 8.40 \text{ V} \\ Y2 &= 85.00\% \cdot 50.00 \text{ Hz} = 42.50 \text{ Hz} \end{aligned}$$

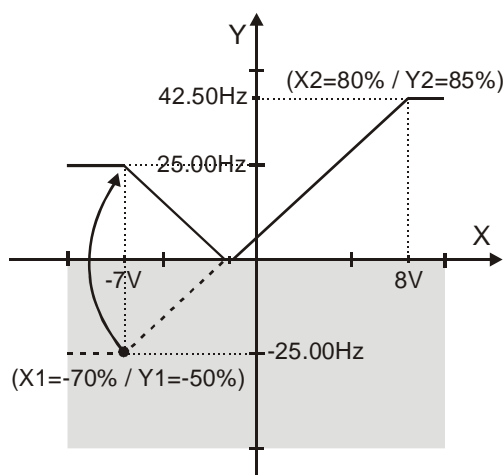
Tolerance band:

$$\begin{aligned} \Delta X &= [2.00\% \cdot (100.00\% - 20.00\%) \\ &\quad \cdot 10 \text{ V}] = 0.16 \text{ V} \end{aligned}$$

The change of direction of rotation is done in the example at an analog input signal of 5.88 V, with a tolerance band of $\pm 0.16 \text{ V}$.

Operation mode "101 – bipolar absolute value"

The operation mode "101 – bipolar absolute value" maps the bipolar analog signal onto a unipolar input characteristic. The formation of the absolute amount takes the characteristic into account comparable to the "bipolar" operation mode, but the characteristic points are reflected on the X-axis with a negative value for the Y-axis.



Characteristic point 1:

$$X1 = -70.00\% \cdot 10 \text{ V} = -7.00 \text{ V}$$

$$Y1 = -50.00\% \cdot 50.00 \text{ Hz} = -25.00 \text{ Hz}$$

Characteristic point 2:

$$X2 = 80.00\% \cdot 10 \text{ V} = 8.00 \text{ V}$$

$$Y2 = 85.00\% \cdot 50.00 \text{ Hz} = 42.50 \text{ Hz}$$

Tolerance band:

$$\Delta X = 2.00\% \cdot 10 \text{ V} = 0.20 \text{ V}$$

In this example, the reference value is again increased from an analog input signal of -1.44 V with a tolerance band of $\pm 0.20 \text{ V}$. The theoretical change of sign of the reference value is used and leads to the tolerance band stated.

There is no change of the direction of rotation.

6.1.4 Scaling

The analog input signal is mapped to the freely configurable characteristic. The maximum admissible setting range of the drive mechanism is to be set according to the configuration selected via the frequency limits or the percentage value limits. In the parameterization of a bipolar characteristic, the minimum and maximum limits for both directions of rotation are taken over. The percentage values of the characteristic points are relative to the maximum limits selected.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
418	Minimum Frequency	0.00 Hz	999.99 Hz	3.50 Hz
419	Maximum Frequency	0.00 Hz	999.99 Hz	50.00 Hz

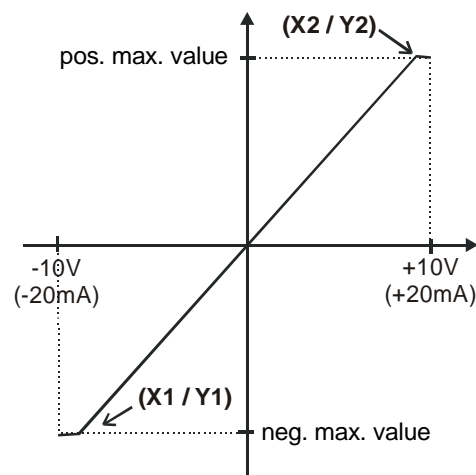
The controls use the maximum value of the output frequency, which is calculated from the *Maximum Frequency* **419** and the compensated slip of the drive mechanism. The frequency limits define the speed range of the drive mechanism and the reference percentage values supplement the scaling of the input characteristic according to the configured functions.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
518	Minimum Reference Percentage	0.00%	300.00%	0.00%
519	Maximum Reference Percentage	0.00%	300.00%	100.00%

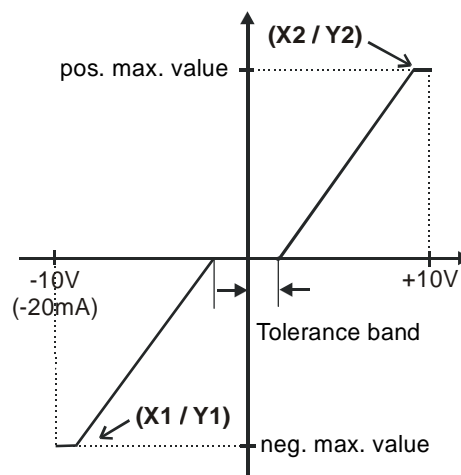
6.1.5 Tolerance band and hysteresis

The analog input characteristic with change of sign of the reference value can be adapted by the parameter *Tolerance band* 560 of the application. The tolerance band to be defined extends the zero crossing of the speed relative to the analog control signal. The percentage parameter value is relative to the maximum current or voltage signal.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
560	Tolerance band	0.00%	25.00%	2.00%

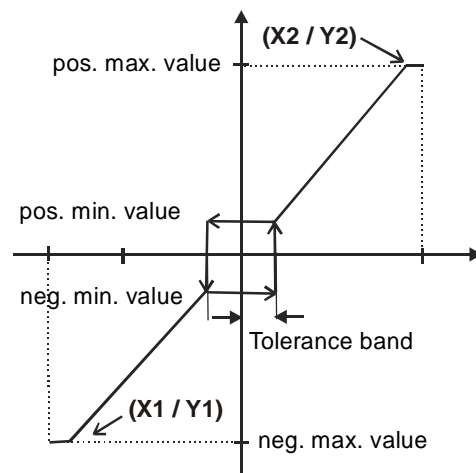


Without tolerance band



With tolerance band

The *Minimum Frequency* 418 or the *Minimum Reference Percentage* 518 set in the factory extends the parameterized tolerance band to the hysteresis.



With tolerance band and minimum value

For example, the output variable resulting from the positive input signals is kept at the positive minimum value until the input signal is below the value for the tolerance band in a negative direction. After that proceed on the set characteristic.

6.1.6 Error and warning behavior

The monitoring of the analog input signal necessary according to the application is to be configured via the parameter *Error/Warning Behavior 563*.

<i>Error/Warning Behavior 563</i>	Function
0 - Off	The input signal is not monitored. Factory setting.
1 - Warning < 1 V/2 mA	If the input signal is less than 1 V, there is a warning message.
2 - Shutdown < 1 V/2 mA	If the input signal is less than 1 V, there is a warning message, the drive mechanism is decelerated according to stopping behavior 1.
3 - Error switch-off < 1 V/2 mA	If the input signal is less than 1 V, there is a warning and fault message and the drive mechanism stops freely.

The monitoring of the analog input signal is active independent of the release of the frequency inverter according to the operation mode selected.

In operation mode **2**, the drive mechanism is decelerated independent of the stopping behavior set (Parameter *Operation Mode 630*) according to stopping behavior 1 (shutdown and switch-off). If the set holding time has expired, there is a fault message. A repeat start of the drive mechanism is possible by switching the start signal on and off if the fault has been cleared.

Operation mode **3** defines the free stoppage of the drive mechanism, independent of the stopping behavior selected, which is stipulated with the parameter *Stop function 630*.

Attention! Monitoring of the analog input signal via the parameter *Error/Warning Behavior 563* demands a check of the characteristic parameters.

6.1.7 Adjustment

As a result of component tolerances, it can be necessary to adjust the analog input. Parameter *Adjustment 568* is used for this purpose.

<i>Adjustment 568</i>	Function
0 - no adjustment	Normal operation. Factory setting.
1 - Adjustment 0 V	Adjustment of the measurement with an analog signal of 0 V.
2 - Adjustment 10 V	Adjustment of the measurement with an analog signal of 10 V.

Example of the adjustment of the analog input with a voltage signal:

Note: The measurements for the adjustment are to be done with a suitable measuring instrument and the correct polarity.
If not, faulty measurements can result.

- Apply 0 V to the analog input; e.g. with a wired link from the socket of the analog input X410A.6 to socket X210B.7 (GND) of the frequency inverter.
- Select operation mode "1 - Adjustment 0 V".
- Apply 10 V to the analog input, e.g. with a wired link from the socket of the analog input to socket X210B.5 (reference output 10 V) of the frequency inverter.
- Select operation mode "2 - Adjustment 10 V".

6.1.8 Filter time constant

The time constant of the filter for the reference analog value can be set via the parameter *Filter time constant 561*.

The time constant states the time for which the input signal is averaged by means of a low pass filter, e.g. in order to eliminate fault effects.

The setting range is a range of values between 0 ms and 5000 ms in 15 steps.

<i>Filter time constant 561</i>	Function
0 - Time constant 0 ms	Filter deactivated – analog reference value is forwarded unfiltered
2 - Time constant 2 ms	
4 - Time constant 4 ms	
8 - Time constant 8 ms	
16 - Time constant 16 ms	
32 - Time constant 32 ms	
64 - Time constant 64 ms	
128 - Time constant 128 ms	
256 - Time constant 256 ms	
512 - Time constant 512 ms	
1000 - Time constant 1000 ms	
2000 - Time constant 2000 ms	
3000 - Time constant 3000 ms	
4000 - Time constant 4000 ms	
5000 - Time constant 5000 ms	

6.2 Digital outputs EM-S1OUTD and EM-S2OUTD

6.2.1 General

Parameterization of this digital output permits a linking to a variety of functions. The selection of functions depends on the parameterized configuration.

6.2.2 Operation modes

The operation mode of the digital output EM-S1OUTD (terminal X410A.3) is selected via the parameter *Op. Mode EM-S1OUTD 533*. The factory setting of this parameter is "41 - Brake release".

The operation mode of the digital output EM-S2OUTD (terminal X410A.4) is selected via the parameter *Op. Mode EM-S2OUTD 534*. The factory setting of this parameter is "0 - off".

The operation modes to be selected correspond to the table shown in the operating instructions of the frequency inverter in the chapter "Digital outputs".

6.2.3 Repetition frequency output via EM-S1OUTD and EM-S2OUTD

The digital outputs EM-S1OUTD and EM-S2OUTD can be used as repetition frequency output. The output value at the repetition frequency output corresponds to the mechanical frequency of the connected encoder.

The digital outputs EM-S1OUTD and EM-S2OUTD can be set as repetition frequency output via parameter *Repetition Frequency EM-S1/S2OUTD 509*.

Operation modes for P. 509	Function
0 - Off	Repetition frequency output is switched off. Factory setting.
2 - On, division marks = P. 1183/2	Repetition frequency output via digital outputs EM-S1OUTD and EM-S2OUTD is switched on. The division marks of Repetition frequency output is $\frac{1}{2}$ of encoder division marks (set via <i>Division Marks 1183</i> , refer to chapter 6.4.1).

6.3 Digital inputs EM-SxIND

The EM-SinCos-01 expansion module has three digital inputs. The assignment of the control signals to the available software functions can be adapted to the application in question. As a function of the selected *Configuration 30*, the factory-set assignment and the selection of the operation mode differ. In addition to the digital control inputs available, further internal signals are also available as sources.

The individual software functions are assigned to the various signal sources via parameterization-capable inputs. This enables a flexible and varied use of the digital control signals.

Operation mode	Function
320 - EM-S1IND	Signal on digital input 1 (X410B.2)
321 - EM-S2IND	Signal on digital input 2 (X410B.3)
322 - EM-S3IND	Signal on digital input 3 (X410B.4)
520 - EM-S1IND inverted	Inverted signal on digital input 1 (X410B.2)
521 - EM-S2IND inverted	Inverted signal on digital input 2 (X410B.3)
522 - EM-S3IND inverted	Inverted signal on digital input 3 (X410B.4)

Additional to the listed operation modes, those listed in the operating instructions of the frequency inverter in the chapter "Digital inputs" also apply.

6.3.1 Fixed reference values and fixed value switch-over

Depending on the *Reference Frequency Source 475* selected, fixed frequencies can be used as reference values. The expansion module extends the functionality described in the operating instructions of the frequency inverter (parameter *Fixed frequency change-over 1 66* and *Fixed frequency change-over 2 67*) by the parameter *Fixed frequency change-over 3 131* and the matching parameters *Fixed frequency 5 485*, *Fixed frequency 6 486*, *Fixed frequency 7 487*, *Fixed frequency 8 488*.

	<i>Fixed frequency change-over 1 66</i>	<i>Fixed frequency change-over 2 67</i>	<i>Fixed frequency change-over 3 131</i>
<i>Fixed frequency 1 480</i>	0	0	0
<i>Fixed frequency 2 481</i>	1	0	0
<i>Fixed frequency 3 482</i>	1	1	0
<i>Fixed frequency 4 483</i>	0	1	0
<i>Fixed frequency 5 485</i>	0	1	1
<i>Fixed frequency 6 486</i>	1	1	1
<i>Fixed frequency 7 487</i>	1	0	1
<i>Fixed frequency 8 488</i>	0	0	1

6.4 Encoder input EM-SinCos

The encoder input is used for evaluating the position information from the encoder.

6.4.1 Division Marks

Via Parameter *Division Marks* **1183** the encoder type-dependent number of division marks can be set.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
1183	Division Marks	0	8192	1024

6.4.2 Track signals

Via Parameter *Track signals* **1184** the encoder type-dependent number of analog track signals and the evaluation of a reference track can be set.

<i>Track signals 1184</i>	Function
0 - Off	Evaluation is switched off. Factory setting.
1 - A/B	Evaluation of analog track signals A and B.
3 - A/B, C/D	Evaluation of analog track signals A and B and commutating track signals C and D.
5 - A/B, R	Evaluation of analog track signals A and B as well as reference track R. Monitoring and adjustment of track signals.
7 - A/B, C/D, R	Evaluation of analog track signals A/B and commutating track signals C/D as well as reference track R. Monitoring and adjustment of track signals.

6.4.3 Voltage supply

Via parameter *Voltage supply* **1186** the voltage source for encoder voltage supply can be selected.

Depending on the power requirement of the encoder an external voltage supply can be connected at terminals X410A.1 and X410A.2 (refer to chapter 4.3.3 "External voltage supply"). In this case the parameter *Voltage supply* **1186** must be set to "2 – External" or "6 – External, Sense".

The operation modes with sense measuring line (*Voltage supply* **1186** = "5 - Internal, Sense" or "6 – External, Sense") enable the control of encoder supply voltage. In these settings the encoder supply voltage is corrected if the encoder supply voltage deviates from the adjusted value. The voltage is measured at the end of the supply cable (at the SinCos-encoder) and controlled. In the operation modes 1 and 2 the voltage at the SinCos-module is controlled, voltage loss during energy transmission via supply cable is not corrected.

The SinCos-encoder can be supplied with voltage:

- via control terminals X410A.5 (0 ... 10 VDC) and X410A.7 (GND) or
- via HD-Sub-D socket contacts X412.6 (V_{Enc}) and X412.15 (0VL)

Refer to chapters 4.3.2 "Control terminals" and 4.3.3 "External voltage supply".

<i>Voltage supply</i> 1186	
0 - Off	Voltage supply for encoder not selected. Factory setting.
1 - Internal	Voltage supply for encoder <ul style="list-style-type: none"> – at terminals X410A.5 (0 ... 10 VDC) and X410A.7 (GND) – at contacts X412.6 (V_{Enc}: 0 ... 10 VDC) and X412.15 (0VL). The source for voltage supply is internally provided by the frequency inverter.
2 - External	Voltage supply for encoder <ul style="list-style-type: none"> – at terminals X410A.5 (0 ... 10 VDC) and X410A.7 (GND) – at contacts X412.6 (V_{Enc}: 0 ... 10 VDC) and X412.15 (0VL). The source for voltage supply is provided by the supply connected at terminals X410A.1 (24 VDC) and X410A.2 (GND).
5 - Internal, Sense	Voltage supply for encoder <ul style="list-style-type: none"> – at terminals X410A.5 (0 ... 10 VDC) and X410A.7 (GND) – at contacts X412.6 (V_{Enc}: 0 ... 10 VDC) and X412.15 (0VL). The source for voltage supply is internally provided by the frequency inverter. The sense measuring line of the encoder for voltage monitoring must be connected.
6 - External, Sense	Voltage supply for encoder <ul style="list-style-type: none"> – at terminals X410A.5 (0 ... 10 VDC) and X410A.7 (GND) – at contacts X412.6 (V_{Enc}: 0 ... 10 VDC) and X412.15 (0VL). The source for voltage supply is provided by the supply connected at terminals X410A.1 (24 VDC) and X410A.2 (GND). The sense measuring line of the encoder for voltage monitoring must be connected.

Note:

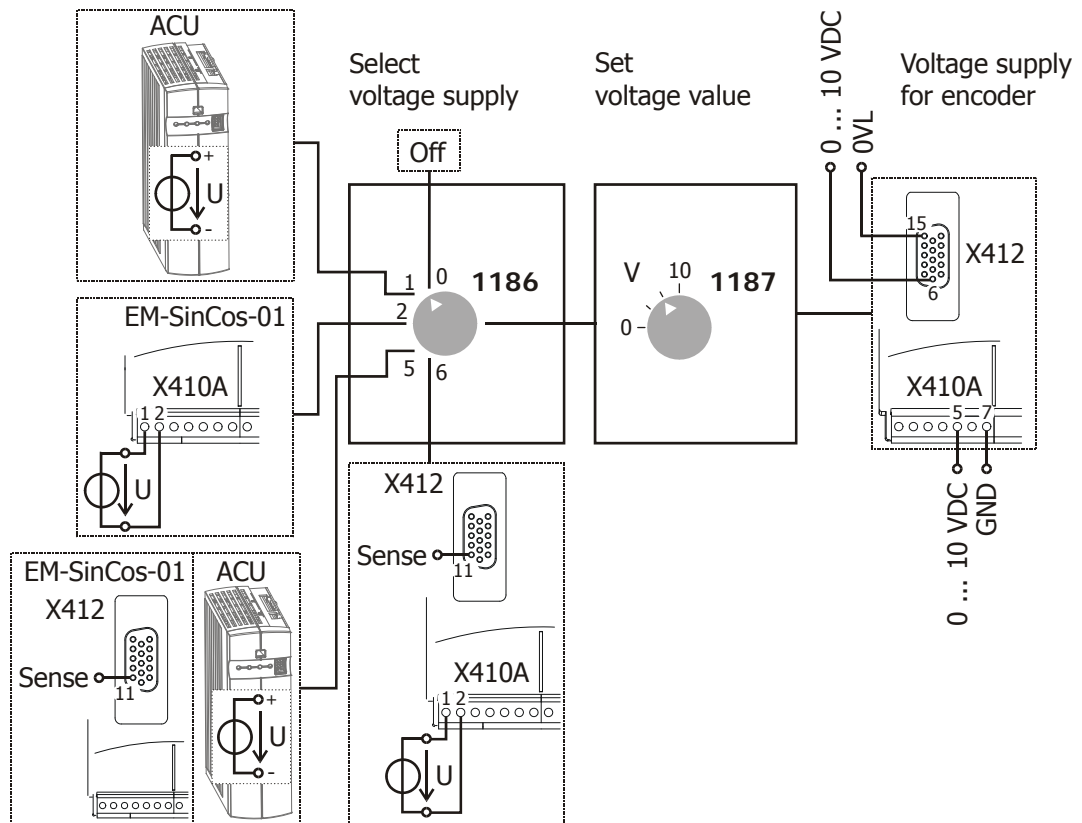
Even if the SinCos-encoder is equipped with a sense measuring line the operation mode 1 or 2 can be selected.

The voltage value can be set via parameter *Supply voltage* **1187**. Refer to chapter 6.4.4 "Supply voltage".

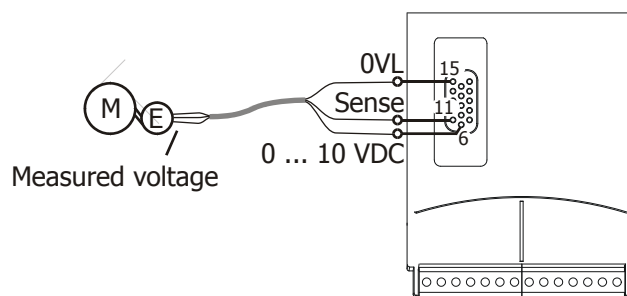
Note:

BONFIGLIOLI VECTRON recommends the connection of an external voltage supply to the voltage input. This provides an auxiliary voltage for the encoder voltage supply. Comply with the power requirement of the encoder according to the manufacturer's data.

Selection of source for encoder voltage supply and voltage value setting



Sense measuring line: constant voltage value at the SinCos-encoder



E: SinCos-encoder

The encoder supply voltage is measured at the SinCos-encoder and keeps constant to the set value of *Supply voltage* **1187** (0 ... 10 VDC).

6.4.4 Supply voltage

Via Parameter *Supply voltage* **1187** the voltage value for the encoder voltage supply can be set.

The SinCos-encoder can be supplied with voltage:

- via control terminals X410A.5 (0 ... 10 VDC) and X410A.7 (GND) or
- via HD-Sub-D socket contacts X412.6 (V_{Enc}) and X412.15 (OVL)

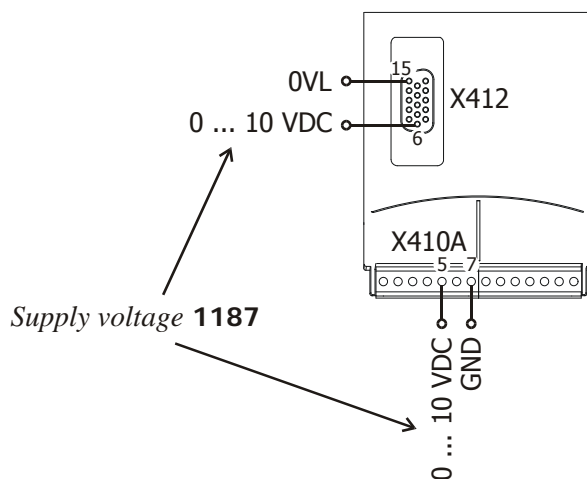
The setting of the parameter becomes effective on the terminals and on the HD-Sub-D socket contacts.



Caution!

Comply with the manufacturer specifications for supply voltage of the used encoder. Non-compliance may result in encoder damage.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
1187	Supply voltage	0.0 V	10.0 V	5.0 V



6.4.5 Speed filter

Via Parameter *Speed filter* **1189** high frequencies of the encoder signals can be filtered and control bandwidth reduced.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
1189	Speed filter	125 μ s	8000 μ s	125 μ s

6.4.6 Offset

In order to enable the start of a synchronous machine, the absolute position of the rotor must be known. This information is required in order to actuate the stator windings in the right order depending on the position of the rotor. The position of the rotary field in the synchronous machine must be controlled in order to obtain a continuous movement of the rotor. During first commissioning, the position of the rotor winding of the encoder is adjusted to the rotor displacement angle of the synchronous motor by adjusting the offset. For operating a synchronous machine with encoder, the offset must be adjusted in order to obtain perfectly true running and a maximum torque. The correct *Offset* **1188** is adjusted when the *Flux-Forming Voltage* **235** reaches the value 0 (approximately) while the motor is turning.

Parameter		Setting		
No.	Description	Min.	Max.	Fact. sett.
1188	Offset	-360.0°	360.0°	0.0°

The offset can be determined and adjusted as follows:

- During first commissioning "SETUP" will be displayed in the control unit. Press ESC to stop this operation. The guided commissioning („SETUP") is performed after adjusting the offset.
- Open the parameter menu "PARA" and enter the machine data indicated on the type plate or the data sheet of the motor.

Before adjusting the offset, take the following **safety precautions**:

- Disable the frequency inverter via the digital inputs for controller release.
- If possible, uncouple the motor from the load so that the motor shaft turns freely. If installed, release the mechanical brake.
If uncoupling is not possible, make sure that the motor is loaded as little as possible.



Warning! In certain circumstances, the motor speed may reach high values. If the motor is not uncoupled from the load, personal injury and material damage may result. To avoid this, make the following settings in any case.

- Set the maximum permissible output frequency of the frequency inverter to a low frequency value via parameter *Switch-Off Limit* **417**. Select the frequency value such that uncontrolled acceleration of the motor ("overspeeding") is detected at an early stage. This limitation is necessary in order to avoid personal injury and material damage.
- Set parameter *Current Limit* **728** of the speed controller to a low current value (e.g. 10% of the rated motor current). In this way it is made sure that there are no excessive currents of the offset is set incorrectly.
- Turn motor shaft manually. Check the sense of rotation of the encoder via the actual value of parameter *Encoder 2 Frequency* **219**. In the case of a clock-wise rotation of the motor shaft, positive values are displayed for the actual frequency value. If the displayed sense of rotation does not correspond to the actual sense of rotation, change the connections of tracks A and B.

The *Offset* **1188** must be between 0° and 360°, divided by the number of motor pole pairs. The possible range is between 0° and the maximum offset.

$$\text{Max. Offset} = \frac{360^\circ}{\text{number of motor pole pairs}}$$

If the adjusted value is changed by the maximum offset, this does not affect the *Flux-Forming Voltage* **235**.

- Adjust a low reference speed value (approx. 10% lower than the *Frequency Switch-off Limit* **417**), and enable the frequency inverter via controller release and S2IND (start clock-wise operation) in order to accelerate the motor.
- If an overcurrent is detected or a fault message is issued due to an overload, the guided commissioning (setup) will start first. Confirm the machine data. After completion of the guided commissioning, adjust the parameter *Current Limit* **728** to a low value again because this value was overwritten during the guided commissioning.

Depending on the behavior of the motor after start, carry out the following steps:

- **Motor does not turn, or the motor shaft only turns to a new position and stops again:**
 - Check if the parameter *No. of Pole Pairs* **373** of the motor is set correctly.

If this value is adjusted correctly, take the following measures complying with the safety instructions.



Warning! The mains, direct voltage and motor sockets can be live with dangerous voltage after disconnection of the frequency inverter. Work only on the device after a waiting period of some minutes until the DC link capacitors have discharged.

- Before electrical installation work, de-energize the frequency inverter and take appropriate precautions to make sure it is not re-energized unintentionally. Make sure that the frequency inverter is de-energized.
- Exchange two motor phases (e.g. U and V) at the frequency inverter sockets because the senses of rotation of the motor and the encoder do not correspond to each other.
- Switch on the power supply again.
- As described above, adjust a low speed reference value and start the motor.

If the motor does not start despite the phase exchange:

- Increase the parameter value for *Offset 1188* by 90°, divided by the number of motor pole pairs.

If the motor still does not turn, exchange the two motor phases (e.g. U and V) again.

- **The motor turns and accelerates until it reaches the *Frequency Switch-off Limit 417*:**
 - Check the encoder lines and check the encoder connection contacts.
 - In the case of fault message "Overfrequency" F1100: increase the parameter value for *Offset 1188* by 180°, divided by the number of motor pole pairs.
- **If the motor turns at the adjusted speed and in the right direction, carry out the fine adjustment of the offset:**
 - Adjust the parameter value for *Offset 1188* in small steps (e.g. 2.5°) until the *Flux-Forming Voltage 235* is approximately 0.
 - In case the flux-forming voltage deviates from 0 significantly, adjust the offset in bigger steps.
 - In the case of a positive flux-forming voltage, increase the offset.
 - In the case of a negative flux-forming voltage, reduce the offset.
 - Adjust parameters *Frequency Switch-off Limit 417* and *Current Limit 728* to the required values.
 - Repeat the **fine adjustment** of the offset at 50% of the rated frequency.

This completes the offset adjustment.

- Start the guided commissioning. This is required for optimum current control.

6.4.7 Actual speed source

The encoder can be selected via *Actual Speed Source 766*. If the encoder provides the actual value signal for the speed controller, speed sensor 2 must be selected as the source. In the factory setting, speed sensor 1 is used as the actual value source.

<i>Actual Speed Source 766</i>	Function
1 - Speed sensor 1	The actual speed source is speed sensor (encoder) 1 of the basic device (factory setting).
2 - Speed sensor 2	The actual speed source is speed sensor (encoder) 2 of the EM-SinCos-01 expansion module.

6.5 Frequency and percentage reference channel

The varied functions for the specification of the reference values are connected in the various configurations by the frequency or percentage reference channel. The *Reference frequency source 475*, and the *Reference percentage source 476* determine the additive connection of the available reference sources as a function of the installed hardware.

Operation mode	Function
2 - Abs. Analog Value EM-S1INA	Reference source is the analog input EM-S1INA of the expansion module.
4 - Abs. Value MFI1A + EM-S1INA	Reference sources are the multifunctional input MFI1A of the frequency inverter and the analog input EM-S1INA of the expansion module.
14 - Abs. Value MFI1A + EM-S1INA + FP (or FF)	Reference sources are the multifunctional input MFI1A, analog input EM-S1INA and fixed percentage FP (or fixed frequency FF).
24 - Abs. Value MFI1A + EM-S1INA + MP	Reference sources are the multifunctional input MFI1A, analog input EM-S1INA and the motor potentiometer function MP.
102 to 124	Operation modes with signs (+/-).

Additional to the operation modes listed, those stated in the operating instructions of the frequency inverter in the chapter "Frequency reference channel", and in the chapter "Percentage reference channel" also apply.

6.6 Actual value display

The actual value of speed sensor 2 can be read via the parameters *Encoder 2 Frequency 219* and *Encoder 2 Speed 220*.

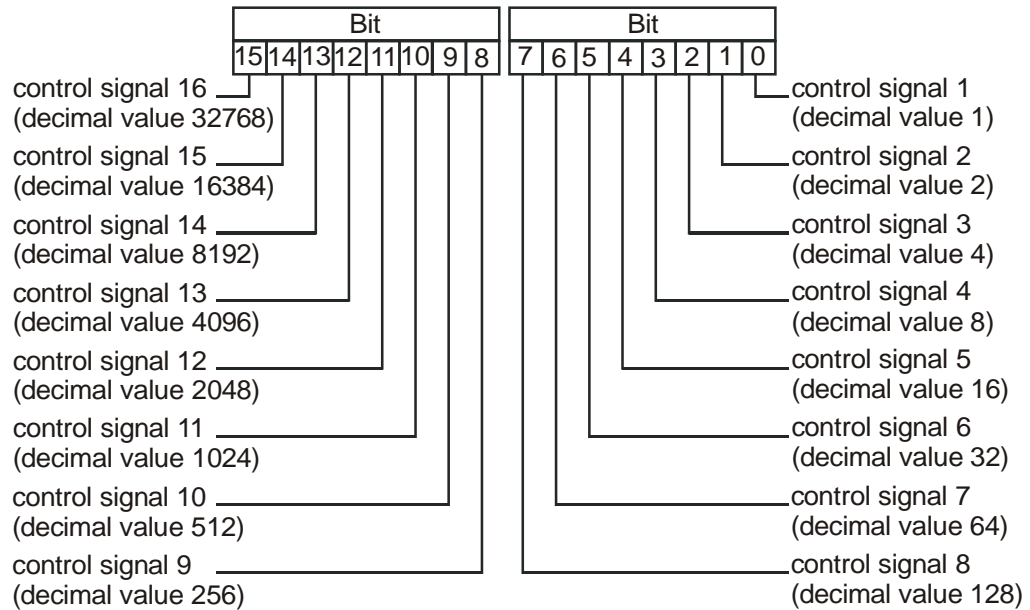
The analog input signal on analog input EM-S1INA is displayed via the actual value parameter *Analog input EM-S1INA 253*.

6.7 Status of the digital signals

The status of the digital signals can be read in decimal coding via the parameters *Digital inputs* **250** and *Digital outputs* **254**. The display of the digital input signals enables checking the various control signals and their connections with the software functions in question, in particular in commissioning.

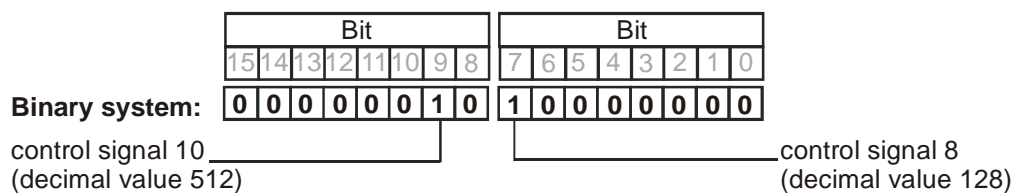
After conversion of the decimal figure into the binary system, bits 8, 9 and 10 display the states of the inputs EM-S1IND, EM-S2IND and EM-S3IND.

Coding of the status of the digital signals



Example:

The actual value parameter *Digital inputs* **250** displays the decimal value **640**. After conversion into the binary system, the following combination results:



The following status of the digital input signals of the expansion module has been displayed:

- Digital input EM-S1IND = 1 – control signal 8
- Digital input EM-S2IND = 0 – control signal 9
- Digital input EM-S3IND = 1 – control signal 10

6.8 Motor temperature

Temperature monitoring forms part of the configurable error- and warning behavior. The connected load can be monitored by connecting a measuring resistor (motor PTC) with temperature characteristics according to DIN 44081 or by means of a bimetal temperature sensor (break contact).

The operation mode of the motor ptc port can be selected via parameter *Motor Temp. Operation Mode 570*. The operation modes described in chapter "Motor Temperature" of the frequency inverter operating instructions are complemented by the following operation modes with the expansion module:

Operation mode	Function
11 - EM-MPTC: Warning only	The critical operating point is displayed by the control unit and parameter <i>Warnings 269</i> .
12 - EM-MPTC: Error Switch-Off	Error-switch-off is displayed by message F0400. Error-switch-off can be acknowledged via the control unit or the digital input.
13 - EM-MPTC: Err.Switch-Off 1 min delayed	Error-switch-off according to operation mode 2, delayed by one minute.
14 - EM-MPTC: Err.Switch-Off 5 min delayed	Error-switch-off according to operation mode 2, delayed by five minutes.
15 - EM-MPTC: Err.Switch-Off 10 min delayed	Error-switch-off according to operation mode 2, delayed by ten minutes.




The function to be adjusted by parameter *Motor Temp. Operation Mode 570* results in signaling the overtemperature by the red LED of the frequency inverter, irrespective of the selected operation modes of the control inputs and outputs.

The operation modes with error-switch-off result in the fault message "FAULT" with fault number "F0400" being displayed on the control unit KP500.

The fault message can be acknowledged via parameter *Program 34* or the logic signal linked with parameter *Error Acknowledgement 103*.

7 Parameter list







The parameter list is structured according to the menu branches of the control unit. For better clarity, the parameters are marked with pictograms:

-  The parameter is available in the four data sets
-  The parameter value is adjusted by the SETUP routine if a control method for a synchronous machine is selected for parameter *Configuration 30*.
-  This parameter cannot be written in the operation of the frequency inverter

7.1 Actual value menu (VAL)

Actual values of the machine				
No.	Description	Unit	Display range	Chapter
219	Encoder 2 Frequency	Hz	0.0 ... 999.99	6.6
220	Encoder 2 Speed	rpm	0 ... 60000	6.6
Actual values of the frequency inverter				
253	Analog input EM-S1INA	V	-10 ... +10	6.6

7.2 Parameter menu (PARA)

No.	Description	Unit	Setting range	Chapter
Repetition frequency output				
509	Repetition Frequency EM-S1/S2OUTD	-	Selection	6.2.3
Digital outputs				
533	Op. Mode EM-S1OUTD	-	Selection	6.2.2
534	Op. Mode EM-S2OUTD	-	Selection	6.2.2
Analog input				
 560	Tolerance band	%	0.00 ... 25.00	6.1.5
561	Filter time constant	-	Selection	6.1.8
562	Operation mode	-	Selection	6.1.3
563	Error/warning Behavior	-	Selection	6.1.6
 564	Point X1	%	-100.00 ... 100.00	6.1.2
 565	Point Y1	%	-100.00 ... 100.00	6.1.2
 566	Point X2	%	-100.00 ... 100.00	6.1.2
 567	Point Y2	%	-100.00 ... 100.00	6.1.2
568	Adjustment	-	Selection	6.1.7
Speed controller				
 766	Actual speed source	-	Selection	6.4.7
System bus				
900	Node-ID	-	-1 ... 63	5.5
903	Baud-Rate	-	Selection	5.4
904	Boot-Up Delay	ms	3500 ... 50000	5.8.4
918	SYNC-Identifier	-	0 ... 2047	5.8.2
919	SYNC-Time	ms	0 ... 50000	5.9.2
921	RxSDO1-Identifier	-	0 ... 2047	5.9.4
922	TxSDO1-Identifier	-	0 ... 2047	5.9.4
923	SDO2 Set Active	-	Selection	5.9.4
924	RxPDO1-Identifier	-	0 ... 2047	5.11.1
925	TxPDO1-Identifier	-	0 ... 2047	5.11.1
926	RxPDO2-Identifier	-	0 ... 2047	5.11.1
927	TxPDO2-Identifier	-	0 ... 2047	5.11.1
928	RxPDO3-Identifier	-	0 ... 2047	5.11.1

No.	Description	Unit	Setting range	Chapter
929	TxPDO3-Identifier	-	0 ... 2047	5.11.1
930	TxPDO1 Function	-	Selection	5.11.2
931	TxPDO1 Time	ms	0 ... 50000	5.11.2
932	TxPDO2 Function	-	Selection	5.11.2
933	TxPDO2 Time	ms	0 ... 50000	5.11.2
934	TxPDO3 Function	-	Selection	5.11.2
935	TxPDO3 Time	ms	0 ... 50000	5.11.2
936	RxPDO1 Function	-	Selection	5.11.2
937	RxPDO2 Function	-	Selection	5.11.2
938	RxPDO3 Function	-	Selection	5.11.2
939	SYNC Timeout	ms	0 ... 60000	5.11.3
941	RxPDO1 Timeout	ms	0 ... 60000	5.11.3
942	RxPDO2 Timeout	ms	0 ... 60000	5.11.3
945	RxPDO3 Timeout	ms	0 ... 60000	5.11.3
946	TxPDO1 Boolean1	-	Selection	5.11.5.1
947	TxPDO1 Boolean2	-	Selection	5.11.5.1
948	TxPDO1 Boolean3	-	Selection	5.11.5.1
949	TxPDO1 Boolean4	-	Selection	5.11.5.1
950	TxPDO1 Word1	-	Selection	5.11.5.1
951	TxPDO1 Word2	-	Selection	5.11.5.1
952	TxPDO1 Word3	-	Selection	5.11.5.1
953	TxPDO1 Word4	-	Selection	5.11.5.1
954	TxPDO1 Long1	-	Selection	5.11.5.1
955	TxPDO1 Long2	-	Selection	5.11.5.1
956	TxPDO2 Boolean1	-	Selection	5.11.5.1
957	TxPDO2 Boolean2	-	Selection	5.11.5.1
958	TxPDO2 Boolean3	-	Selection	5.11.5.1
959	TxPDO2 Boolean4	-	Selection	5.11.5.1
960	TxPDO2 Word1	-	Selection	5.11.5.1
961	TxPDO2 Word2	-	Selection	5.11.5.1
962	TxPDO2 Word3	-	Selection	5.11.5.1
963	TxPDO2 Word4	-	Selection	5.11.5.1
964	TxPDO2 Long1	-	Selection	5.11.5.1
965	TxPDO2 Long2	-	Selection	5.11.5.1
966	TxPDO3 Boolean1	-	Selection	5.11.5.1
967	TxPDO3 Boolean2	-	Selection	5.11.5.1
968	TxPDO3 Boolean3	-	Selection	5.11.5.1
969	TxPDO3 Boolean4	-	Selection	5.11.5.1
972	TxPDO3 Word1	-	Selection	5.11.5.1
973	TxPDO3 Word2	-	Selection	5.11.5.1
974	TxPDO3 Word3	-	Selection	5.11.5.1
975	TxPDO3 Word4	-	Selection	5.11.5.1
976	TxPDO3 Long1	-	Selection	5.11.5.1
977	TxPDO3 Long2	-	Selection	5.11.5.1
989	Emergency Reaction	-	Selection	5.8.3
SinCos-encoder				
1183	Division Marks	-	0 ... 8192	6.4.1
1184	Track signals	-	Selection	6.4.2
1186	Voltage supply	-	Selection	6.4.3
1187	Supply voltage	V	0.00 ... 10.0	6.4.4
1188	Offset	°	-360.0 ... 360.0	6.4.6
1189	Speed filter	µs	125 ... 8000	6.4.5

8 Annex

8.1 Error messages

The various control functions and methods and the hardware of the frequency inverter contain functions which continuously monitor the application. As a supplement to the messages documented in these operating instructions, the following failure keys are activated by the EM-SinCos-01 expansion module.

Error messages and fault clearance		
F04	00	Motor temperature too high or connection fault of temperature evaluation. Check wiring and control terminal connections.
F14	80	Initialization fault EM-Module. Expansion module cannot be initialized. Check if the expansion module is fixed properly.
	81	Communication fault EM-Module. Communication between expansion module and frequency inverter is faulty. Check EMC.
	82	Common fault EM-Module. Error on expansion module. One of the following errors F1483 ... F1493 occurs.
	83	EM-SinCos: Ext. 24V missing. Via parameter <i>Voltage supply</i> 1186 an operation mode with external voltage supply is selected, but no external voltage applies. Connect external voltage supply or change operation mode.
	84	EM-SinCos: Undervoltage ext. 24V. The external supply voltage is too low or the voltage supply is surcharged. Check voltage value of external voltage supply.
	85	EM-SinCos: Undervoltage int. 24V. The voltage supply for encoder provided internally by the frequency inverter is surcharged. Check wiring of control terminals.
	86	EM-SinCos: Sense-Cable missing. Sense measuring line not detected. – Via parameter <i>Voltage supply</i> 1186 an operation mode with sense measuring line is selected, but no sense measuring line is connected. Connect sense measuring line if applicable or change operation mode. – Defect or broken wire of sense measuring line. Check wiring and control terminal connections.
	87	EM-SinCos: Missing Track A/B. A/B track not detected. Connect A/B-track. Broken wire of A/B-track line. Check wiring.
	88	EM-SinCos: Error Correction Track A/B. Evaluation error of A/B-track. Internal measuring accuracy error. Correction of amplification error or offset error has reached the limit value.
	89	EM-SinCos: Missing Track C/D. C/D track not detected. – Via parameter <i>Track signals</i> 1184 an operation mode with C/D-track is selected, but no C/D-track is connected. Connect C/D-track if applicable or change operation mode. – Defect or broken wire of C/D-track line. Check wiring and control terminal connections.
	90	EM-SinCos: Error Correction Track C/D. Evaluation error of C/D-track. Internal measuring accuracy error. Correction of amplification error or offset error has reached the limit value.

Error message and fault clearance		
F14	91	EM-SinCos: Missing Track R. Reference track not detected. <ul style="list-style-type: none"> – Via parameter <i>Track signals</i> 1184 an operation mode with reference-track is selected, but no reference-track is connected. Connect reference-track if applicable or change operation mode. – Setting of <i>Division Marks</i> 1183 does not correspond to the encoder type-specific value. Check the setting. – Broken wire of R-track line. Check wiring and control terminal connections.
	92	EM-SinCos: Count Error. <ul style="list-style-type: none"> – Encoder evaluation is faulty. Check EMC. – Setting of <i>Division Marks</i> 1183 does not correspond to the encoder type-specific value. Check the setting.
	93	EM-SinCos: Connection Fault. Group fault indication. At least two of the following errors occur: <ul style="list-style-type: none"> – F1486 "Sense-Cable missing" – F1487 "Missing Track A/B" – F1489 "Missing Track C/D"
F21	nn	Fault report to system bus master in fault in system bus slave. nn = Node ID of slave (hex)
F22	00	Communication fault, system bus, timeout SYNC telegram
	01	Communication fault, system bus, timeout RxPDO1
	02	Communication fault, system bus, timeout RxPDO2
	03	Communication fault, system bus, timeout RxPDO3
	10	Communication fault, system bus, bus OFF

Additional to the listed fault messages, there are further fault messages for internal purposes and not listed here. If you receive fault messages, which are not listed here, please contact us by phone.



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