VACUUM SOLUTIONS

R5 / COBRA / DOLPHIN

With Variable Speed Drive (VSD)
R5 RA 0255 D / 0305 D, RA/RC 0400 C / 0502 C / 0630 B/C
COBRA NC 0300 B / 0400 B / 0630 C, COBRA NX 0450 A / 0650 A / 0950 A
DOLPHIN LM 0180 – 0800 A, LT 0170 – 0220 A, 0320 A, 0430 A, 0510 A, 0630 A

Pump Control Instructions

Get technical data, instruction manuals, service kits

VACUUM APP

0870208958 | -0003_en | Original instructions

07/03/2022

Table of Contents

1 Safety

These pump control instructions shall give further information concerning individual setting or data analysis to experienced and trained users. Prior to handling the product, this document should be read and understood. If anything needs to be clarified please contact your Busch representative.

Read carefully before use and keep for future reference.

This document remains valid as long as the customer does not change anything on the product.

The product is intended for industrial use. It shall be handled only by qualified personnel.

The product has been designed and manufactured according to state-of-the-art methods. Nevertheless, residual risks may remain. This instruction manual highlights potential hazards where appropriate. Safety notes and warning messages are tagged with one of the keywords DANGER, WARNING, CAUTION and NOTICE as follows:

DANGER

... indicates an imminent dangerous situation that will result in death or serious injuries if not prevented.

WARNING

... indicates a potentially dangerous situation that could result in death or serious injuries.

CAUTION

... indicates a potentially dangerous situation that could result in minor injuries.

NOTICE

... indicates a potentially dangerous situation that could result in damage to property.

NOTE

... indicates helpful tips and recommendations, as well as information for efficient and trouble-free operation.

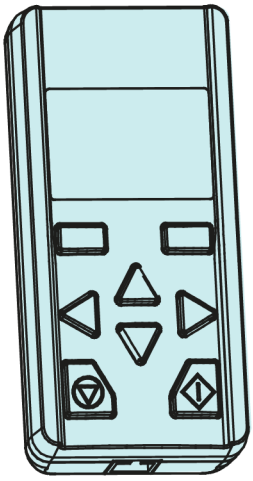
2 Introduction

NOTE

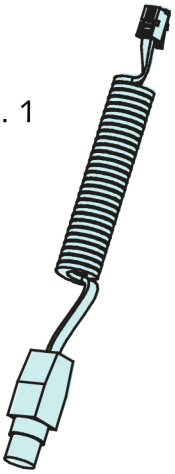
Pump control instructions.

This document is delivered along with the Busch variable speed drive, which is supplied with Busch vacuum pumps or which is retrofitted to existing pumps.
It only contains information about the variable speed drive parametrisation and control.
Please refer to the original instruction manual of the corresponding machine which content remains valid.

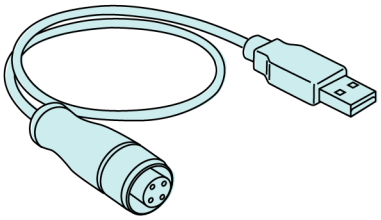
3 Product Description



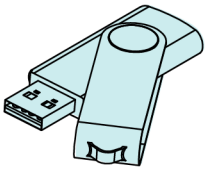
Pos. 1



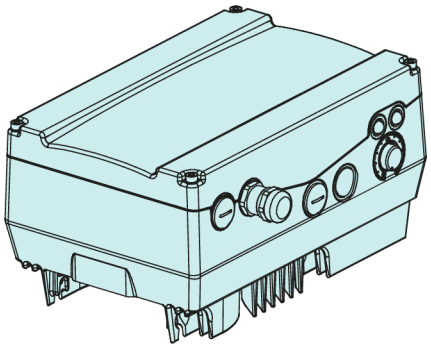
Pos. 2



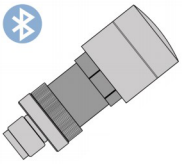
Pos. 3



Pos. 4



Pos. 5



Pos. 6

Pos.	Part	Part no.
1	Remote control including cable to variable speed drive	0987 208 729
2	Connection cable for PC	0987 208 730
3	USB Stick including PC-Software, pump control instructions, setup file	Specific to pump
4	Variable speed drive	-
5	Bluetooth stick	0646 241 856
6	Vacuum pump with variable speed drive	Specific to pump

Different interfaces are available to connect to the VSD for:

- Parametrisation of the variable speed drive
- Control (e.g. locking and releasing)
- Display of various process values

Available interfaces:

- Remote control (pos.1)
- Connection cable for PC (pos.2)
- Bluetooth stick to connect a smartphone (pos.5)

The following machines can be equipped with variable speed drive:

- R5 RA 0255 D
- R5 RA 0305 D
- R5 RA/RC 0400 C
- R5 RA/RC 0502 C
- R5 RA/RC 0630 C
- COBRA NC 0300 B
- COBRA NC 0400 B
- COBRA NC 0630 C
- COBRA NX 0450 A
- COBRA NX 0650 A
- COBRA NX 0950 A
- DOLPHIN LM 0180 – 0800 A
- DOLPHIN LT 0170, 0220, 0320, 0430, 0510, 0630 A

4 Installation

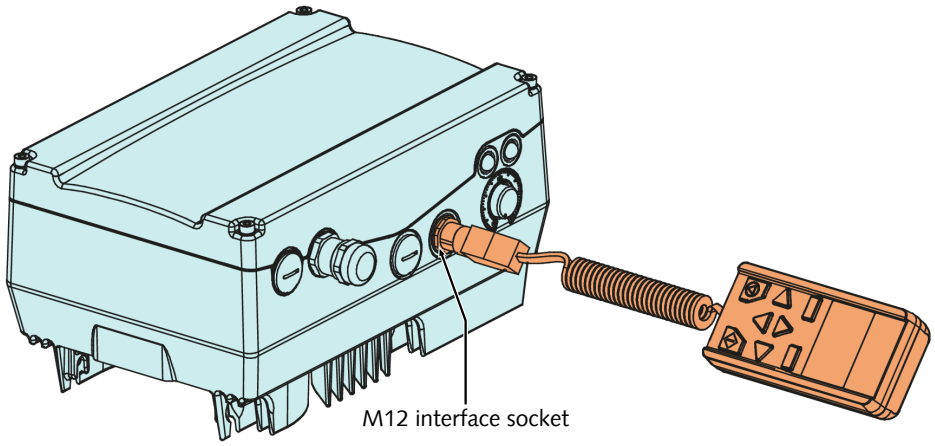
4.1 Remote Control Connection

NOTICE

Non-compatible variable speed drive.

Risk of damage to the variable speed drive!

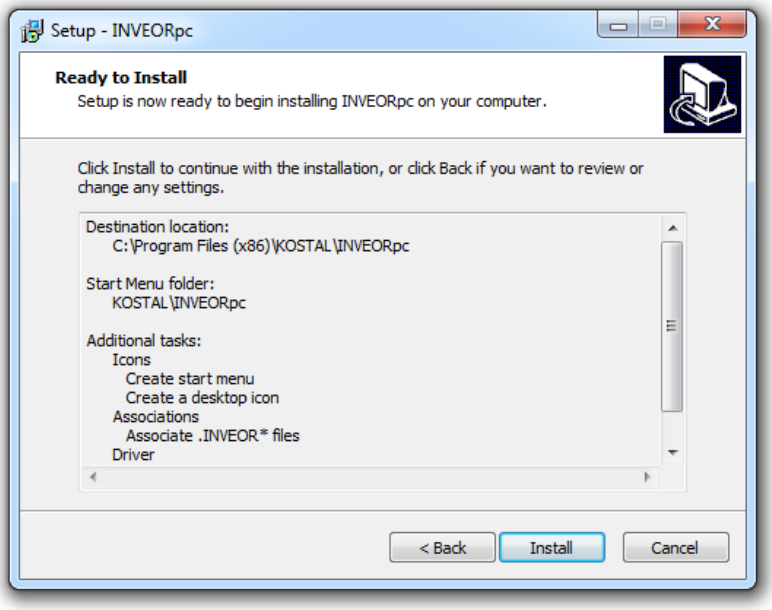
- The remote control must only be operated with „INVEOR“ variable speed drive.



- Connect the cable of the remote control to the M12 interface socket.

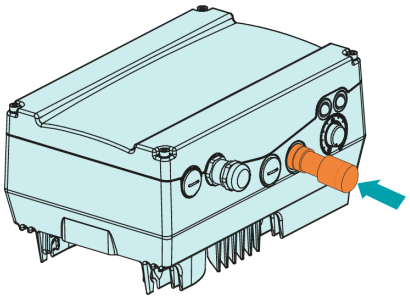
4.2 PC-Software Installation

- Start the setup file of the PC-Software from the USB stick or download it from the Busch website *www.buschvacuum.com* .
- Install the PC-Software on your computer.



4.3 Bluetooth Stick Connection

- Fit the Bluetooth stick to the M12 interface socket.

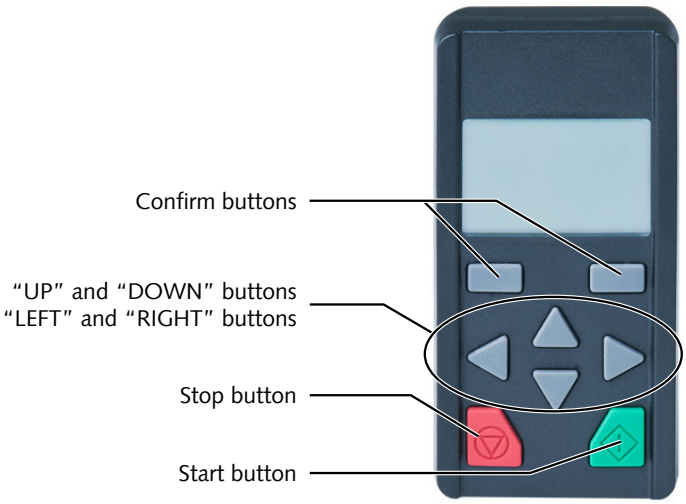


- Download Busch VSD App.

5 Commissioning

5.1 Operate the Remote Control

5.1.1 Key Overview



5.1.2 Navigation and Input

Buttons	Function
"UP"/"DOWN" buttons	Selecting parameters, changing values
"LEFT"/"RIGHT" buttons	Navigating cursor
Confirm buttons	With these buttons, the command showed in the display is activated via the button
"START"/"STOP" buttons	With these buttons, the motor is started or stopped

Commands	Procedures
Next	Calling up parameters and submenu
Back	One menu level higher
Cancel	End entry without saving
Change	Call up edit mode (cursor blinks)
Save	Save selection, entry or change
Enter	Confirm the selected parameter set
Start	Command for motor detection

Enter	Procedures
Displaying tens, hundreds, thousands place	Press "LEFT" arrow until the desired tens, hundreds or thousands place is displayed
Displaying decimal places	Press "RIGHT" arrow until the desired decimal places are displayed
Entering negative values	Place cursor on the plus sign, select the minus sign with the "UP" arrow and save

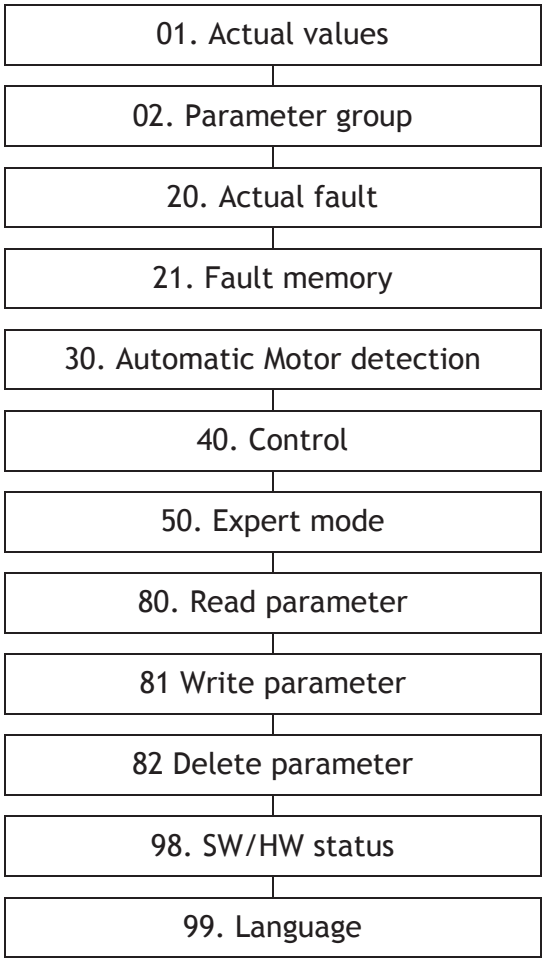
5.1.3 Menu

The menu appears on the remote control display when the variable speed drive is switched on.

For parameter groups menu, there are two different modes:

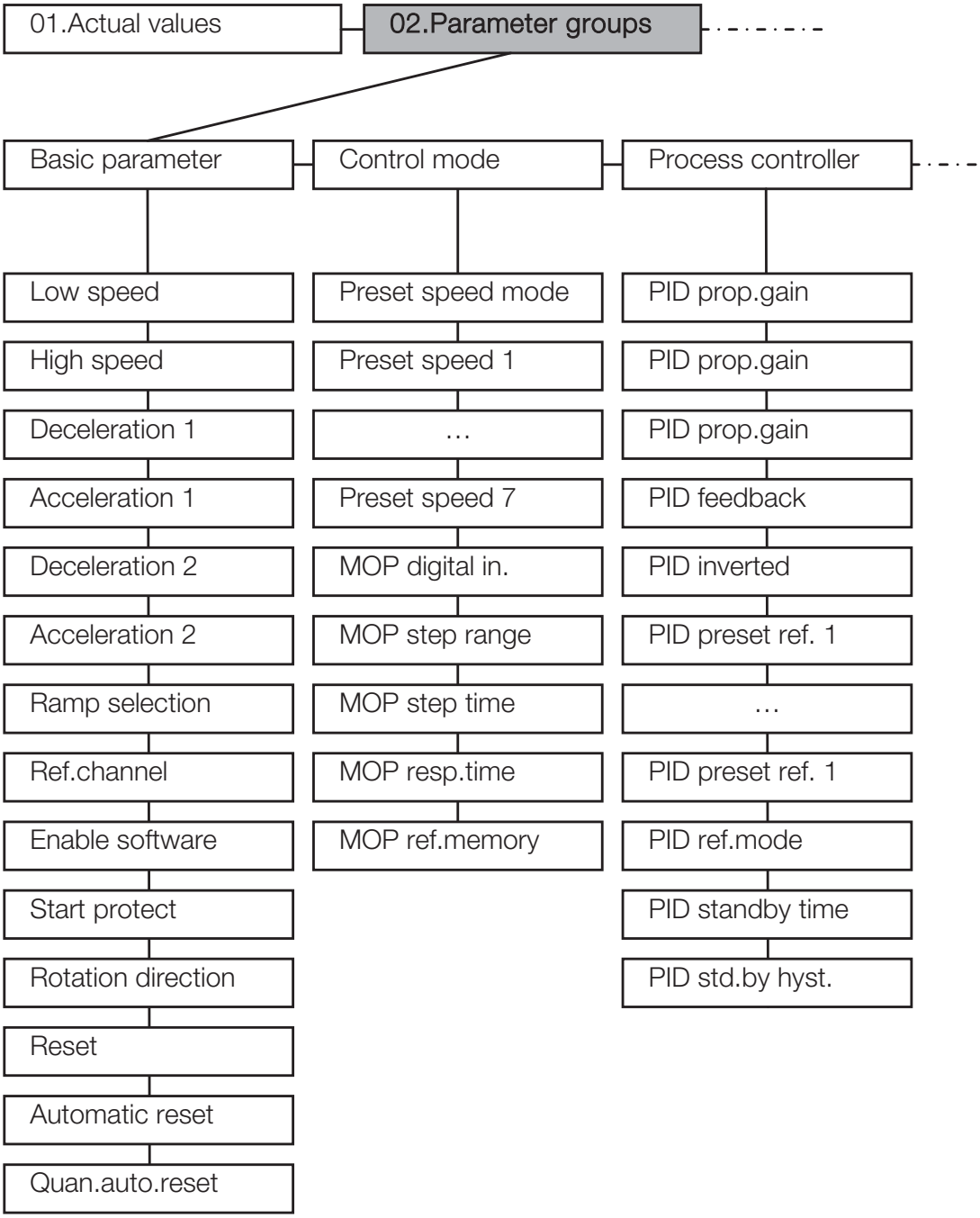
- Standard mode:
  Contains all necessary parameters for standard application from the factory.
- Expert mode, see *Parameter Group Menu (Expert Mode)* [→ 11]:
  Contains advanced parameters for special uses, the expert mode is activated in the main menu.

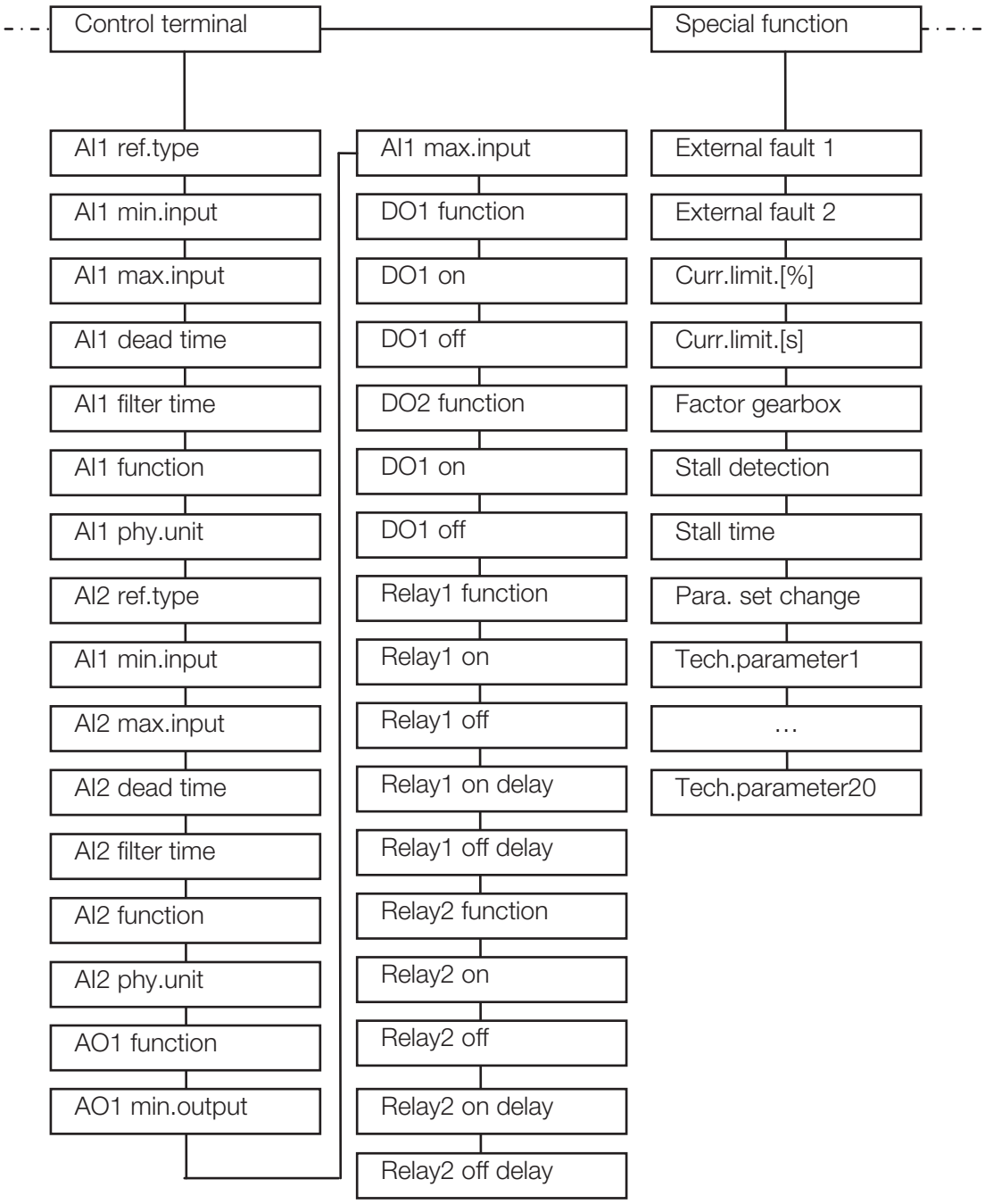
The remote control always starts in standard mode.

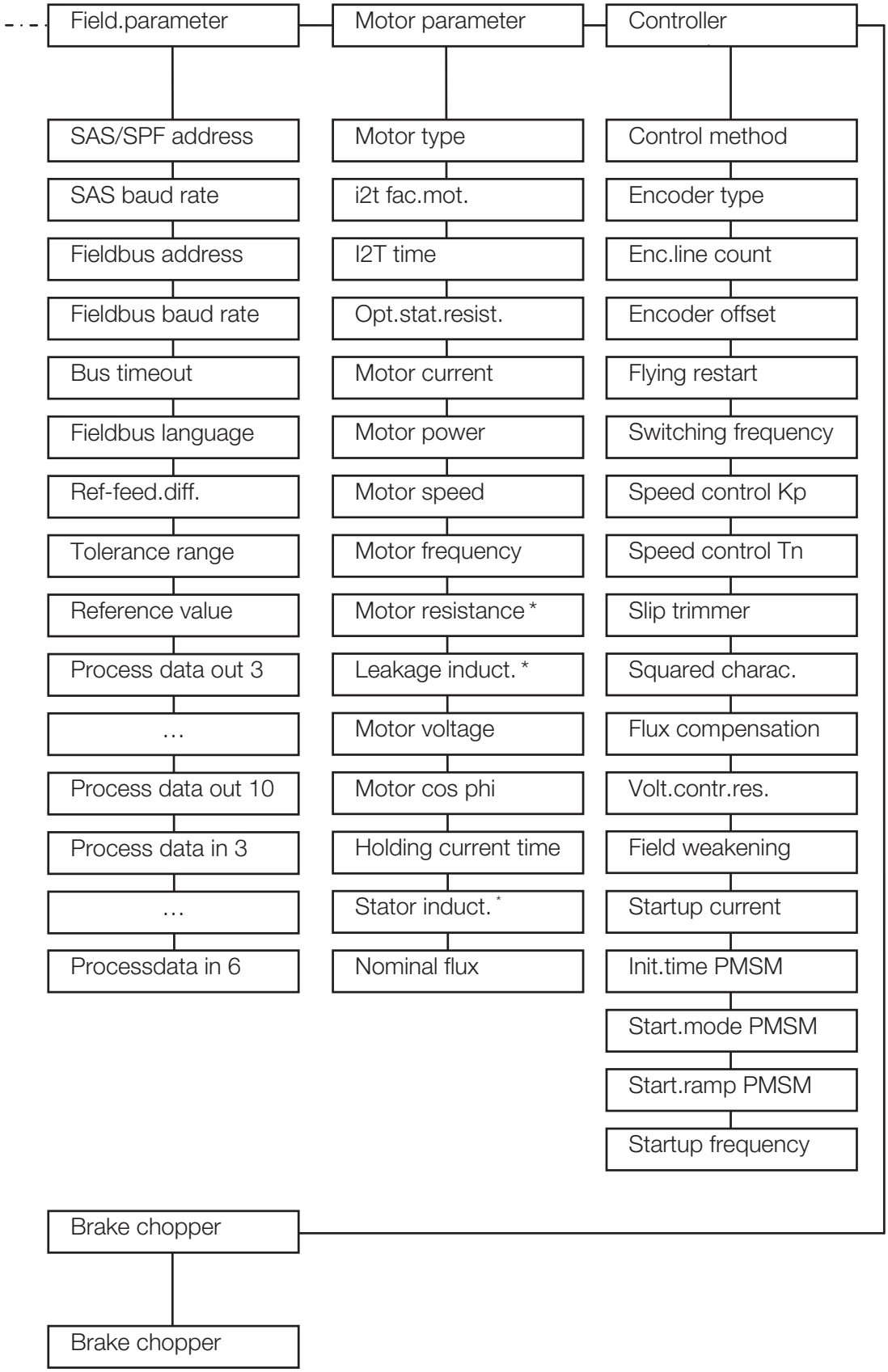


5.1.4 Parameter Group Menu (Expert Mode)

In expert mode, the "0.2 Parameter group" menu contains advanced parameters for special applications.




Control terminal
Special function
AI1 ref.type
AI1 min.input
AI1 max.input
AI1 dead time
AI1 filter time
AI1 function
AI1 phy.unit
AI2 ref.type
AI1 min.input
AI2 max.input
AI2 dead time
AI2 filter time
AI2 function
AI2 phy.unit
AO1 function
AO1 min.output
AI1 max.input
DO1 function
DO1 on
DO1 off
DO2 function
DO1 on
DO1 off
Relay1 function
Relay1 on
Relay1 off
Relay1 on delay
Relay1 off delay
Relay2 function
Relay2 on
Relay2 off
Relay2 on delay
Relay2 off delay
External fault 1
External fault 2
Curr.limit.[%]
Curr.limit.[s]
Factor gearbox
Stall detection
Stall time
Para. set change
Tech.parameter1
…
Tech.parameter20



*) These values are automatically determined and entered during motor detection.

5.2 Run the Machine

NOTICE

Frequent starts and stops by connecting and disconnecting from the power supply.

Risk of damage to the machine!

Starting the machine by connecting and disconnecting the power supply is permitted max. 2x per minute. Between disconnecting and connecting at least 10 seconds must have been passed. If the process requires more frequent starts/stops of the machine:

- Use the digital start signal.

Machine type	Motor frequency
R5 RA 0255 D	60 Hz
R5 RA 0305 D	60 Hz
R5 RA/RC 0400 C	60 Hz
R5 RA/RC 0502 C	60 Hz
R5 RA/RC 0630 C	60 Hz
COBRA NC 0300 B	60 Hz
COBRA NC 0400 B	60 Hz
COBRA NC 0630 C	According to module maximum speed
COBRA NX 0650 A	50 or 60 Hz
COBRA NX 0450 A	60 Hz
COBRA NX 0950 A	72 Hz
DOLPHIN LM 0180 – 0800 A	60 Hz
DOLPHIN LT 0170 – 0220 A	60 Hz
DOLPHIN LT 0320 A	60 Hz
DOLPHIN LT 0430 A	60 Hz
DOLPHIN LT 0510 A	60 Hz
DOLPHIN LT 0630 A	60 Hz

- Refer to the Installation and Retrofit instructions of the corresponding machine for the complete commissioning procedure and for the electrical connection of the machine.
- Maximum permissible number of starts by using the digital signal: unlimited

As soon as the machine is operated under normal operating conditions:

- Measure the mains current or read it via PC-Software or controller.

5.3 Alarm Trip Settings

Please refer to the Electrical Schematics supplied with the machine for pre-installed safety sensors. On COBRA and R5 machines typically one temperature switch is wired to Digital Input no. 3 and stops the machine in case of a trip alarm.

6 Custom Parametrisation

DANGER

Maintenance work without disconnecting the variable speed drive.

Risk of electrical shock.

- Disconnect and isolate the variable speed drive before attempting any work on it. High voltages are present at the terminals and within the variable speed drive for up to 10 minutes after disconnection of the electrical supply.
- Always ensure by using a suitable multimeter that no voltage is present on any drive power terminals prior to commencing any work.

DANGER

Live wires. Carry out any work on the variable speed drive and motor.

Risk of electrical shock!

- Electrical installation work must only be executed by qualified personnel.

NOTICE

Change factory settings.

Risk of damage to the machine!

If wrong or not allowed parameters have been set, Busch disclaims any liability for damage to the machine.

- Change only the allowed parameters described in the chapter *Input / Output Description* [➔ 21].

NOTE

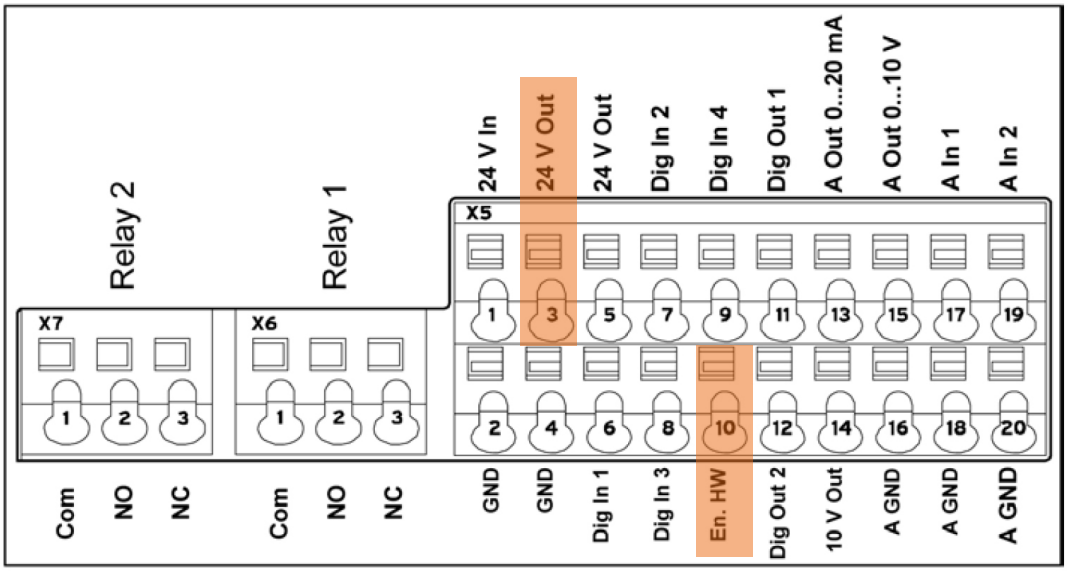
Parameterisation is possible prior to device installation.

Parameterisation can be performed before the drive controller is installed in the motor.

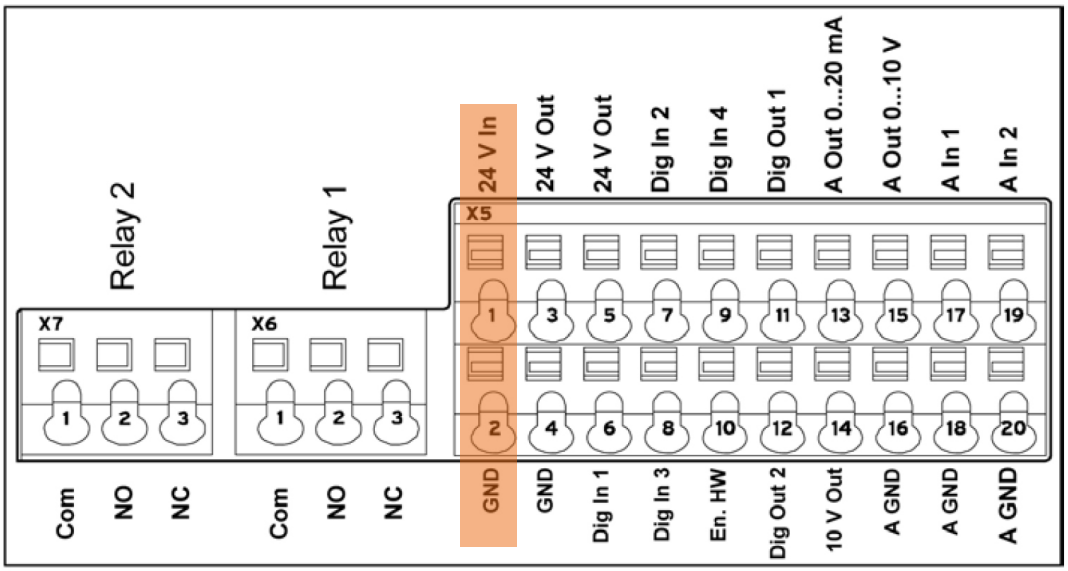
The variable-frequency drive has a 24 V low-voltage input for this purpose, which can supply the electric system without requiring mains power.

6.1 Disable the Machine

- Make sure that the variable speed drive is de-energised.
- Remove the bridge between “24V Out” (int. power supply) and “En HW” (enable hardware) in order to avoid any start up.



- Energise the variable speed drive either from 24 VDC power supply or from the mains power.

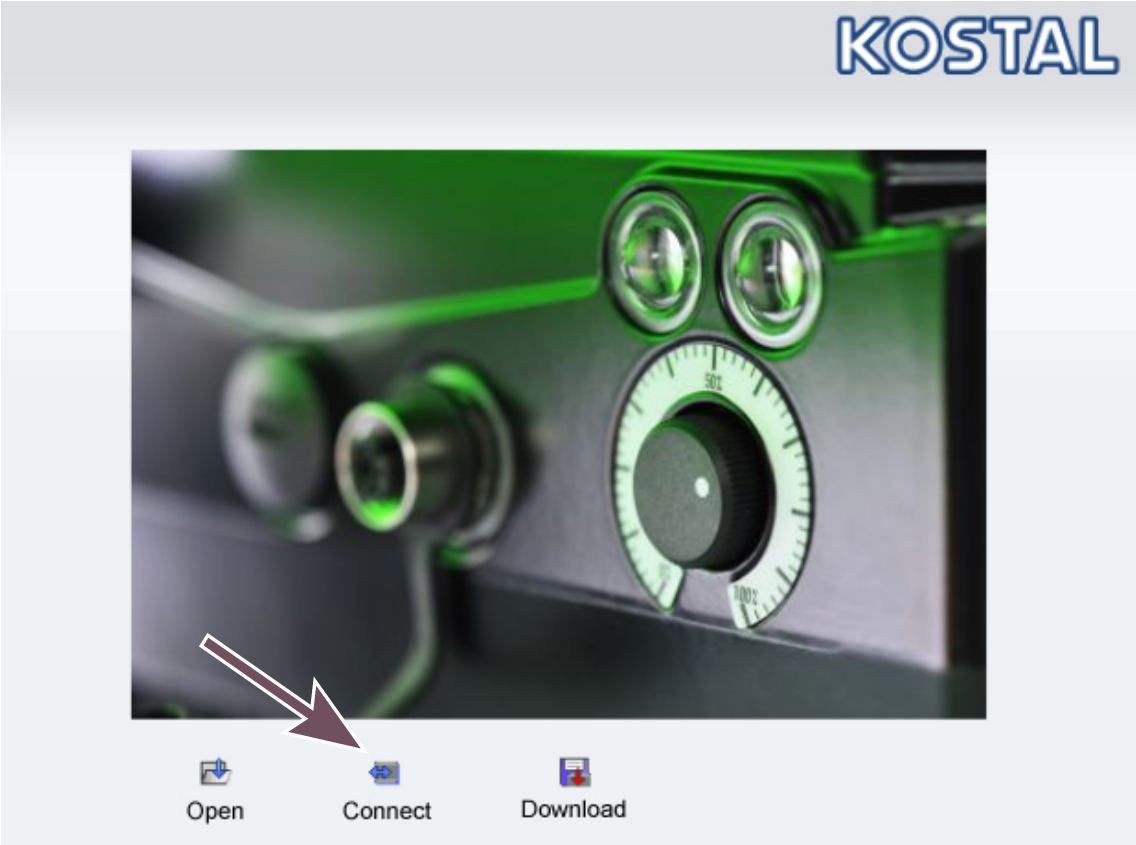


6.2 Save Parameters

NOTE

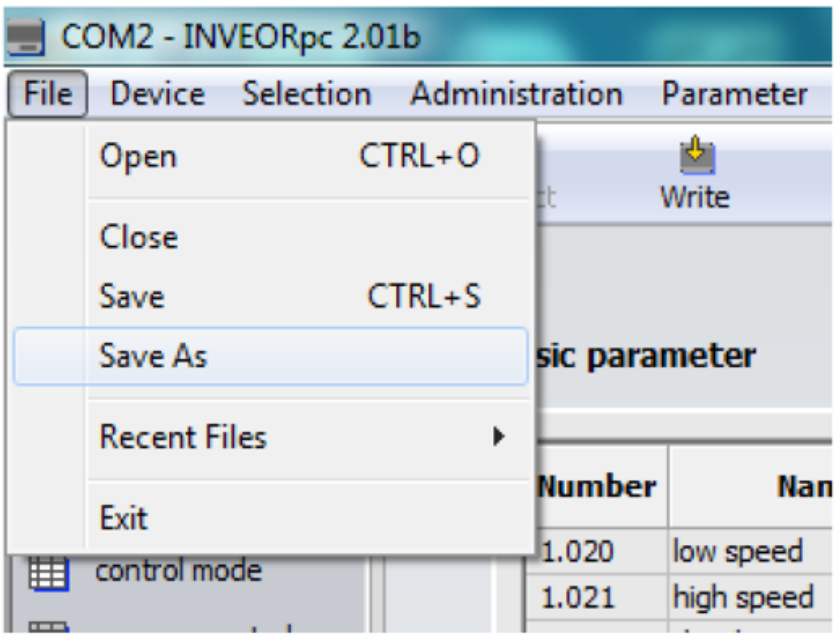
Before making any change, backup the current parameters via PC-Software.

- Make sure that the machine is disabled, see *Disable the Machine* [➔ 16].
- Connect the variable speed drive to the computer with the provided cable.
- Start the PC-Software previously installed, see *PC-Software Installation* [➔ 7].
- Select “Connect”



- Select the communication port of the cable (usually never COM1)
- Press “OK”

- Go to “File” → “Save As”
- Save the file “.inveor” in your database in order to reload the initial or specific parameters for future purposes.



NOTE

Custom parametrisation via the remote control.

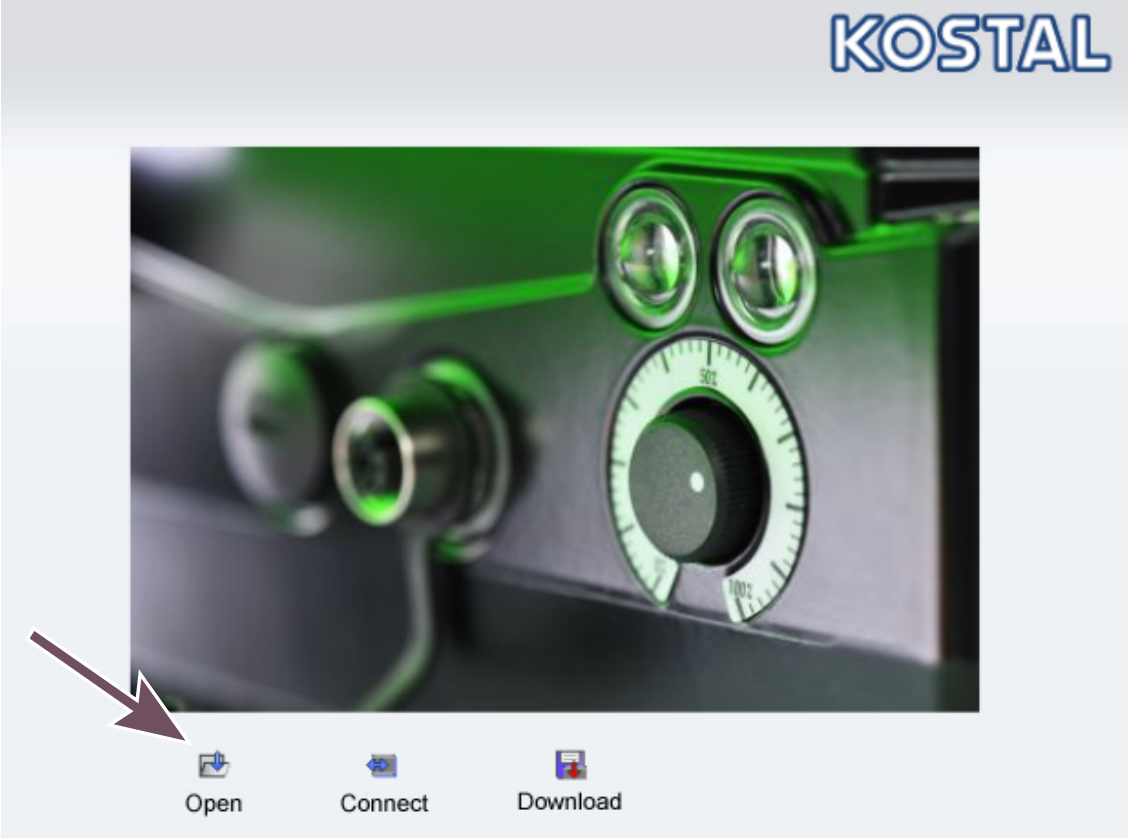
Please keep a note of each changed parameters.

As soon as the parametrisation is finished:

- De-energise the variable speed drive.
- Reconnect the variable speed drive inputs according to your parameter list without forgetting to connect the “En HW” input.

6.3 Reload Factory Settings

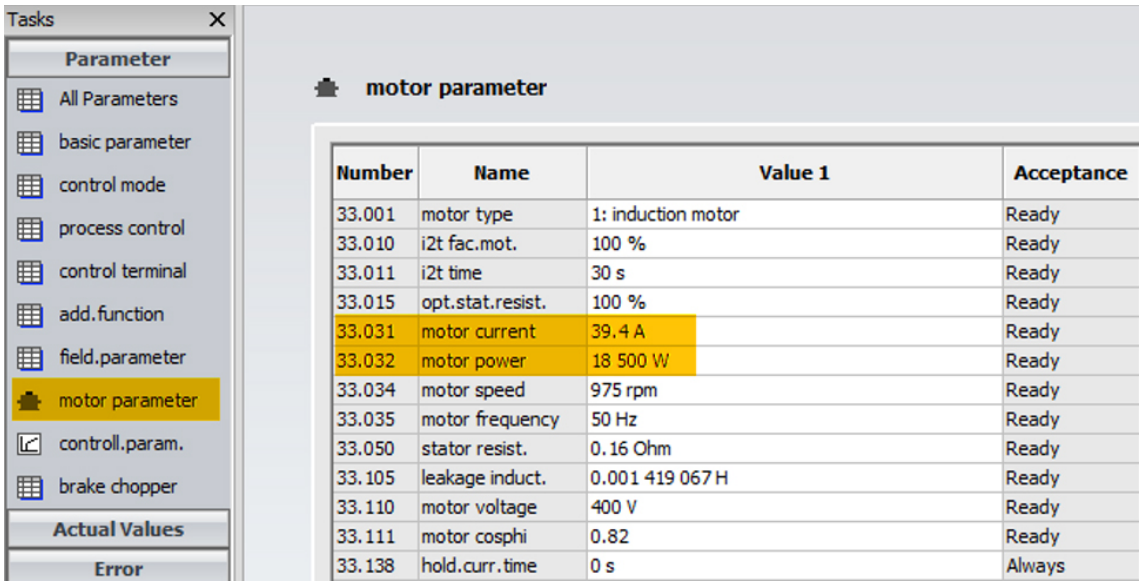
- Make sure that the machine is disabled, see *Disable the Machine* [➔ 16].
- Connect the variable speed drive to the computer with the provided cable.
- Start the PC-Software previously installed, see *PC-Software Installation* [➔ 7].
- Select “Open” to load the file “.inveor” of your parameter list.



- Click on “Write”.

- Select the communication port of the cable (usually never COM1)
- Press “OK”

- Wait until the end of the program downloading.
- Check the motor parameters match to the motor fitted on the machine.



Number	Name	Value 1	Acceptance
33.001	motor type	1: induction motor	Ready
33.010	i2t fac.mot.	100 %	Ready
33.011	i2t time	30 s	Ready
33.015	opt.stat.resist.	100 %	Ready
33.031	motor current	39.4 A	Ready
33.032	motor power	18 500 W	Ready
33.034	motor speed	975 rpm	Ready
33.035	motor frequency	50 Hz	Ready
33.050	stator resist.	0.16 Ohm	Ready
33.105	leakage induct.	0.001 419 067 H	Ready
33.110	motor voltage	400 V	Ready
33.111	motor cosphi	0.82	Ready
33.138	hold.curr.time	0 s	Always

As soon as the parametrisation file is loaded:

- De-energise the variable speed drive.
- Reconnect the variable speed drive inputs according to your parameter list without forgetting to connect the “En HW” input.

7 Input / Output Description

DANGER

Live wires. Carry out any work on the variable speed drive and motor.

Risk of electrical shock!

- Electrical installation work must only be executed by qualified personnel.

NOTICE

Change factory settings.

Risk of damage to the machine!

If wrong or not allowed parameters have been set, Busch disclaims any liability for damage to the machine.

- Change only the allowed parameters described in the chapter *Input / Output Description* [➔ 21].

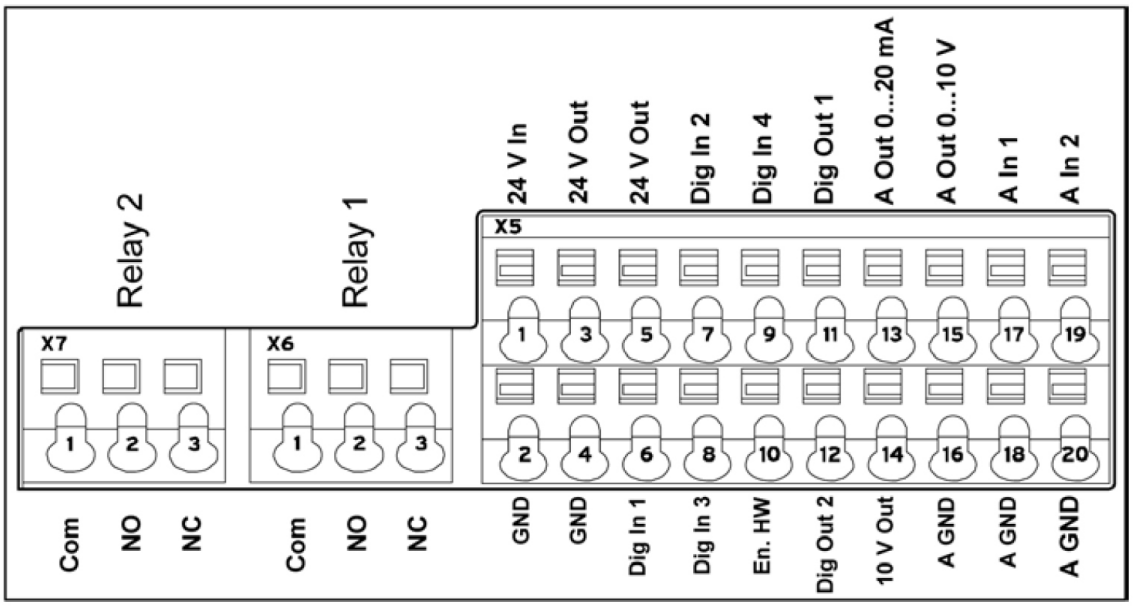
NOTICE

Changing of any other parameters than described below.

Risk of damage to the machine!

- Do not change any other parameter than described below.

7.1 Overview I/O Connections



Terminals	Plug terminal clamp with activation button (slot screwdriver, max. width 2.5 mm)
Connection cross section	0.5 to 1.5 mm^2, single-wire, AWG 20 to AWG 14 *
Connection cross section	0.75 to 1.5 mm^2, fine-wired, AWG 18 to AWG 14 *
Connection cross section	0.5 to 1.0 mm^2, fine-wired (core end sleeves with and without plastic collars)
Length of stripped insulation	9 to 10 mm

* AWG : American Wire Gauge

Designation	Function
Digital inputs 1 – 4	- Switching level low < 2 V / high > 18 V - Imax (at 24 V) = 3 mA - Rin = 8.6 kOhm
Hardware approval for input. Enable Hardware (En. HW)	- Switching level low < 3 V / high > 18 V - Imax (at 24 V) = 8 mA
Analogue inputs 1, 2	- In +/- 10 V or 0 ... 20 mA - In 2 ... 10 V or 4 ... 20 mA - 10-bit resolution - Tolerance +/- 2 % Voltage input: - Rin = 10 kOhm Current input: - Working resistance = 500 Ohm
Digital outputs 1, 2	- Short-circuit proof - Imax = 20 mA
Relays 1, 2	1 changeover contact (NO/NC) Maximum switching power * - at ohmic load (cos ϕ = 1): 5 A at ~ 230 V or = 30 V - at inductive load (cos ϕ = 0.4 and L/R = 7 ms): 2 A at ~ 230 V or = 30 V Maximum reaction time: 7 ms ± 0.5 ms Electric life: 100 000 switching cycles
Analogue output 1 (current)	- Short-circuit proof - I out = 0 ... 20 mA - Working resistance = 500 Ohm - Tolerance +/- 2 %
Analogue output 1 (voltage)	- Short-circuit proof - U out = 0 ... 10 V - Imax = 10 mA - Tolerance +/- 2 %
Power supply 24 V out	- Auxiliary voltage U = 24 VDC - SELV - Short-circuit proof - Imax = 100 mA - external feeding of 24 V possible
Power supply 10 V out	- Auxiliary voltage U = 10 VDC - Short-circuit proof - Imax = 30 mA

* in terms of the UL 508C standard, the maximum allowed is 2 A!

7.2 Preventing Electromagnetic Interferences

Where possible use shielded lines for control circuits.
The shielding should be applied to the line end with special care and without laying the leads across longer stretches without shielding.

Ensure that no parasitic currents (compensating currents etc.) can flow via the analogue cable's shielding.
Route the control lines as far away as possible from the power lines. Under certain circumstances, separate power ducts should be used.
If lines do cross, an angle of 90° should be observed.

Upstream circuit elements, such as protector switches and brake coils, or circuit elements that are operated via the outputs of the drive controller have to be interference-suppressed. RC circuits are suitable as AC voltage protector switches, while free-wheeling diodes or varistors are usually used as DC voltage protector switches. These interference suppression devices are attached directly to the protector switch coils.

NOTE

Where possible, the power for a mechanical brake should be supplied in a separate cable.

Power connections between the drive controller and motor should always be shielded or reinforced, and the shielding must have large-scale grounding at both ends! The use of EMC cable screw connections is recommended. These are not part of the scope of delivery.

Wiring suitable for EMC must be ensured.

7.3 Parameters Set Change Values

7.3.1 Parameters not to be changed

There are some parameters you are not allowed to change.

If you need to modify some parameters to add or set a new functionality, please do not change the following parameters as it may result to wrong running or possible damages to the pump:

- **5.070 curr.limit.[%]**
- **5.090 para.set change**
- **4.230 VO function**
- **4.231 VO on**
- **4.232 VO off**
- **4.233 VO on delay**
- **4.234 VO off delay**

Important: If you need to change some of the parameters described in the next chapter, do not forget and make sure to set Value 1 and Value 2 with the same value!

7.4 Start / Stop Functionality

7.4.1 Description

The start / stop signal comes from one of the 4 digital inputs (1.131).
By default the machine starts when the frequency converter is energized.
The machine can also be started remotely using a digital input.

7.4.2 Parameters

1.131 Enable software

CAUTION

The motor may start immediately, depending on the setting.

Selection of the source for the control release.
0 = digital input 1
1 = digital input 2
2 = digital input 3
3 = digital input 4

Refer to the Electrical Schematics supplied with the machine for bridges pre-installed ex works.

7.5 Speed Control via Digital Inputs

7.5.1 Description

This operating mode allows control of the frequency drive with up to 7 configurable fixed frequencies + one more for the minimum frequency. Depending on the number of fixed frequencies required, up to 3 digital inputs are **permanently assigned**:

Frequency	Digital input 3	Digital input 2	Digital input 1
Minimum frequency	0	0	0
Frequency 1	0	0	1
Frequency 2	0	1	0
Frequency 3	0	1	1
Frequency 4	1	0	0
Frequency 5	1	0	1
Frequency 6	1	1	0
Frequency 7	1	1	1

7.5.2 Speed Control: 1 Fixed Frequency + Min. Frequency

In this configuration, if the "Digital Input 1" is permanently assigned to the frequency selection:

Frequency	Digital input 1
Minimum frequency	0
Frequency 1	1

1.100 Control mode

Selecting the operation mode, following software enabling (1.131) and hardware enabling, the drive controller runs as follows:

2 = preset speed in inverter software, with the frequencies defined in parameters 2.051 and Minimum frequency

2.050 Preset speed mode in software

0 = Digital Input 1 ► preset Frequency 1 (2.051)

2.051 Preset speed 1 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

1.020 Minimum speed

This parameter must not be changed, risk of damage to the machine!

7.5.3 Speed Control: 3 Fixed Frequency + Min. Frequency

In this configuration, if the "Digital Input 1" and "Digital Input 2" are permanently assigned to the frequency selection:

Frequency	Digital input 2	Digital input 1
Minimum frequency	0	0
Frequency 1	0	1
Frequency 2	1	0
Frequency 3	1	1

1.100 Control mode

Selecting the operation mode, following software enabling (1.131) and hardware enabling, the drive controller runs as follows:

2 = preset speed in inverter software, with the frequencies defined in parameters 2.051 and Minimum frequency

2.050 Preset speed mode in software

1 = Digital Input 1, 2 ► preset Frequency 1-3 (2.051 to 2.053)

2.051 Preset speed 1 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

2.052 Preset speed 2 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

2.053 Preset speed 3 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

1.020 Minimum speed

This parameter must not be changed, risk of damage to the machine!

7.5.4 Speed Control: 7 Fixed Frequency + Min. Frequency

In this configuration, if the "Digital Input 1" and "Digital Input 2" are permanently assigned to the frequency selection:

Frequency	Digital input 3	Digital input 2	Digital input 1
Minimum frequency	0	0	0
Frequency 1	0	0	1
Frequency 2	0	1	0
Frequency 3	0	1	1
Frequency 4	1	0	0
Frequency 5	1	0	1
Frequency 6	1	1	0
Frequency 7	1	1	1

1.100 Control mode

Selecting the operation mode, following software enabling (1.131) and hardware enabling, the drive controller runs as follows:

2 = preset speed in inverter software, with the frequencies defined in parameters 2.051 and Minimum frequency

2.050 Preset speed mode in software

1 = Digital Input 1, 2, 3 ► preset Frequency 1-7 (2.051 to 2.057)

2.051 Preset speed 1 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

2.052 Preset speed 2 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

2.053 Preset speed 3 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

2.054 Preset speed 4 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

2.055 Preset speed 5 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

2.056 Preset speed 6 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

2.057 Preset speed 7 in software

XX = Set the frequency, it could not be lower than minimum speed and higher than maximum speed.

1.020 Minimum speed

This parameter must not be changed, risk of damage to the machine!

7.6 Speed Control via Analogue Input

7.6.1 Description

In this operating mode, the speed is control by an analogue signal. This analogue signal can be provided by the internal potentiometer or by one of the two analogue input of the frequency drive.

Those analogues have the following characteristics:

Analogue inputs 1, 2	- In +/- 10 V or 0 ... 20 mA - In 2 ... 10 V or 4 ... 20 mA - 10-bit resolution - Tolerance +/- 2 % Voltage input: - Rin = 10 kOhm Current input: - Working resistance = 500 Ohm

7.6.2 Speed Control via Internal Potentiometer

1.100 Control mode

Selecting the operation mode, following software enabling (1.131) and hardware enabling, the drive controller runs as follows:

0 = frequency control mode, with the target value of the selected reference channel 1.130

1.130 Reference channel

Determines the source from which the target value is to be read:

0 = internal potentiometer

7.6.3 Speed Control via Analogue Input 1

7.6.3.1 Voltage Input (see 7.6.3.4 for Current Input)

1.100 Control mode

Selecting the operation mode, following software enabling (1.131) and hardware enabling, the drive controller runs as follows:

0 = frequency control mode, with the target value of the selected reference channel 1.130

1.130 Reference channel

Determines the source from which the target value is to be read:

1 = analogue input 1

4.020 AI1 input type

Function of analogue input 1:

1 = voltage input

4.021 AI1 minimum input (%)

Specifies the minimum value of the analogue inputs as a percentage of the range:

Example: *0 ... 10 V ► 0% ... 100%*

2 ... 10 V ► 20% ... 100%

0 ► 0 V ► 0% = default value to be adapted to your process

4.022 AI1 maximum input (%)

Specifies the maximum value of the analogue inputs as a percentage of the range:

Example: *0 ... 10 V ► 0% ... 100%*

2 ... 10 V ► 20% ... 100%

100 ► 10 V ► 100% = default value to be adapted to your process

4.023 AI1 dead time (%)

Dead time as percentage of the range of the analogue input:

0 = no dead time default value to be adapted to your process

4.024 AI1 filter time (second)

Filter time of analogue inputs in seconds:

0.02 = default value to be adapted to your process

4.030 AI1 function

Function of analogue input 1:

0 = analogue input

4.033 AI1 physical unit

Selection of different physical values to be displayed:

4.033 =	0	%
4.033 =	1	bar
4.033 =	2	mbar
4.033 =	3	psi
4.033 =	4	Pa
4.033 =	5	m^3/h
4.033 =	6	l/min
4.033 =	7	°C
4.033 =	8	°F
4.033 =	9	m
4.033 =	10	mm

4.034 AI1 physical unit minimum

Selection of the lower limit of a physical value to be displayed:

0 = default value to be adapted to your process

4.035 AI1 physical unit maximum

Selection of the upper limit of a physical value to be displayed:

100 = default value to be adapted to your process

7.6.3.2 Current Input

1.100 Control mode

Selecting the operation mode, following software enabling (1.131) and hardware enabling, the drive controller runs as follows:

0 = frequency control mode, with the target value of the selected reference channel 1.130

1.130 Reference channel

Determines the source from which the target value is to be read:

1 = analogue input 1

4.020 AI1 input type

Function of analogue input 1:

2 = current input

4.021 AI1 minimum input (%)

Specifies the minimum value of the analogue inputs as a percentage of the range:

Example: *0 ... 20 mA ► 0% ... 100%*

4 ... 20 mA ► 20% ... 100%

0 ► 0 mA ► 0% = default value to be adapt to your process

4.022 AI1 maximum input (%)

Specifies the maximum value of the analogue inputs as a percentage of the range:

Example: *0 ... 20 mA ► 0% ... 100%*

4 ... 20 mA ► 20% ... 100%

100 ► 20 mA ► 100% = default value to be adapt to your process

4.023 AI1 dead time (%)

Dead time as percentage of the range of the analogue input:

0 = no dead time default value to be adapted to your process

4.024 AI1 filter time (second)

Filter time of analogue inputs in seconds:

0.02 = default value to be adapted to your process

4.030 AI1 function

Function of analogue input 1:

0 = analogue input

4.033 AI1 physical unit

Selection of different physical values to be displayed:

4.033 =	0	%
4.033 =	1	bar
4.033 =	2	mbar
4.033 =	3	psi
4.033 =	4	Pa
4.033 =	5	m^3/h
4.033 =	6	l/min
4.033 =	7	°C
4.033 =	8	°F
4.033 =	9	m
4.033 =	10	mm

4.034 AI1 physical unit minimum

Selection of the lower limit of a physical value to be displayed:

0 = default value to be adapted to your process

4.035 AI1 physical unit maximum

Selection of the upper limit of a physical value to be displayed:

100 = default value to be adapted to your process

7.6.4 Speed Control via Analogue Input 2

7.6.4.1 Voltage Input

1.100 Control mode

Selecting the operation mode, following software enabling (1.131) and hardware enabling, the drive controller runs as follows:

0 = frequency control mode, with the target value of the selected reference channel 1.130

1.130 Reference channel

Determines the source from which the target value is to be read:

2 = analogue input 2

4.050 AI2 input type

Function of analogue input 2:

1 = voltage input

4.051 AI2 minimum input (%)

Specifies the minimum value of the analogue inputs as a percentage of the range:

Example: *0 ... 10 V ► 0% ... 100%*

2 ... 10 V ► 20% ... 100%

0 ► 0 V ► 0% = default value to be adapt to your process

4.052 AI2 maximum input (%)

Specifies the maximum value of the analogue inputs as a percentage of the range:

Example: *0 ... 10 V ► 0% ... 100%*

2 ... 10 V ► 20% ... 100%

100 ► 10 V ► 100% = default value to be adapted to your process

4.053 AI2 dead time (%)

Dead time as percentage of the range of the analogue input:

0 = no dead time default value, to be adapted to your process

4.054 AI2 filter time (second)

Filter time of analogue inputs in seconds:

0.02 = default value to be adapted to your process

4.060 AI2 function

Function of analogue input 2:

0 = analogue input

4.063 AI2 physical unit

Selection of different physical values to be displayed:

4.063 =	0	%
4.063 =	1	bar
4.063 =	2	mbar
4.063 =	3	psi
4.063 =	4	Pa
4.063 =	5	m^3/h
4.063 =	6	l/min
4.063 =	7	°C
4.063 =	8	°F
4.063 =	9	m
4.063 =	10	mm

4.064 AI2 physical unit minimum

Selection of the lower limit of a physical value to be displayed:

0 = default value to be adapted to your process

4.065 AI2 physical unit maximum

Selection of the upper limit of a physical value to be displayed:

100 = default value to be adapted to your process

7.6.4.2 Current Input

1.100 Control mode

Selecting the operation mode, following software enabling (1.131) and hardware enabling, the drive controller runs as follows:

0 = frequency control mode, with the target value of the selected reference channel 1.130

1.130 Reference channel

Determines the source from which the target value is to be read:

2 = analogue input 2

4.050 AI2 input type

Function of analogue input 2:

2 = current input

4.051 AI2 minimum input (%)

Specifies the minimum value of the analogue inputs as a percentage of the range:

Example: *0 ... 20 mA ► 0% ... 100%*

4 ... 20 mA ► 20% ... 100%

0 ► 0 mA ► 0% = default value to be adapted to your process

4.052 AI2 maximum input (%)

Specifies the maximum value of the analogue inputs as a percentage of the range:

Example: *0 ... 20 mA ► 0% ... 100%*

4 ... 20 mA ► 20% ... 100%

100 ► 20 mA ► 100% = default value to be adapted to your process

4.053 AI2 dead time (%)

Dead time as percentage of the range of the analogue input:

0 = no dead time default value, to be adapted to your process

4.054 AI2 filter time (second)

Filter time of analogue inputs in seconds:

0.02 = default value to be adapted to your process

4.060 AI2 function

Function of analogue input 2:

0 = analogue input

4.063 AI2 physical unit

Selection of different physical values to be displayed:

4.063 =	0	%
4.063 =	1	bar
4.063 =	2	mbar
4.063 =	3	psi
4.063 =	4	Pa
4.063 =	5	m^3/h
4.063 =	6	l/min
4.063 =	7	°C
4.063 =	8	°F
4.063 =	9	m
4.063 =	10	mm

4.064 AI2 physical unit minimum

Selection of the lower limit of a physical value to be displayed:

0 = default value to be adapted to your process

4.065 AI2 physical unit maximum

Selection of the upper limit of a physical value to be displayed:

100 = default value to be adapted to your process

7.7 PID Pressure Control

7.7.1 Description

In the case of PID pressure control, the target pressure value and actual pressure value are compared and the system then regulates the rotational speed to reach the pressure target. This requires to connect the optional pressure transmitter to the analogue input 1 or 2.

7.7.2 PID Pressure Control Setup

1.100 Control mode

Selecting the operation mode, following software enabling (1.131) and hardware enabling, the drive controller runs as follows:

1 = PID process controller, with the target value of the PID process controller (3.050 – 3.071) and target pressure (5.100) in mbar abs.

1.130 Reference channel

Determines the source from which the target value is to be read:

8 = PID fixed target values (3.062 to 3.069)

5.100 Target pressure

Select the required target pressure (mbar abs.)

3.050 PID-P amplification factor

Proportional share of PID controller amplification factor:

1 = should be adapted to your application (depending on the pump capacity and customer installation)

3.051 PID-I amplification factor

Integral share of PID controller amplification factor

0.5 = should be adapted to your application (depending on the pump capacity and customer installation)

3.052 PID-D amplification factor

Differential share of PID controller amplification factor

0 = should be adapted to your application (depending on the pump capacity and customer installation)

3.060 PID actual value (PID feedback)

Selection of the input source from which the actual value for the PID process controller is imported:

0	= analogue input 1
1	= analogue input 2

Configuration of analogue input 1 or 2 ▸ see chapters *Voltage Input (see 7.6.3.4 for Current Input)* [➔ 28] or *Current Input* [➔ 30]

4.020 / 4.050 AI1 / AI2 input type
4.021 / 4.051 AI1 / AI2 standard Low (%)
4.022 / 4.052 AI1 / AI2 standard High (%)
4.023 / 4.053 AI1 / AI2 dead time (%)
4.024 / 4.054 AI1 / AI2 filter time (second)
4.030 / 4.060 AI1 / AI2 function
4.033 / 4.063 AI1 / AI2 physical unit
4.034 / 4.064 AI1 / AI2 physical minimum
4.035 / 4.065 AI1 / AI2 physical maximum

3.061 PID inverted

The actual value source (parameter 3.060) is inverted

0	= disable
1	= enable

To be adapted to customer installation, usually for vacuum application you have to enable this parameter ► 3.061 = 1

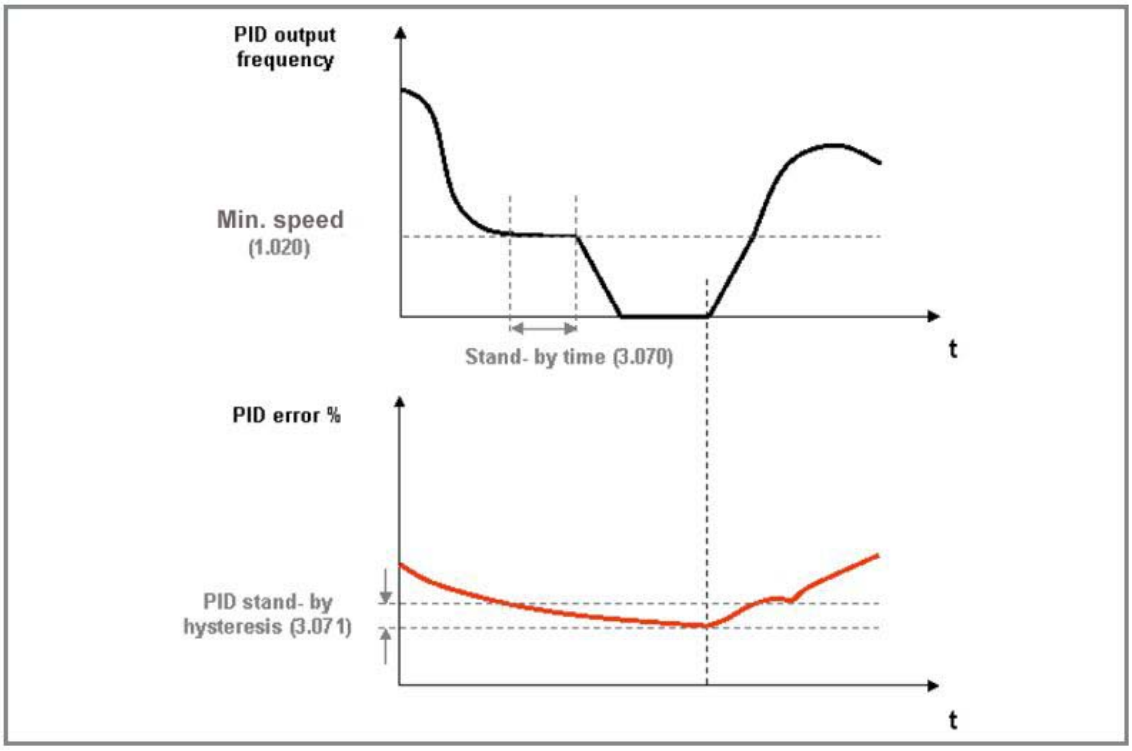
Please note that PID inverted (usually used in vacuum process):
The PID actual value can be inverted using parameter 3.061. The actual value is imported inversely, i.e. 0 V ... 10 V correspond internally to 100%...0%.

7.7.3 Stand-by Function in PID Pressure Control (Sleep Mode)

7.7.3.1 Description

This function can provide energy savings in applications such as central vacuum systems where PID pressure control is used to control to a specific process pressure and the pump has to run at a “minimum speed” (1.020). As the drive controller can reduce the rotational speed of the pump in normal operation when the process pressure is decreasing, but it can never fall below the “minimum speed” (1.020), this provides an opportunity for stopping the motor if it is running speed during a waiting time, the “PID stand-by time” (3.070) with the “minimum speed” (1.020).

Once the actual value deviates from the target value by the set % value, the “PID stand-by hysteresis” (3.071), the control (the motor) is started again.



7.7.3.2 Stand-by Function Setup

3.070 PID standby time

If the drive controller runs for the set time at its minimum frequency (parameter 1.020), the motor is stopped (0 Hz).

Explanation of operating modes / fixed frequency

0 = disable

> 0 = waiting time until stand-by function is enabled

0 = default value to be adapt to your process

3.071 PID stand-by hysteresis

Condition for waking up the PID controller from stand-by.
Once the control difference exceeds the set value as %, the control begins again, see also PID controller operating modes.

0 = default value to be adapt to your process

8 Troubleshooting

DANGER

Live wires. Carry out any work on the variable speed drive and motor.

Risk of electrical shock!

- Electrical installation work must only be executed by qualified personnel.

NOTICE

Variable speed drive maintenance.

Risk of damage to the variable speed drive!

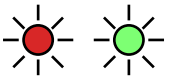
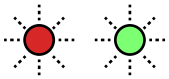
- Maintenance and adjustment must only be executed by qualified personnel.

8.1 LED Flash Codes

When an error occurs, the LEDs on the variable speed drive display a flashing code that allows the errors to be diagnosed.

The following table contains an overview:

Red LED	Green LED	State
		Boot loader active (flashing in turn)
		Ready for operation (activate En_HW for operation)
		Operation / ready
		Warning
		Error
		Identification of motor data
		Initialisation
		Firmware update
		Bus error operation
		Bus error ready for operation

Key			
	LED off		LED on
	LED flashing		LED flashing quickly

8.2 List of Errors

The variable speed drive shuts down if an error occurs. Consult the flash code table / PC tool for the corresponding error numbers.

NOTE

Error messages can only be acknowledged once the error has been remedied.

Error messages can be acknowledged as follows:

- using remote control
- switch device off and on again

The following section contains a list of possible error messages.

Please contact your Busch representative if you encounter errors that are not listed here.

No.	Error name	Description of error	Possible causes/remedy
1	Undervoltage 24 V application	Supply voltage for the application is less than 15 V	24 V supply overload
2	Overvoltage 24 V application	Supply voltage for the application is greater than 31 V	Internal 24 V supply is not OK or external supply is not OK
6	Customer PLC version error	The version of the customer PLC doesn't match the device firmware	Check the version numbers of the customer PLC and device firmware
8	Communication application<>power	Internal communication between the application plate and the power-conducting plate is not OK	EMC interference
10	Parameter distributor	The internal distribution of parameters during initialisation failed	Parameter set is incomplete
11	Time-out power	The power part does not respond	Operation with 24 V without mains feed-in
13	Cable break at analogue in1 (4–20 mA / 2–10 V)	Current or voltage is less than the lower limit of analogue input 1 (monitoring for this error is activated automatically by setting parameter 4.021 to 20%)	Cable break, faulty external sensor
14	Cable break at analogue in 2 (4–40 mA / 2–10 V)	Current or voltage is less than the lower limit of analogue input 2 (monitoring for this error is activated automatically by setting parameter 4.021 to 20%)	Cable break, faulty external sensor
15	Stall detection	The drive shaft of the motor is stalled. 5.080	Remove the blockage
16	PID dry run	No PID actual value despite maximum speed	PID actual value sensor defective Extend dry run time parameter 3.072

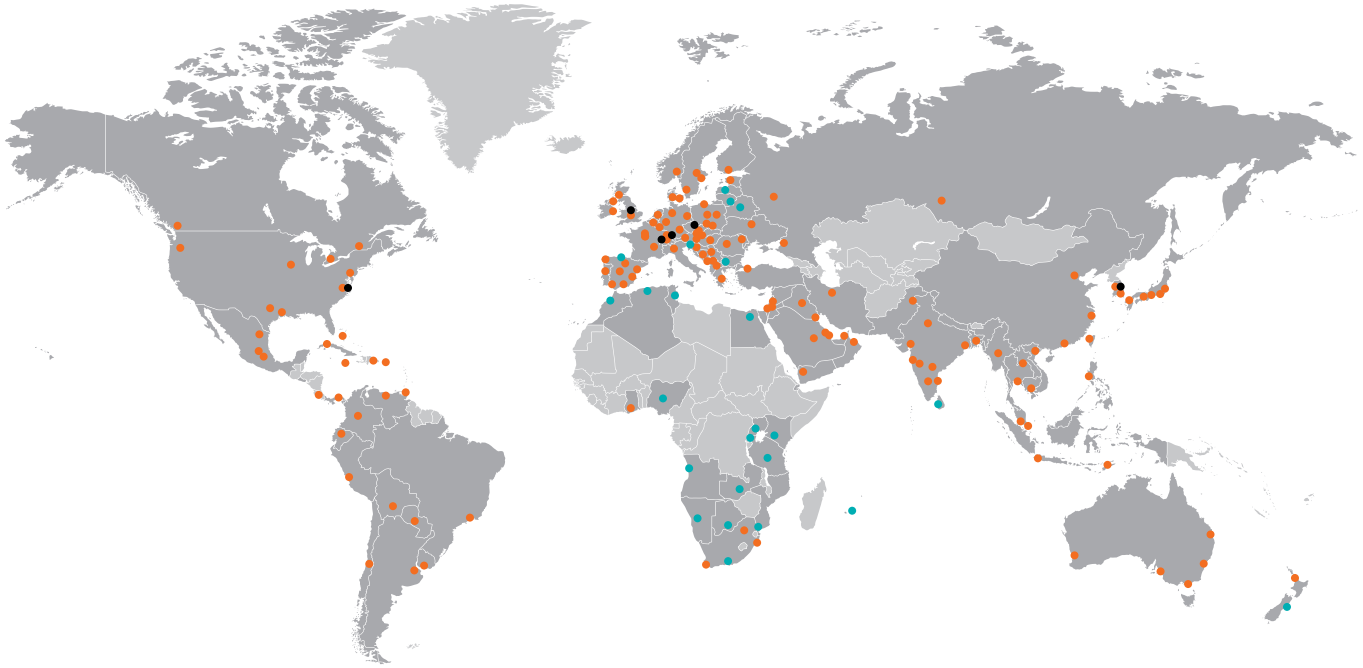
No.	Error name	Description of error	Possible causes/remedy
17	Start-up error	Motor not starting up or starting up incorrectly. 5.082	Check motor connections/check motor and controller parameters; if necessary, disable error (5.082)
18	Excess temperature for frequency converter application	Inner temperature too high	Insufficient cooling, low motor speed and high torque, switching frequency too high
21	Bus time-out	No response from bus sharing unit or remote control/PC	Check bus wiring
22	Acknowledgement error	The number of maximum automatic acknowledgements (1.182) was exceeded	Check error history and remedy error
23	External fault 1	The parameterised fault input is active. 5.010	Correct the external fault
24	External fault 2	The parameterised fault input is active. 5.011	Correct the external fault
25	Motor detection	Motor identification error	Check variable speed drive/ motor and PC / remote control / variable speed drive connections / restart motor identification
26	STO inputs plausibility	The statuses of the two STO inputs have not been identical for more than 2 sec.	Incorrect activation of the STO inputs Check corresponding external wiring
32	Trip IGBT	Protection of the IGBT module against overcurrent has been triggered	Short circuit in the motor or motor feed line / controller settings
33	Overvoltage of intermediate circuit	The maximum intermediate circuit voltage has been exceeded	Feedback by motor in generator mode / mains voltage too high / faulty setting for rotation speed controller / brake resistor not connected or defective / ramp times too short
34	Undervoltage of intermediate circuit	The minimum intermediate circuit voltage has not been reached	Mains voltage too low, mains connection defective / check wiring
35	Excess motor temperature	Motor PTC has been triggered	Overload of the motor (e.g. high torque at low motor speed) / ambient temperature too high
36	Power failure	The grid voltage has dropped briefly	Grid fluctuation / grid voltage interrupted
38	Excess IGBT module temperature	Excess IGBT module temperature	Insufficient cooling, low motor speed and high torque, switching frequency too high
39	Overcurrent	Maximum output current of variable speed drive exceeded	Motor stalled / check motor connection / incorrect speed controller setting / check motor parameters / ramp times too short / brake not open

No.	Error name	Description of error	Possible causes/remedy
40	Excess frequency converter temperature	Inner temperature too high	Insufficient cooling / low motor speed and high torque / switching frequency too high permanent overload / reduce ambient temperature / check fan
42	I2t motor protection shutoff	The internal I2t motor protection (can be parameterised) has been triggered	Permanent overload
43	Ground leak	Ground leak during a motor phase	Insulation fault
45	Motor connection disrupted	No motor current in spite of control through frequency converter	No motor connected or not completely connected Check phases or motor connections and connect correctly when necessary
46	Motor parameters	Plausibility check for motor parameters failed	Parameter set not OK
47	Variable speed drive parameters	Plausibility check for variable speed drive parameters failed	Parameter set not OK, motor type 33.001 and control method 34.010 not plausible
48	Type plate data	No motor data entered	Please enter the motor data according to the motor nameplate
49	Power class restriction	Max. overload of the variable speed drive exceeded for more than 60 sec.	Check application / reduce load / use larger variable speed drive
53	Motor tipped	Only for synchronous motors, field orientation lost	Load too high Optimise controller parameters

Notes

Busch
Vacuum Solutions

With a network of over 60 companies in more than 40 countries and agencies worldwide, Busch has a global presence. In every country, highly competent local personnel delivers custom-tailored support backed by a global network of expertise. Wherever you are. Whatever your business. We are there for you.



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