

Operating instructions Compax3 I30T11

Positioning via Ethernet Powerlink



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1. Introduction

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1.1 Device assignment

This manual applies to the following devices:

- ◆ Compax3S025V2 + supplement
- ◆ Compax3S063V2 + supplement
- ◆ Compax3S100V2 + supplement
- ◆ Compax3S150V2 + supplement
- ◆ Compax3S015V4 + supplement
- ◆ Compax3S038V4 + supplement
- ◆ Compax3S075V4 + supplement
- ◆ Compax3S150V4 + supplement
- ◆ Compax3S300V4 + supplement
- ◆ Compax3H050V4 + supplement
- ◆ Compax3H090V4 + supplement
- ◆ Compax3H125V4 + supplement
- ◆ Compax3H155V4 + supplement
- ◆ Compax3M050D6 + supplement
- ◆ Compax3M100D6 + supplement
- ◆ Compax3M150D6 + supplement
- ◆ Compax3MP10D6

With the supplement:

- ◆ F10 (Resolver)
- ◆ F11 (SinCos®)
- ◆ F12 (linear and rotary direct drives)
- ◆ I30 T11

1.2 Type specification plate

You will find the exact description of the device on the type specification plate, which can be found on the device:

Compax3 - Type specification plate:



Explanation:

1	Type designation The complete order designation of the device (2, 5, 6, 9, 8).
2	C3: Abbreviation for Compax3 S025: Single axis device, nominal device current in 100mA (025=2.5A) M050: Multi-axis device, nominal device current in 100mA (050=5A) H050: High power device, nominal device current in 1A (050=50A) MP10: Mains module 3AC230...480V, nominal power in 1kW (10=10kW) D6: Nominal supply voltage (6=560VDC) V2: Mains supply voltage (2=230VAC/240VAC, 4=400VAC/480VAC)
3	Unique number of the particular device
4	Nominal supply voltage: 1AC = single phase, 3AC = three phase / input current
5	Designation of the feedback system F10: Resolver F11: SinCos® / Single- or Multiturn F12: Feedback module for direct drives
6	Device interface I10: Analog, step/direction and encoder input I11 / I12: Digital Inputs / Outputs and RS232 / RS485 I20: Profibus DP I21: CANopen I22: DeviceNet I30: Ethernet Powerlink C10: integrated controller C3 <i>powerPLmC</i> C13: integrated controller C3 <i>powerPLmC</i> with Profibus
7	Date of factory test
8	Options Mxx: I/O extension, HEDA Sx: optional safety technology on the C3M
9	Technology function T10: Servo controller T11: Positioning T30: Motion control programmable according to IEC61131-3 T40: Electronic cam generation
10	CE compliance
11	Certified safety technology
12	UL certification

1.3 Packaging, transport, storage

Packaging material and transport

Caution! *The packaging material is inflammable, if it is disposed of improperly by burning, lethal fumes may develop.*

The packaging material must be kept and reused in the case of a return shipment. Improper or faulty packaging may lead to transport damages.

Make sure to transport the drive always in a safe manner and with the aid of suitable lifting equipment (**Weight** (see page 376, see page 366)). Do never use the electric connections for lifting. Before the transport, a clean, level surface should be prepared to place the device on. The electric connections may not be damaged when placing the device.

First device checkup

- ◆ Check the device for signs of transport damages.
- ◆ Verify, if the indications on the **Type identification plate** (see page 11) correspond to your requirements.
- ◆ Check if the consignment is complete.

Storage

If you do not wish to mount and install the device immediately, make sure to store it in a dry and clean **environment** (see page 377). Make sure that the device is not stored near strong heat sources and that no metal chippings can get into the device.

Disposal

This product contains materials that fall under the special disposal regulation from 1996, which corresponds to the EC directory 91/689/EEC for dangerous disposal material. We recommend to dispose of the respective materials in accordance with the respectively valid environmental laws. The following table states the materials suitable for recycling and the materials which have to be disposed of separately.

Material	suitable for recycling	Disposal
Metal	yes	no
Plastic materials	yes	no
Circuit boards	no	yes

Please dispose of the circuit boards according to one of the following methods:

- ◆ Burning at high temperatures (at least 1200°C) in an incineration plant licensed in accordance part A or B of the environmental protection act.
- ◆ Disposal via a technical waste dump which is allowed to take on electrolytic aluminium condensers. Do under no circumstances dump the circuit boards at a place near a normal waste dump.

1.4 Safety Instructions

In this chapter you can read about:

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1.4.1. General hazards

General Hazards on Non-Compliance with the Safety Instructions

The device described in this manual is designed in accordance with the latest technology and is safe in operation. Nevertheless, the device can entail certain hazards if used improperly or for purposes other than those explicitly intended.

Electronic, moving and rotating components can

- ◆ constitute a hazard for body and life of the user, and
- ◆ cause material damage

Usage in accordance with intended purpose

The device is designed for operation in electric power drive systems (VDE0160). Motion sequences can be automated with this device. Several motion sequences can be combined by interconnecting several of these devices. Mutual interlocking functions must be incorporated for this purpose.

1.4.2. Safety-conscious working

This device may be operated only by qualified personnel.

Qualified personnel in the sense of these operating instructions consists of:

- ◆ Persons who, by virtue to their training, experience and instruction, and their knowledge of pertinent norms, specifications, accident prevention regulations and operational relationships, have been authorized by the officer responsible for the safety of the system to perform the required task and in the process are capable of recognizing potential hazards and avoiding them (definition of technical personnel according to VDE105 or IEC364),
- ◆ Persons who have a knowledge of first-aid techniques and the local emergency rescue services.
- ◆ Persons who have read and will observe the safety instructions.
- ◆ Those who have read and observe the manual or help (or the sections pertinent to the work to be carried out).

This applies to all work relating to setting up, commissioning, configuring, programming, modifying the conditions of utilization and operating modes, and to maintenance work.

This manual and the help information must be available close to the device during the performance of all tasks.

1.4.3. Special safety instructions

- ◆ Check the correct association of the device and its documentation.
- ◆ Never detach electrical connections while voltage is applied to them.
- ◆ Safety devices must be provided to prevent human contact with moving or rotating parts.
- ◆ Make sure that the device is operated only when it is in perfect condition.
- ◆ Implement and activate the stipulated safety functions and devices.
- ◆ Operate the device only with the housing closed.
- ◆ Make sure that all axes are sufficiently fixed.
- ◆ Attention during configuration downloads with master - slave couplings (electronic gear, cam)
Deactivate the drive before starting the configuration download: Master and Slave axis
- ◆ Check that all live terminals are secured against contact. Fatal voltage levels of to 850V occur.
- ◆ Do not bypass power direct current



Due to movable machine parts and high voltages, the device can pose a lethal danger. Danger of electric shock in the case of non-respect of the following instructions. The device corresponds to DIN EN 61800-3, i.e. it is subject to limited sale. The device can emit disturbances in certain local environments. In this case, the user is liable to take suitable measures.

- ◆ The device must be permanently grounded due to high earth leakage currents.
- ◆ The drive motor must be grounded with a suitable protective lead.
- ◆ The devices are equipped with high voltage DC condensers. Before removing the protective cover, the discharging time must be awaited. After switching off the energy, it may take up to 5 minutes to discharge the capacitors. Danger of electric shock in case of non respect.
- ◆ Before you can work on the device, the supply voltage must be switched off at the L1, L2 and L3 clamps. Wait at least 3 minutes so that the power direct current may sink to a secure value (<50V). Check with the aid of a voltmeter, if the voltage at the DC+ and DC- clamps has fallen to a value below 50V (not possible on the Compax3M).
- ◆ Do never perform resistance tests with elevated voltages (over 690V) on the wiring without separating the circuit to be tested from the drive.
- ◆ In the event of a device exchange it is absolutely necessary to transfer the configuration determining the correct operation of the drive to the device, before the device is put into operation.
- ◆ The device contains electrostatically sensitive components. Please heed the electrostatic protection measures while working at/with the device as well as during installation and maintenance.



Attention hot surface!

The heat dissipator can reach very high temperatures (>70°C)

Protective covers

The user is responsible for protective covers and/or additional safety measures in order to prevent damages to persons and electric accidents.

1.5 Warranty conditions

- ◆ The device must not be opened.
- ◆ Do not make any modifications to the device, except for those described in the manual.
- ◆ Make connections to the inputs, outputs and interfaces only in the manner described in the manual.
- ◆ Fix the devices according to our **mounting instructions**. (see page 64)
We cannot provide any guarantee for any other mounting methods.

Note on exchange of options

Compax3 options must be exchanged in the factory to ensure hardware and software compatibility.

- ◆ When installing the device, make sure the heat dissipators of the device receive sufficient air and respect the recommended mounting distances of the devices with integrated ventilator fans in order to ensure free circulation of the cooling air.
- ◆ Make sure that the mounting plate is not exposed to external temperature influences.

1.6 Conditions of utilization

In this chapter you can read about:

Conditions of utilization for CE-conform operation	16
Conditions of utilization for UL certification Compax3S	19
Current on the mains PE (leakage current)	20
Supply networks	21

1.6.1. Conditions of utilization for CE-conform operation

- Industry and trade -

The EC guidelines for electromagnetic compatibility 2006/95/EC and for electrical operating devices for utilization within certain voltage limits 2004/108/EC are fulfilled when the following boundary conditions are observed:

Operation of the devices only in the condition in which they were delivered, i.e. with all housing panels.

In order to ensure contact protection, all mating plugs must be present on the device connections even if they are not wired.

Mains filter: A mains filter is required in the mains input line if the motor cable exceeds a certain length. Filtering can be provided centrally at the plant mains input or separately at the mains input to each device or with C3M for each axis combination.

Devices in a commercial and residential area (limit values of Class C2 in accordance with EN 61800-3)

The following mains filters are available for independent utilization:

Device: Compax3	Order No.:	Condition:
S0xxV2	NFI01/01	Only for motor lines > 10m
S1xxV2, S0xxV4, S150V4	NFI01/02	Only for motor lines > 10m
S300V4	NFI01/03	independent of the length of the motor cable (always required)
Device: Compax3	Order No.:	Condition:
H050V4	NFI02/01	Only for motor lines > 10m
H090V4	NFI02/02	Only for motor lines > 10m
H1xxV4	NFI02/03	Only for motor lines > 10m

Industrial area (limit values class C3 in accordance with EN 61800-3)

Longer motor cable lengths are possible in industrial areas.

Devices in the industrial area (limit values class C3 in accordance with EN 61800-3)

The following mains filters are available for independent utilization:

Device: Compax3	Order No.:	Condition:
MP10	NFI03/01	Reference axis combination 6x10m
MP10	NFI03/02	Reference axis combination 6x50m

Connection length: Connection between mains filter and device:

unshielded: < 0.5m
shielded: < 5m (fully shielded on ground – e.g. ground of control cabinet)

Motor and Feedback cable:

Operation of the devices only with motor and feedback cables whose plugs contain a special full surface area screening.

Requirements for Compax3S motor cable

<100 m (the cable must not be rolled up!)
 A **motor output filter** (see page 326) is required for motor cables >20m :
 ◆MDR01/04 (max. 6.3A rated motor current)
 ◆MDR01/01 (max. 16A rated motor current)
 ◆MDR01/02 (max. 30A rated motor current)

Requirements for Compax3H motor cable

A motor output filter is required for motor cables >50m. Please contact us.

Requirements for Compax3M motor cable

<80m per axis (the cable must not be rolled up!)
 The entire length of the motor cable per axis combination may not exceed 300m.
 A **motor output filter** (see page 326) is required for motor cables >20m :
 ◆MDR01/04 (max. 6.3A rated motor current)
 ◆MDR01/01 (max. 16A rated motor current)
 ◆MDR01/02 (max. 30A rated motor current)

Shielding connection of the motor cable

The cable should be fully screened and connected to the Compax3 housing. We offer a special Shield connecting terminal as accessory item (ZBH./...). The shield of the cable must also be connected with the motor housing. The fixing (via plug or screw in the terminal box) depends on the motor type.

Requirements for encoder cable Compax3:

<100m

Requirements for encoder cable Compax3M:

<80m

Requirements for other cables

Corresponding to the specifications of the terminal clamp with a temperature range of up to 60°C.

Motors: Operation with standard motors.

Control: Use only with aligned controller (to avoid control loop oscillation).

Grounding: Connect the filter housing and the Compax3 to the cabinet frame, making sure that the contact area is adequate and that the connection has low resistance and low inductance.
 Never mount the filter housing and the device on paint-coated surfaces!

Cable installation:

Signal lines and power lines should be installed as far apart as possible. Signal leads should never pass close to excessive sources of interference (motors, transformers, contactors etc.).

Accessories: Make sure to use only the accessories recommended by Parker

Connect all cable shields at both ends, ensuring large contact areas!

Warning:

This is a product in the restricted sales distribution class according to EN 61800-3. In a domestic area this product can cause radio frequency disturbance, in which case the user may be required to implement appropriate remedial measures.

1.6.2. Conditions of utilization for UL certification Compax3S

UL certification for Compax3S

conform to UL:	◆ according to UL508C
Certified	◆ E-File_No.: E235 342

The UL certification is documented by a "UL" logo on the device (type specification plate).



"UL" logo

Conditions of utilization

- ◆ The devices are only to be installed in a degree of contamination 2 environment (maximum).
- ◆ The devices must be appropriately protected (e.g. by a switching cabinet).
- ◆ The X2 terminals are not suitable for field wiring.
- ◆ Tightening torque of the field wiring terminals (green Phoenix plugs)

◆ C3S0xxV2	0.57 - 0.79Nm	5 - 7Lb.in
◆ C3S1xxV2, C3S0xxV4, C3S150V4	0.57 - 0.79Nm	5 - 7Lb.in
◆ C3S300V4	1.25 - 1.7Nm	11 - 15Lb.in
- ◆ Temperature rating of field installed conductors shall be at least 60°C Use copper lines only
Please use the cables described in the **accessories chapter** (see page 313, see page 315), they do have a temperature rating of at least 60°C.
- ◆ Maximum ambient temperature: 45°C.
- ◆ Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes and 480 volts maximum.



ATTENTION

Danger of electric shock.
Discharge time of the bus capacitor is 5 minutes.

- ◆ The drive provides internal motor overload protection.
This must be set so that 200% of the motor nominal current are not exceeded.
- ◆ Cable cross-sections
 - ◆ Mains input: corresponding to the recommended fuses.
 - ◆ **Motor cable:** (see page 332) corresponding to the **nominal output currents** (see page 367)
 - ◆ Maximum cross-section limited by the terminals mm² / AWG

◆ C3S0xxV2	2.5mm ²	AWG 12
◆ C3S1xxV2, C3S0xxV4, C3S150V4	4.0mm ²	AWG 10
◆ C3S300V4	6.0mm ²	AWG 7

◆ Fuses

In addition to the main fuse, the devices must be equipped with a S 201 K or S 203 K fuse made by ABB.

- ◆ C3S025V2: ABB, nominal 480V 10A, 6kA
- ◆ C3S063V2: ABB, nominal 480V, 16A, 6kA
- ◆ C3S100V2: ABB, nominal 480V, 16A, 6kA
- ◆ C3S150V2: ABB, nominal 480V, 20A, 6kA
- ◆ C3S015V4: ABB, nominal 480V, 6A, 6kA
- ◆ C3S038V4: ABB, nominal 480V, 10A, 6kA
- ◆ C3S075V4: ABB, nominal 480V, 16A, 6kA
- ◆ C3S150V4: ABB, nominal 480V, 20A, 6kA
- ◆ C3S300V4: ABB, nominal 480V, 25A, 6kA

1.6.3. Current on the mains PE (leakage current)



This product can cause a direct current in the protective lead. If a residual current device (RCD) is used for protection in the event of direct or indirect contact, only a type B (all current sensitive) RCD is permitted on the current supply side of this product. On the other hand a different protective measure must be taken, such as for example separation from the environment by double or enforced insulation or separation from the supply network by a transformer.

Please heed the connection instructions of the RCD supplier.

Mains filters do have high leakage currents due to their internal capacity. An internal mains filter is usually integrated into the Compax3 servo controllers. Additional leakage currents are caused by the capacities of the motor cable and of the motor windings. Due to the high clock frequency of the power output stage, the leakage currents do have high-frequency components. Please check if the FI protection switch is suitable for the individual application.

If an external mains filter is used, an additional leakage current will be produced.

The figure of the leakage current depends on the following factors:

- ◆ Length and properties of the motor cable
- ◆ Switching frequency
- ◆ Operation with or without external mains filter
- ◆ Motor cable with or without shield network
- ◆ Motor housing grounding (how and where)

Remark:

- ◆ The leakage current is important with respect to the handling and usage safety of the device.
- ◆ A pulsing leakage current occurs if the supply voltage is switched on.

Please note:

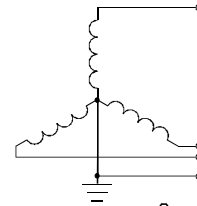
The device must be operated with effective grounding connection, which must comply with the local regulations for high leakage currents (>3.5mA).

Due to the high leakage currents it is not advisable to operate the servo controller with an earth leakage circuit breaker.

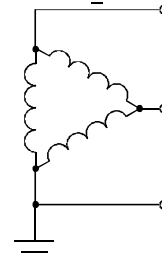
1.6.4. Supply networks

The Compax3 servo controller series is designed for fixed connection to TN networks (TN-C, TN-C-S or TN-S). Please note that the line-earth voltage may not exceed 300VAC.

- ◆ When grounding the neutral conductor, mains voltages of up to 480VAC are permitted.



- ◆ When grounding an external conductor (delta mains, two-phase mains), mains voltages (external conductor voltages) of up to 300VAC are permitted.



Servo controllers which are to be connected to an IT network must be provided with a separating transformer. Then the Compax3 device is operated locally like in a TN network. The secondary sided center of the separating transformer must be grounded and connected to the PE connector of the Compax3.

2. Compax3 Xxxx I30T11 Introduction

Due to its high functionality, the Positioning version of Compax3 forms an ideal basis for many applications in high-performance motion automation.

Up to 31 motion profiles with the motion functions:

- ◆ Absolute or relative positioning,
- ◆ electronic gearing
- ◆ register-related positioning,
- ◆ speed control,
- ◆ Stop - Set

can be created with the help of the PC software.

Via different operating modes:

- ◆ Speed Control
- ◆ Direct positioning
- ◆ Positioning with set selection

the motion functions can be triggered via the bus.

A number of different transfer telegrams, which can be conveniently adjusted with the Compax3 ServoManager), can be used to adjust cyclic bus communication to the requirements of specific applications.

Compax3 control technology

High-performance control technology and openness for various sender systems are fundamental requirements for a fast and high-quality automation of movement.

Model / standards / auxiliary material

The structure and size of the device are of considerable importance. High-quality electronics are a fundamental requirement for the particularly small and compact form of the Compax3 devices. All connectors are located on the front of the Compax3S.

Partly integrated mains filters permit connection of motor cables up to a certain length without requiring additional measures. EMC compatibility is within the limits set by EN 61800-3, Class A. The Compax3 is CE-conform.

The intuitive user interface familiar from many applications, together with the oscilloscope function, wizards and online help, simplifies making and modifying settings via the PC.

The optional **Operator control module (BDM01/01** (see page 353)) for Compax3S makes it possible to exchange devices quickly without requiring a PC.



Configuration

Configuration is made on a PC using the Compax3 ServoManager.
General proceeding (see page 83)

Ethernet Powerlink - characteristics

Profile	◆ Motion Control CiADS402
Baud rate	◆ 100Mbits (FastEthernet)
EDS file	◆ C3_EPL_cn.EDS
Service data object	◆ SDO
Cycle time	◆ <200µs, up to 240 nodes
Synchronicity precision of the SYNC telegram	◆ maximum jitter: +/-25µs ◆ Typical cycle times: >= 1ms
Typical cycle times	◆ >= 1ms
Deviations from the Device Profile DSP402	◆ For the velocity mode profile the setpoint acceleration is also applicable when braking. ◆ Only one rotation speed is possible for machine zero run start (objects 0x6099.1 and .2 are the same).

3. Compax3 device description

In this chapter you can read about:

Meaning of the status LEDs - Compax3 axis controller.....24
 Meaning of the status LEDs - Compax3MP (mains module).....24
 Connections of Compax3S.....25
 Compax3MP/Compax3M connections36
 Connections of Compax3H.....45
 Communication interfaces55
 Signal interfaces60
 Installation and dimensions Compax364
 Safety function – safe standstill – Compax3S72

3.1 Meaning of the status LEDs - Compax3 axis controller

Device status LEDs	Right LED (red)	Left LED (green)
Voltages missing	off	off
During the booting sequence	alternately flashing	
- No configuration present. - SinCos® feedback not detected. - Compax3 IEC61131-3 program not compatible with Compax3 Firmware. - no Compax3 IEC61131-3 program - For F12: Hall signals invalid.	Flashes slowly	off
Axis without current excitation	off	Flashes slowly
Power supplied to axis; commutation calibration running	off	Flashes quickly
Axis with current excitation	off	on
Axis in fault status / fault present / axis energized (error reaction 1)	Flashes quickly	on
Axis in fault status / fault present / axis deenergized (error reaction 2)	on	off
Compax3 faulty: Please contact us.	on	on

Note on Compax3H: The **internal** device status LEDs are only connected to the **external** housing LEDs, if the RS232 jumper at X10 is fitted to the control and the upper dummy cover is fitted.

3.2 Meaning of the status LEDs - Compax3MP (mains module)

C3MP10 Status LEDs	Left LED (green)	Right LED (red)
Control voltage 24 VDC iss missing	off	off
Error of mains module*	off	on
DC power voltage is built up	-	Flashes quickly
Phase failure / mains power supply undervoltage	on	Flashes slowly
Address assignment CPU active	Flashes quickly	-
Address assignment CPU completed	Flashes slowly	-
C3MPxx Ready - State	on	off

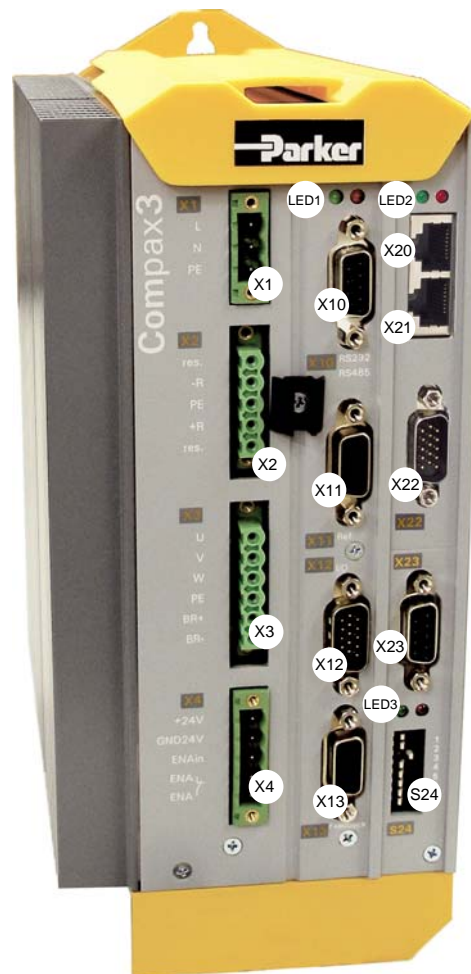
*can be read out in each axis controller

3.3 Connections of Compax3S

In this chapter you can read about:

Compax3S connectors 25
 Connector and pin assignment C3S 26
 Control voltage 24VDC / enable connector X4 C3S 28
 Motor / Motor brake (C3S connector X3) 29
 C3Sxxx V2 30
 C3Sxxx V4 33

3.3.1. Compax3S connectors



X1	AC Supply	X20	HEDA in (Option)
X2	Ballast / DC power voltage	X21	HEDA out (Option)
X3	Motor / Brake	X22	Inputs Outputs (Option M10/12)
X4	24VDC / Enable	X23	Bus (Option) connector type depends on the bus system!
X10	RS232/RS485	S24	bus settings
X11	Analog/Encoder	LED1	Device status LEDs
X12	Inputs/Outputs	LED2	HEDA LEDs
X13	Motor position feedback	LED3	Bus LEDs



Always switch devices off before wiring them!

Dangerous voltages are still present until 5 minutes after switching off the power supply!



Caution!

When the control voltage is missing there is no indication whether or not high voltage supply is available.



PE connection

The PE connection is made with 10mm² via a grounding screw at the bottom of the device.



Attention hot surface!

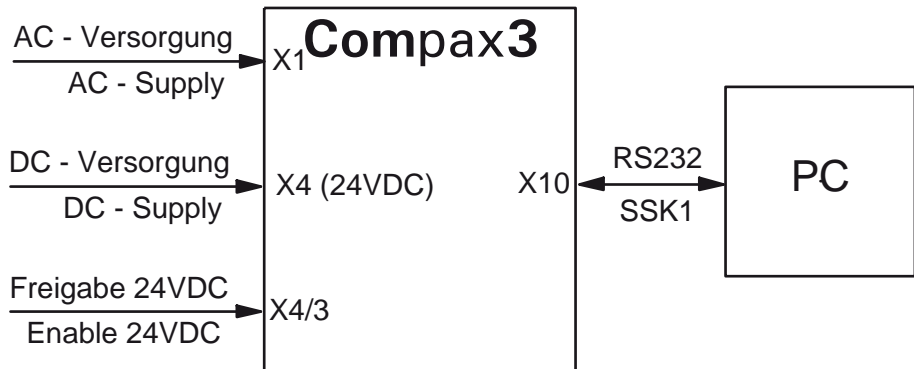
The heat dissipator can reach very high temperatures (>70°C)

Line cross sections of the line connections X1, X2, X3

Compax3 device:	Cross-section: Minimum... Maximum[mm ²]
S025V2, S063V2	0,25 ... 2.5 (AWG: 24 ... 12)
S100V2, S150V2 S015V4, S038V4, S075V4, S150V4	0,25 ... 4 (AWG: 24 ... 10)
S300V4	0,5 ... 6 (AWG: 20 ... 7)

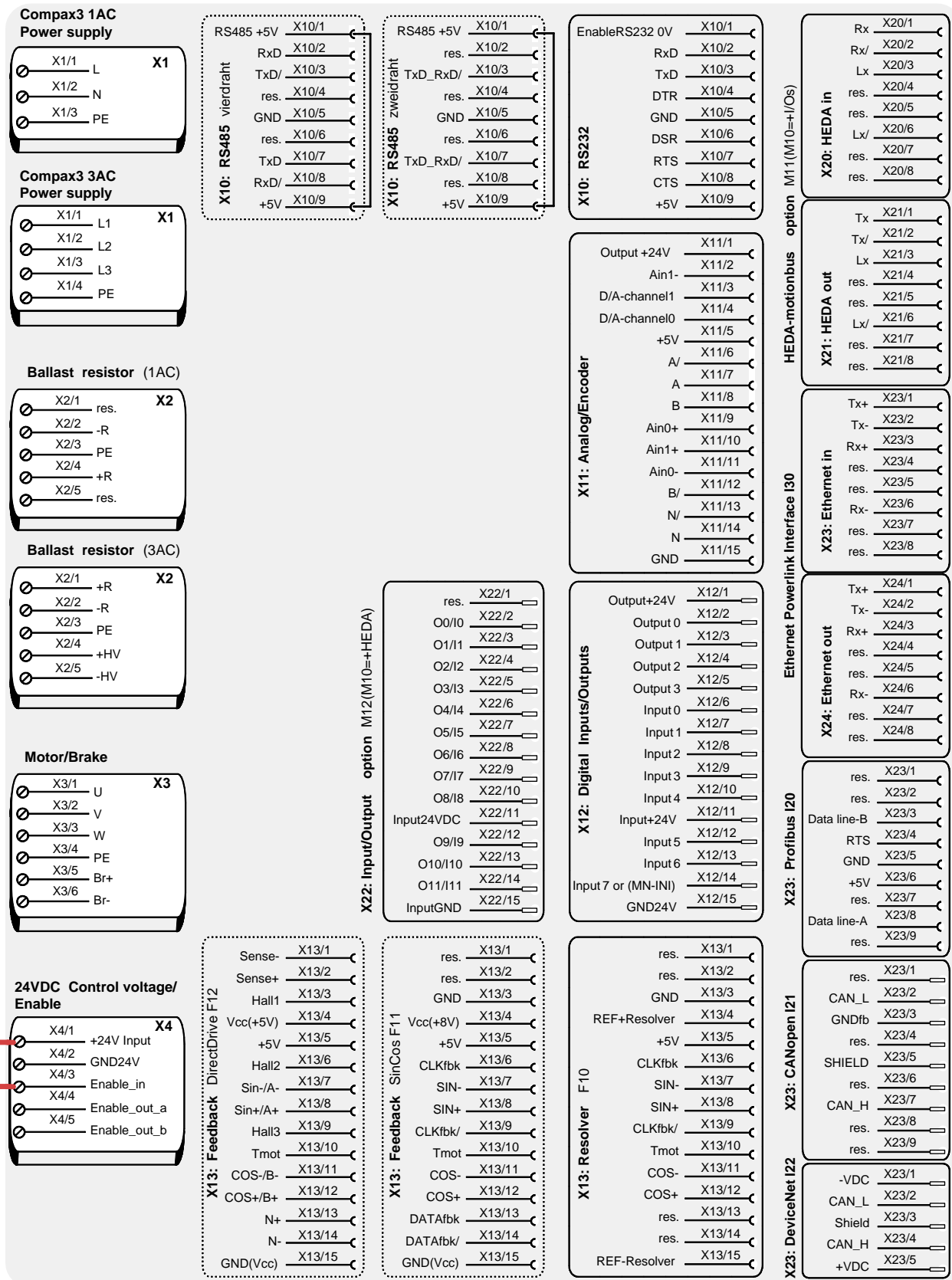
3.3.2. Connector and pin assignment C3S

Overview:



Further information on the assignment of the plug mounted at the particular device can be found below!

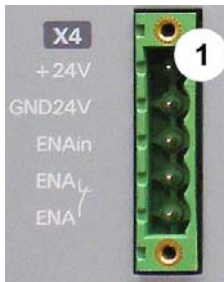
In detail: The fitting of the different plugs depends on the extension level of Compax3. In part, the assignment depends on the Compax3 option implemented.



The jumper drawn in at X4 (at the left side in red) is used to enable the device for testing purposes.

During operation, the enable input is in most cases switched externally.

3.3.3. Control voltage 24VDC / enable connector X4 C3S



PIN	Description
1	+24V (supply)
2	Gnd24 V
3	Enable_in
4	Enable_out_a
5	Enable_out_b

Line cross sections:
 minimum: 0.25mm²
 maximum: 2.5mm²
 (AWG: 24 ... 12)

Control voltage 24VDC Compax3S and Compax3H

Controller type	Compax3
Voltage range	21 - 27VDC
Mains module	with switch-on current limitation, due to capacitive load
Fuse	MTP miniature circuit breaker or "delayed action fuse", due to capacitive load
Current drain of the device	0.8A
Total current drain	0.8 A + Total load of the digital outputs + current for the motor holding brake
Ripple	0.5Vpp
Requirement according to safe extra low voltage (SELV)	yes
Short-circuit proof	conditional (internally protected with 3.15AT)

Hardware - enable (input X4/3 = 24VDC)

This input is used as safety interrupt for the power output stage.
 Tolerance range: 18.0V - 33.6V / 720Ω

Safe standstill (X4/3=0V)

For implementation of the "Safe standstill" safety feature in accordance with the "protection against unexpected start-up" described in EN1037. Observe instructions in the corresponding **section** (see page 72) with the circuitry examples!

The energy supply to the drive is reliably shut off, the motor has no torque. A relay contact is located between X4/4 and X4/5 (normally closed contact)

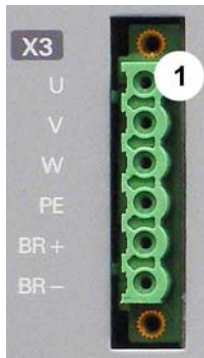
Enable_out_a - Enable_out_b	Power output stage is
Contact opened	activated
Contact closed	disabled

Series connection of these contacts permits certain determination of whether all drives are de-energized.

Relay contact data:

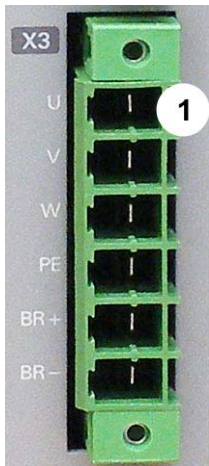
Switching voltage (AC/DC): 100mV -60V
 Switching current: 10mA - 0.3A
 Switching power: 1mW...7W

3.3.4. Motor / Motor brake (C3S connector X3)



PIN	Designation	
1	U (motor)	
2	V (motor)	
3	W (motor)	
4	PE (motor)	
5	BR+	Motor holding brake *
6	BR-	Motor holding brake *

*** Please note that Compax3 will report error "open circuit at holding brake" (5481h / 2163d) if the current is < 150mA. If needs be, use a parallel resistor of 150Ohm for relay control!**



Requirements for motor cable

<100 m (the cable must not be rolled up!)
 A **motor output filter** (see page 326) is required for motor cables >20m :

Shielding connection of the motor cable

The cable should be fully screened and connected to the Compax3 housing. We offer a special Shield connecting terminal as accessory item (ZBH./...). The shield of the cable must also be connected with the motor housing. The fixing (via plug or screw in the terminal box) depends on the motor type.

	<p>Motor holding brake! Connect the brake only on motors which have a holding brake! Otherwise make no brake connections at all.</p> <p>Requirements cables for motor holding brake If a motor holding brake is present, a cable of the motor holding brake must be fed on the device side through the toroidal core ferrite provided as accessory ZBH0x/xx (63Ω @1MHz, di=5.1mm), in order to ensure error-free switching on and off of the motor holding brake.</p>
--	---

Motor holding brake output

Motor holding brake output	Compax3
Voltage range	21 – 27VDC
Maximum output current (short circuit proof)	1.6A
Minimum output current	150 mA

Motor cable (see page 332)

3.3.5. C3Sxxx V2

In this chapter you can read about:

Main voltage supply C3S connector X130
 Braking resistor / high voltage DC C3S connector X231

3.3.5.1 Main voltage supply C3S connector X1

In this chapter you can read about:

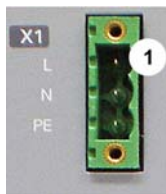
Power supply plug X1 for 1 AC 230VAC/240VAC devices30
 Power supply plug X1 for 3AC 230VAC/240VAC devices31

Device protection

By cyclically switching on and off the power voltage, the input current limitation can be overloaded, which will cause a device error.

Therefore please wait at least 2 minutes after switching off before you switch the device on again!

Power supply plug X1 for 1 AC 230VAC/240VAC devices



PIN	Designation
1	L
2	N
3	PE

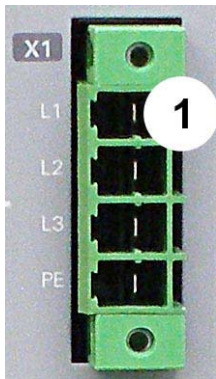
Mains connection Compax3S0xxV2 1AC

Controller type	S025V2	S063V2
Supply voltage	Single phase 230VAC/240VAC 80-253 VAC/50-60Hz	
Input current	6Aeff	13Aeff
Maximum fuse rating per device (=short circuit rating)	10 A (circuit breaker K)	16 A (circuit breaker K)



Always switch devices off before wiring them!

Dangerous voltages are still present until 5 minutes after switching off the power supply!



Power supply plug X1 for 3AC 230VAC/240VAC devices

PIN	Designation
1	L1
2	L2
3	L3
4	PE

Mains connection Compax3S1xxV2 3AC

Controller type	S100V2	S150V2
Supply voltage	Three phase 3* 230VAC/240VAC 80-253 VAC/50-60Hz	
Input current	10Aeff	13Aeff
Maximum fuse rating per device (=short circuit rating)	16 A (circuit breaker K)	20 A (circuit breaker K)

Caution!

The 3AC V2 – devices must only be operated with three phases!



Always switch devices off before wiring them!

Dangerous voltages are still present until 5 minutes after switching off the power supply!

3.3.5.2 Braking resistor / high voltage DC C3S connector X2

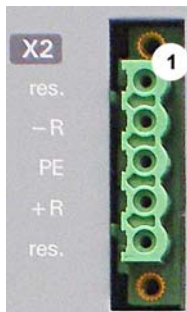
In this chapter you can read about:

Braking resistor / high voltage supply plug X2 for 1AC 230VAC/240VAC devices..... 31
 Braking resistor / high voltage supply plug X2 for 3AC 230VAC/240VAC devices..... 32
 Connection of a braking resistor..... 32

The energy generated during braking operation is absorbed by the Compax3 storage capacity.

If this capacity is too small, the braking energy must be drained via a braking resistor.

Braking resistor / high voltage supply plug X2 for 1AC 230VAC/240VAC devices



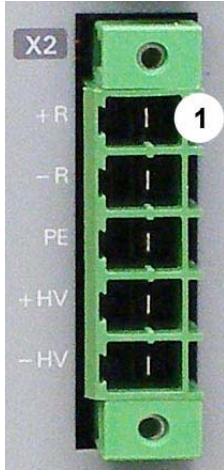
PIN	Designation
1	Reserved
2	- braking resistor (not short-circuit protected!)
3	PE
4	+ braking resistor (not short-circuit protected!)
5	Reserved

Braking operation Compax3S0xxV2 1AC

Controller type	S025V2	S063V2
Capacitance / storable energy	560µF / 15Ws	1120µF / 30Ws
Minimum braking- resistance	100Ω	56Ω
Recommended nominal power rating	20 ... 60W	60 ... 180W
Maximum continuous current	8A	15A

Caution! The power voltage DC of two Compax3 1AC V2 devices (230VAC/240VAC devices) must not be connected.

Braking resistor / high voltage supply plug X2 for 3AC 230VAC/240VAC devices



PIN	Description	
1	+ Braking resistor	no short-circuit protection!
2	- Braking resistor	
3	PE	
4	+ DC high voltage supply	
5	- DC high voltage supply	

Braking operation Compax3S1xxV2 3AC

Controller type	S100V2	S150V2
Capacitance / storable energy	780µF / 21Ws	1170µF / 31Ws
Minimum braking- resistance	22Ω	15Ω
Recommended nominal power rating	60 ... 450W	60 ... 600W
Maximum continuous current	20A	20A

Connection of a braking resistor

Minimum line cross section: 1.5mm²
 Maximum line length: 2m
 Maximum output voltage: 800VDC

3.3.6. C3Sxxx V4

In this chapter you can read about:

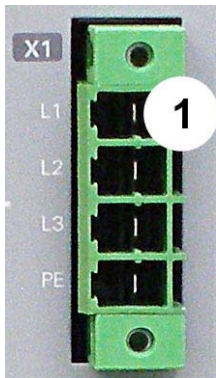
Power supply connector X1 for 3AC 400VAC/480VAC-C3S devices.....33
 Braking resistor / high voltage supply connector X2 for 3AC 400VAC/480VAC_C3S devices 34
 Connection of the power voltage of 2 C3S 3AC devices35

3.3.6.1 Power supply connector X1 for 3AC 400VAC/480VAC-C3S devices

Device protection

By cyclically switching on and off the power voltage, the input current limitation can be overloaded, which will cause a device error.

Therefore please wait at least 2 minutes after switching off before you switch the device on again!



PIN	Designation
1	L1
2	L2
3	L3
4	PE

Mains connection Compax3SxxxV4 3AC

Controller type	S015V4	S038V4	S075V4	S150V4	S300V4
Supply voltage	Three phase 3*400VAC/480VAC 80-528VAC / 50-60Hz				
Input current	3Aeff	6Aeff	10Aeff	16Aeff	22Aeff
Maximum fuse rating per device(=short circuit rating)	6A	10A	16A	20A	25A
	MTP miniature circuit breaker				D*

* for UL conform operation (see page 19): MTP miniature circuit breaker S273-K.

Caution!

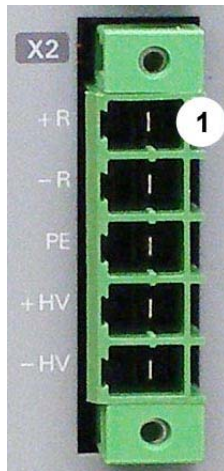
The 3AC V4 – devices must only be operated with three phases!



Always switch devices off before wiring them!

Dangerous voltages are still present until 5 minutes after switching off the power supply!

3.3.6.2 Braking resistor / high voltage supply connector X2 for 3AC 400VAC/480VAC_C3S devices



PIN	Description	
1	+ Braking resistor	no short-circuit protection!
2	- Braking resistor	
3	PE	
4	+ DC high voltage supply	
5	- DC high voltage supply	

Braking operation Compax3SxxxV4 3AC

Controller type	S015V4	S038V4	S075V4	S150V4	S300V4
Capacitance / storable energy	235 μ F / 37Ws	235 μ F / 37Ws	470 μ F / 75Ws	690 μ F / 110Ws	1100 μ F / 176Ws
Minimum braking-resistance	100 Ω	100 Ω	56 Ω	33 Ω	15 Ω
Recommended nominal power rating	60 ... 100W	60 ... 250W	60 ... 500 W	60 ... 1000 W	60 ... 1000 W
Maximum continuous current	10A	10A	15A	20A	30A

Connection of a braking resistor

Minimum line cross section: 1.5mm²
 Maximum line length: 2m
 Maximum output voltage: 800VDC

3.3.6.3 Connection of the power voltage of 2 C3S 3AC devices

Caution!

The power voltage DC of the single phase Compax3 servo axes must not be connected!

In order to improve the conditions during brake operation, the DC power voltage of 2 servo axes may be connected.

The capacity as well as the storable energy are increased; furthermore the braking energy of one servo axis may be utilized by a second servo axis, depending on the application.



It is not permitted to connect the power voltage in order to use one brake circuit for two servo axes, as this function cannot be ensured reliably.

Note the following:

Caution! In case of non-compliance with the following instructions, the device may be destroyed!

- ◆ You can only connect two similar servo axes (same power supply; same rated currents)
- ◆ Connected servo axes must always be fed separately via the AC power supply. If the external pre-fuse of one of the servo axes takes action, the second servo axis must also be disconnected automatically.

Please connect as follows:

Servo axis 1 X2/4 to servo axis 2 X2/4
Servo axis 1 X2/5 to servo axis 2 X2/5

3.4 Compax3MP/Compax3M connections

In this chapter you can read about:

Front connector 36
 Connections on the device bottom 37
 Connections of the axis combination 38
 Connector and pin assignment 39
 Control voltage 24VDC Compax3MP (mains module) 41
 Mains supply Compax3MP (mains module) 41
 Braking resistor / temperature switch Compax3MP (mains module) 42
 Motor / motor brake Compax3M (axis controller) 43

3.4.1. Front connector



MP	Power module
LED1	Status LEDs Mains module
S1	Basic address
X3	Configuraiton interface (USB)
X9	Supply voltage 24VDC
M	Axis controller
LED2	Status LEDs of the axis
S10	Function
X11	Analog/Encoder
X12	Inputs/Outputs
X13	Motor position feedback
X14	Safety technology (option)
X15	Motor temperature monitoring
LED3	HEDA LEDs
X20	HEDA in (Option)
X21	HEDA out (Option)
X22	Inputs Outputs (Option M10/12)
X23	Bus (option) connector type depends on the bus system!
X24	Bus (option) depends on the bus system!
LED4	Bus LEDs
S24	bus settings
1	Behind the yellow protective covers you can find the rails for the supply voltage connection. Supply voltage 24VDC DC power voltage supply

3.4.2. Connections on the device bottom



Always switch devices off before wiring them!

Dangerous voltages are still present until 5 minutes after switching off the power supply!



Caution!

When the control voltage is missing there is no indication whether or not high voltage supply is available.

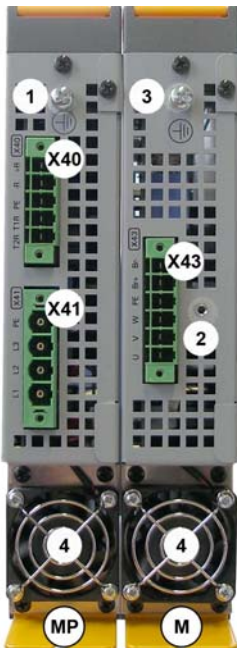


PE connection

The PE connection is made with 10mm² via a grounding screw at the bottom of the device.

Attention hot surface!

The heat dissipator can reach very high temperatures (>70°C)



MP		Power module
X40		Braking Resistor
X41		Mains supply VAC/PE
1		Central ground connection for the axis combination, with 10mm ² to the ground screw on the housing.
4		Fan*
M		Axis controller
X43		Motor / Brake
2		Fixing for motor shield clamp
4		Fan*
3		optionally, the axis controller features a ground screw on the housing, if the grounding is not possible via the back plate.

* is internally supplied.

Line cross-sections of the power connections (on the device bottoms)

Compax3 device:	Cross-section: Minimum... Maximum[mm ² with contactor sleeve]
M050, M100, M150	0,25 ... 4 (AWG: 23 ... 11)
MP10	Mains supply: 0,5 ... 6 (AWG: 20 ... 10) Braking resistor: 0,25 ... 4 (AWG: 23 ... 11)

3.4.3. Connections of the axis combination

The Compax3M axis controllers are connected to the supply voltages via rails.

- ◆ Supply voltage 24VDC
- ◆ DC power voltage supply

The rails can be found behind the yellow protective covers. In order to connect the rails of the devices, you may have to remove the yellow plastic device inserted at the side.

Protective covers

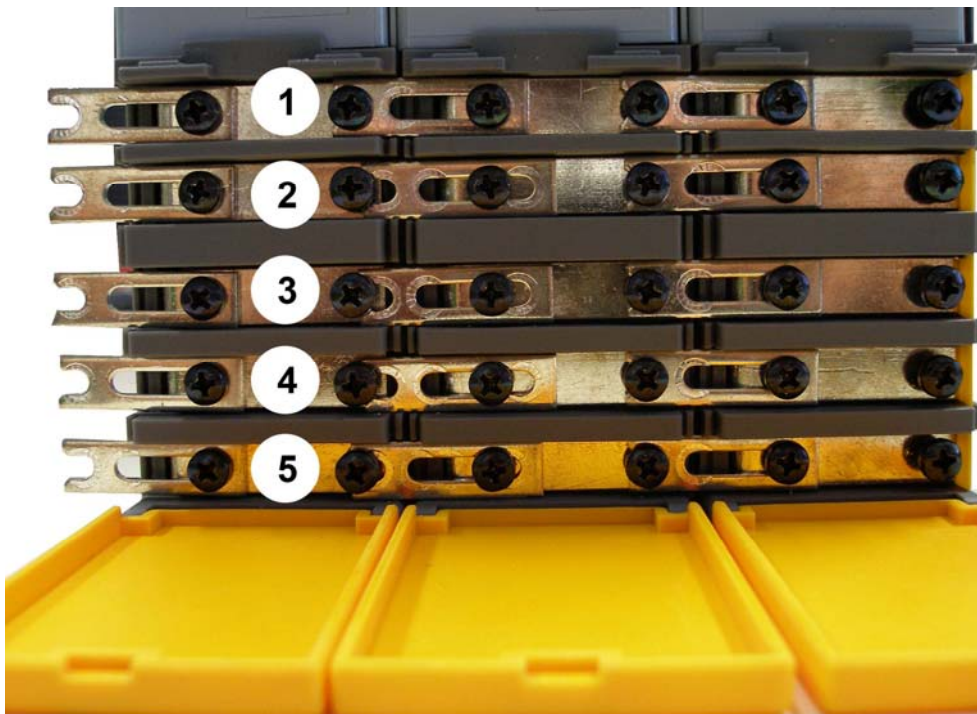


In order to secure the contact protection against the alive rails, it is absolutely necessary to respect the following:

Insert the yellow plastic device at the left or right of the rails.

Make sure that the yellow plastic device is placed at the left of the first device and at the right of the last device in the combination and have not been removed.

Setup of the devices only with closed protective covers.



- 1 24VDC
- 2 Gnd 24 V
- 3 -HV DC
- 4 PE
- 5 +HV DC

Note: External components **may not** be connected to the rail system.

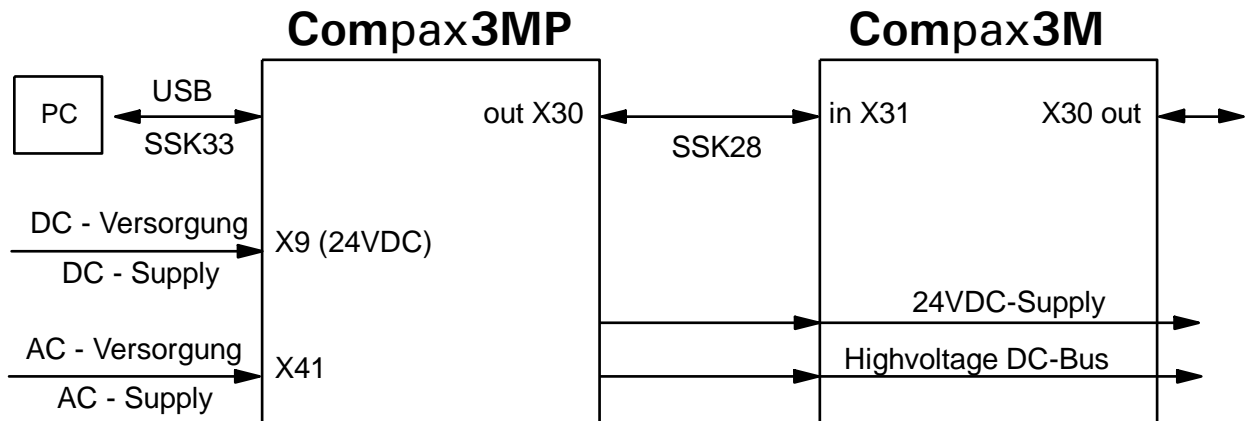
Protective covers



The user is responsible for protective covers and/or additional safety measures in order to prevent damages to persons and electric accidents.

3.4.4. Connector and pin assignment

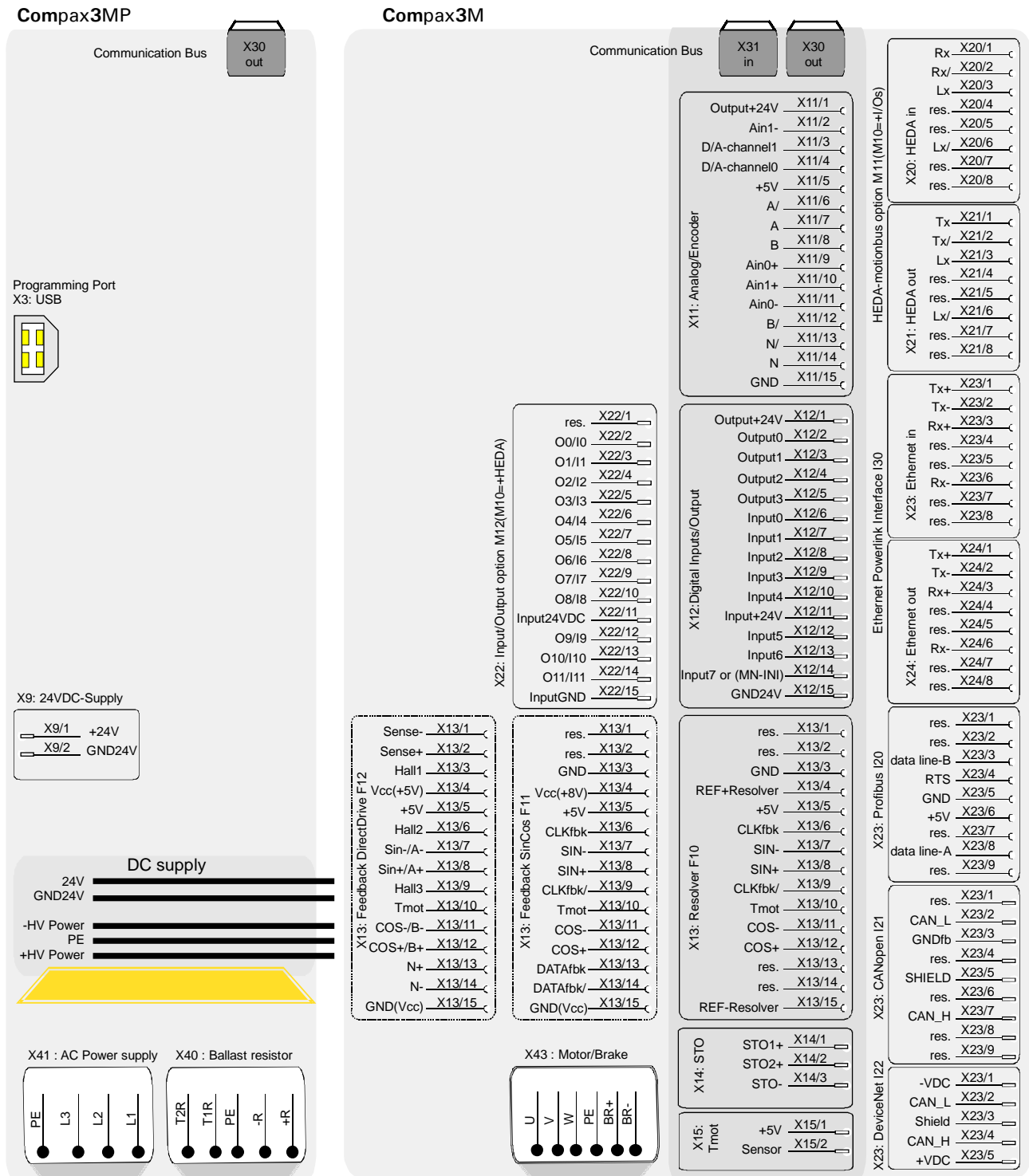
Overview:



Maximum no. of C3M axes in a combination: 15 axes (max. 2400µF)

Further information on the assignment of the plug mounted at the particular device can be found below!

In detail: The fitting of the different plugs depends on the extension level of Compax3. In part, the assignment depends on the Compax3 option implemented.



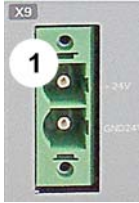
Protective covers



The user is responsible for protective covers and/or additional safety measures in order to prevent damages to persons and electric accidents.

3.4.5. Control voltage 24VDC Compax3MP (mains module)

connector X9



PIN	Designation
1	+24 V
2	Gnd 24 V

Line cross sections:
 minimum: 0.5mm² with contactor sleeve
 maximum: 6mm² with contactor sleeve
 (AWG: 20 ... 10)

Control voltage 24VDC Compax3MP / Compax3M

Device type	Compax3MP / Compax3M
Voltage range	21 - 27VDC
Mains module	with switch-on current limitation, due to capacitive load
Fuse	MTP miniature circuit breaker or "delayed action fuse", due to capacitive load
Current drain of the device	C3MP10D6: 0.2A
Total current drain	C3M050D6: 0.85A C3M100D6: 0.85A C3M150D6: 0.85A + Total load of the digital outputs + current for the motor holding brake
Ripple	0.5Vpp
Requirement according to safe extra low voltage (SELV)	yes
Short-circuit proof	conditional (internally protected with 3.15AT)

3.4.6. Mains supply Compax3MP (mains module)

Device protection

By cyclically switching on and off the power voltage, the input current limitation can be overloaded, which may cause damage to the device.

Wait at least one minute between two switching on processes!

Connector X41



Pin designation
PE
L3
L2
L1

Mains connection Compax3MP10D6

Device type Compax3	MP10
Supply voltage	Rated voltage 3AC 400V 230-480VAC ±10% / 50-60Hz
Input current	22Aeff
Maximum fuse rating per device (=short circuit rating)	25A MTP miniature circuit breaker (ABB) Recommendation: S203-K25

Caution!

The Compax3MP10D6 devices must only be operated with three phases!



Always switch devices off before wiring them!

Dangerous voltages are still present until 5 minutes after switching off the power supply!

3.4.7. Braking resistor / temperature switch Compax3MP (mains module)

The energy generated during braking operation must be dissipated via a braking resistor.

Connector X40



PIN	Description	
+R	+ Braking resistor	no short-circuit protection!
-R	- Braking resistor	
PE	PE	
T1R	Temperature Switch	
T2R	Temperature Switch	

Braking operation Compax3MP10D6 (mains module)

Device type Compax3	MP10
Capacitance / storable energy	550µF/ 92Ws at 400V 53Ws at 480V
Minimum braking- resistance	27Ω
Recommended nominal power rating	500 ... 1500W
Pulse power rating for 1s	22kW
Maximum permissible continuous current	13A

Braking operation Compax3MxxxD6 (axis controller)

Device type Compax3	M050	M100	M150
Capacitance / storable energy	110µF/ 18Ws at 400V 10Ws at 480V	220µF/ 37Ws at 400V 21Ws at 480V	220µF/ 37Ws at 400V 21Ws at 480V

Maximum capacity in the axis combination: 2400µF

Connection of a braking resistor on Compax3MP (mains module)

Minimum line cross section: 1.5mm²
 Maximum line length: 2m
 Maximum intermediate circuit voltage: 810VDC
 Switch-on threshold: 780VDC

3.4.7.1 Temperature switch Compax3MP (mains module)

Connector X40 Pin T1R, T2R

Temperature monitoring:

The temperature switch (normally closed contact) must be connected, unless an error message will be issued.

Temperature switch/relay

No galvanic separation, the temperature sensor (normally closed contact) must comply with the safe separation according to EN 60664.

If there is no temperature monitoring due to the connected braking resistor, the T1R and T2R connections must be connected by a jumper.

Without temperature monitoring, the braking resistor might be destroyed.



3.4.8. Motor / motor brake Compax3M (axis controller)

Connector X43



PIN	Designation
BR+	Motor holding brake *
BR-	Motor holding brake *
PE	PE (motor)
W	W (motor)
V	V (motor)
U	U (motor)

*** Please note that Compax3 will report error "open circuit at holding brake" (5481h / 2163d) if the current is < 150mA.**

Requirements for Compax3M motor cable


<80m per axis (the cable must not be rolled up!
 The entire length of the motor cable per axis combination may not exceed 300m.
 A **motor output filter** (see page 326) is required for motor cables >20m :
 ♦ MDR01/04 (max. 6.3A rated motor current)
 ♦ MDR01/01 (max. 16A rated motor current)
 ♦ MDR01/02 (max. 30A rated motor current)

Shielding connection of the motor cable

The cable should be fully screened and connected to the Compax3 housing. We offer a special Shield connecting terminal as accessory item (ZBH./...). The shield of the cable must also be connected with the motor housing. The fixing (via plug or screw in the terminal box) depends on the motor type.
Motor cables (see page 332) can be found in the accessories chapter of the device description.

Motor holding brake output

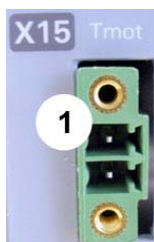
Motor holding brake output	Compax3
Voltage range	21 – 27VDC
Maximum output current (short circuit proof)	1.6A
Minimum output current	150 mA
Securing of brake Compax3M	3.15A

	<p>Motor holding brake! Connect the brake only on motors which have a holding brake! Otherwise make no brake connections at all.</p> <p>Requirements cables for motor holding brake If a motor holding brake is present, a cable of the motor holding brake must be fed on the device side through the toroidal core ferrite provided as accessory ZBH0x/xx (63Ω @1MHz, di=5.1mm), in order to ensure error-free switching on and off of the motor holding brake.</p>
---	--

3.4.8.1 Measurement of the motor temperature of Compax3M (axis controller)

Connector X15

The acquisition of the motor temperature by the axis controller can either take place via the connection of X15 (Tmot) or via the feedback cable and the corresponding connection on X13 PIN10.



PIN	Description
1	+5V
2	Sensor

The temperature acquisition on X15 Tmot can not be connected at the same time as X13 Pin 10.

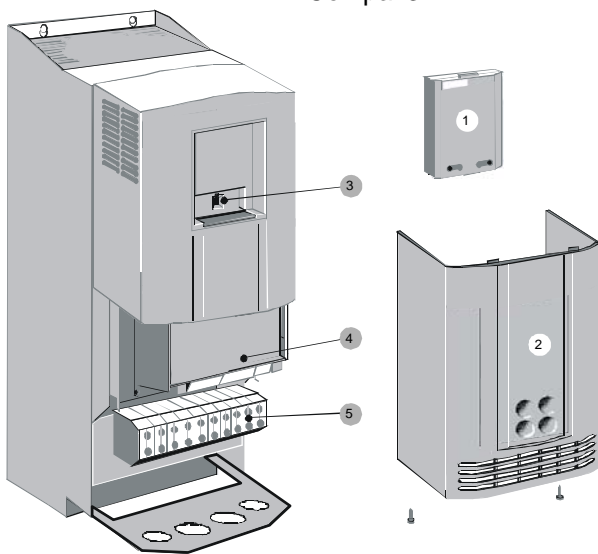
3.5 Connections of Compax3H

In this chapter you can read about:

Compax3H plugs/connections	45
Terminal clamps – max. line cross section C3H	47
Plug and pin assignment C3H	48
Motor / Motor brake C3H	50
Control voltage 24 VDC C3H	51
Mains connection Compax3H	52
Braking resistor / supply voltage C3H	52

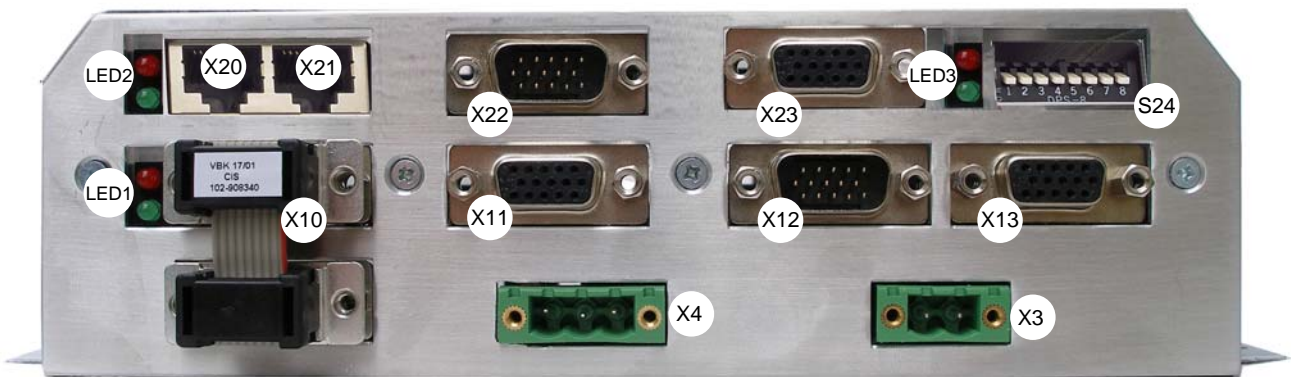
3.5.1. Compax3H plugs/connections

The following figure is an example for all sizes.
The fitting of the different controller plugs depends on the extension level of Compax3.



- (1): Dummy cover with display of the **external** device status LEDs.
- (2): lower clamp cover, fixed by 2 screws at the device bottom.
- (3): RS232 programming interface
Connection to the PC via adapter cable SSK32/20 (furnished with the device) and standard RS232 cable SSK1.
- (4): Controlling
- (5): Power connections

Controller front plate



X3	Motor brake	X20	HEDA in (Option)
X4	24VDC	X21	HEDA out (Option)
X10	RS232/RS485 with jumper to the programming interface	X22	Inputs Outputs (Option M10/12)
X11	Analog/Encoder	X23	Bus (Option) connector type depends on the bus system!
X12	Inputs/Outputs	S24	bus settings
X13	Motor position feedback	LED1	Device status LEDs
		LED2	HEDA LEDs
		LED3	Bus LEDs

Note on Compax3H: The **internal** device status LEDs are only connected to the **external** housing LEDs, if the RS232 jumper at X10 is fitted to the control and the upper dummy cover is fitted.

The RS232 programming interface under the upper dummy cover is only available if the X10 jumper at the controller is fitted.



Always switch devices off before wiring them!

Dangerous voltages are still present until 5 minutes after switching off the power supply!



Caution!

If the control voltage is missing and if the X10-X10 jumper is not fitted (VBK17/01) on the control part, the availability of power voltage is not displayed.



PE connection

The PE connection is made with 10mm² via a grounding screw at the bottom of the device.

Attention hot surface!

Metal parts can heat up to a temperature of 90°C during operation.



3.5.2. Terminal clamps – max. line cross section C3H

Terminal clamps – max. line cross section

The line cross sections must correspond to the locally valid safety regulations. The local regulations have always priority.

	Power clamps (minimum/maximum section)		Control lines
C3H050V4	2.5 / 16mm ²		2.5mm ²
	massive	multiwire	
C3H090V4	16 / 50mm ²	25 / 50mm ²	2.5mm ²
C3H1xxV4	25 / 95mm ²	35 / 95mm ²	2.5mm ²

The standard connection clamps of Compax3H090V4 and Compax3H1xxV4 are not suitable for flat line bars.

Cover plate for cable feedthrough

The cable feedthrough holes have the following dimensions:

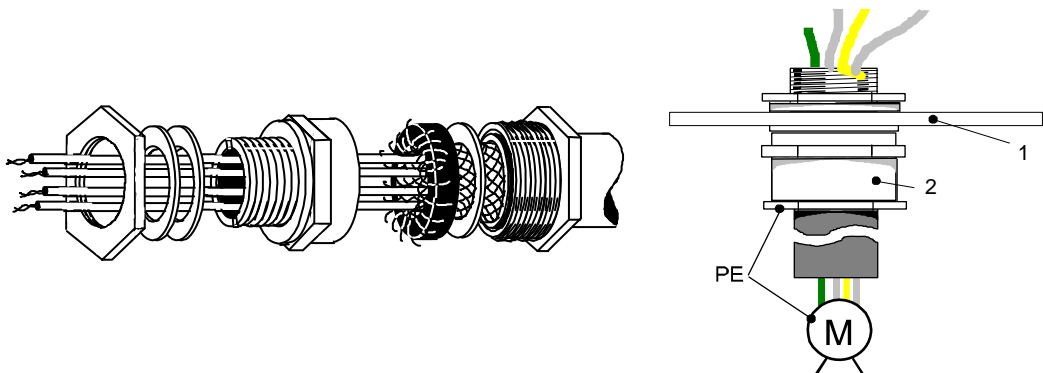
C3H050V4	28.6mm for M20, PG16 and ½" NPT (America). 37.3mm for M32, PG29 and 1" NPT (America).
C3H090V4	22.8mm for M20, PG16 and ½" NPT (America). 28.6mm for M25, PG21 and ¾" NPT (America). 47.3mm for M40, PG36 and 1¼" NPT (America). 54.3mm for M50, PG42 and 1½" NPT (America).
C3H1xxV4	22.8mm for M20, PG16 and ½" NPT (America) 28.6mm for M25, PG21 and ¾" NPT (America)

Recommended tightening torques

	High voltage supply	Braking Resistor	Grounding
C3H050V4	4Nm / 15.88kg-in	4Nm / 15.88kg-in	4.5Nm / 18.14kg-in
C3H090V4	6-8Nm / 53-70lb-in	6-8Nm / 53-70lb-in	6-8Nm / 53-70lb-in
C3H1xxV4	15-20Nm / 132-177lb-in	0.7Nm / 2.77kg-in	42Nm / 375lb-in

Cable joints

Use metallic cable joints permitting a 360° shielding in order to comply with the EMC directive.



1: Cable feedthrough plate

2: metallic joint with 360° shielding for EMC compliant design

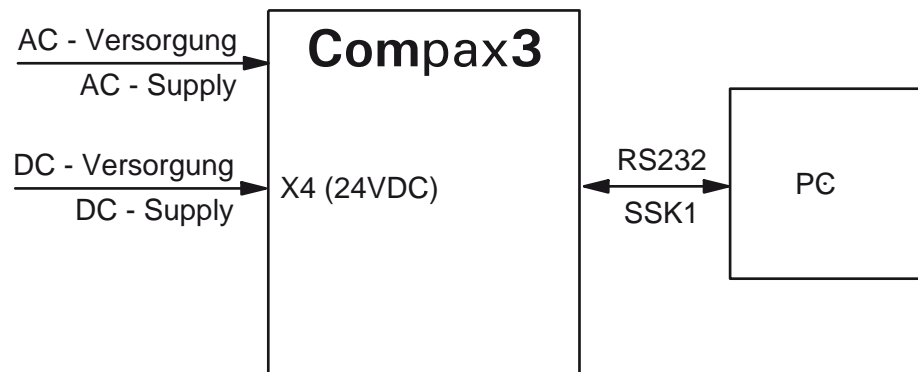
The device must be grounded without interruption according to EN 61800-5-1. The mains supply lines must be protected with a suitable fuse or a circuit breaker (FI switches or earth fault fuses are not recommended).

For installation in accordance with EN 61800-5-1 mm Europe:

- ◆ For grounding without interruption, two separate protective leads (<10mm² cross-section) or one lead (>10mm² cross-section) are required. Each protective lead must meet the requirements according to EN 60204.

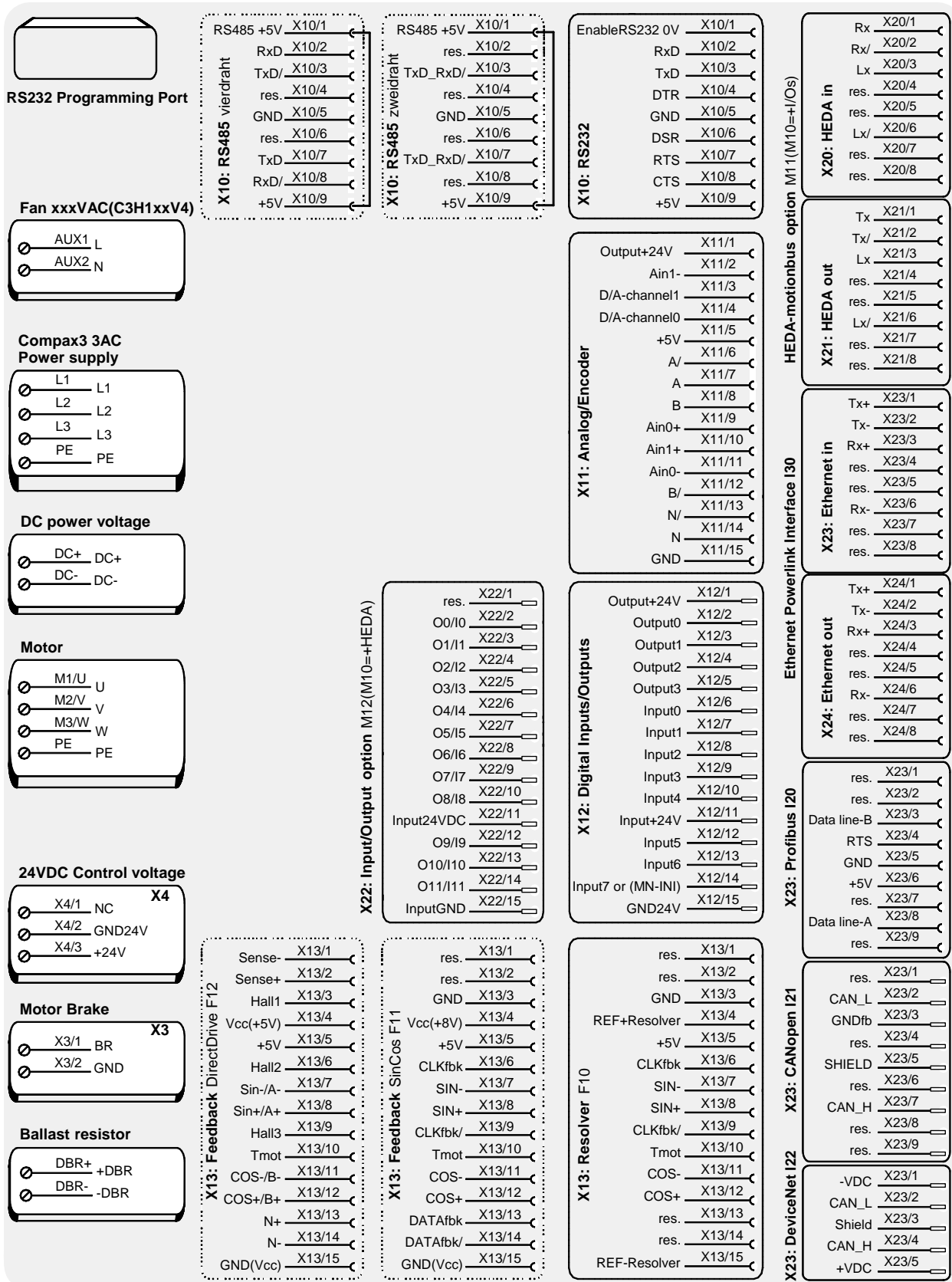
3.5.3. Plug and pin assignment C3H

Overview



Further information on the assignment of the plug mounted at the particular device can be found below!

In detail: The fitting of the different plugs depends on the extension level of Compax3. In part, the assignment depends on the Compax3 option implemented.



The RS232 programming interface under the upper dummy cover is only available if the X10 jumper at the controller is fitted.

Please note

C3H1xxV4 uses a ventilator fan which must be externally supplied via separate connections. The ventilator fan is available in two versions for single phase feed: 220/240VAC 110/120VAC

3.5.4. Motor / Motor brake C3H

Motor connection clamps

PIN	Designation
M1/U	U (motor)
M2/V	V (motor)
M3/W	W (motor)
PE	PE (motor)

Requirements for Compax3H motor cable

A motor output filter is required for motor cables >50m. Please contact us.

Shielding connection of the motor cable

The motor cable should be fully screened and connected to the Compax3 housing. The shield of the motor cable must also be connected with the motor housing. The fixing (via plug or screw in the terminal box) depends on the motor type.



Motor holding brake!

Connect the brake only on motors which have a holding brake! Otherwise make no brake connections at all.

Requirements cables for motor holding brake

If a motor holding brake is present, a **cable** of the motor holding brake must be fed on the device side through the toroidal core ferrite provided as accessory ZBH0x/xx (63Ω @1MHz, di=5.1mm), in order to ensure error-free switching on and off of the motor holding brake.



Connection of motor brake X3

PIN	Designation
1	BR
2	GND

Motor holding brake output

Motor holding brake output	Compax3
Voltage range	21 – 27VDC
Maximum output current (short circuit proof)	1.6A
Minimum output current	150 mA

3.5.5. Control voltage 24 VDC C3H



Connector X4 Pin	Description	
1	NC	NC
2	Gnd 24 V	GND
3	+24V	24 VDC (power supply)

Control voltage 24VDC Compax3S and Compax3H

Controller type	Compax3
Voltage range	21 - 27VDC
Mains module	with switch-on current limitation, due to capacitive load
Fuse	MTP miniature circuit breaker or "delayed action fuse", due to capacitive load
Current drain of the device	0.8A
Total current drain	0.8 A + Total load of the digital outputs + current for the motor holding brake
Ripple	0.5Vpp
Requirement according to safe extra low voltage (SELV)	yes
Short-circuit proof	conditional (internally protected with 3.15AT)

3.5.6. Mains connection Compax3H

Device protection

Avoid permanent switching on and off so that the charging connection is not overloaded.

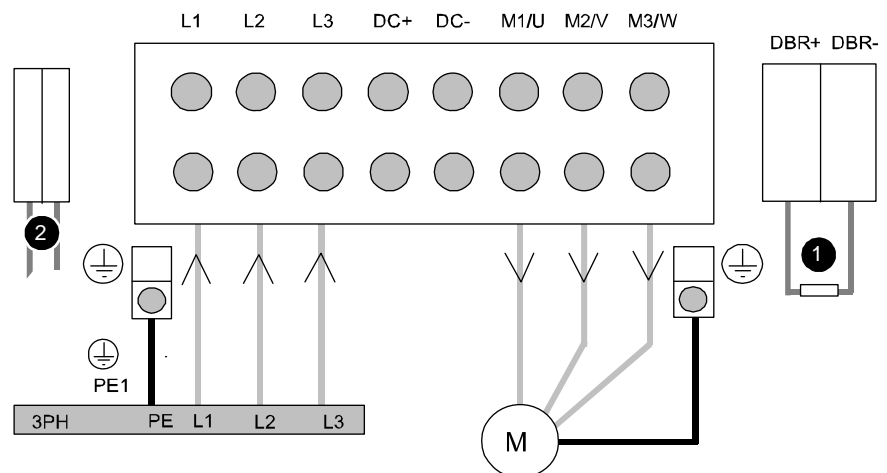
Mains connection Compax3HxxxV4

Controller type	H050V4	H090V4	H125V4	H155V4
Supply voltage	Three phase 3*400VAC/480VAC 350-528VAC / 50-60Hz			
Input current	54Aeff	93Aeff	118Aeff	140Aeff
Maximum fuse rating per device(=short circuit rating)	60A JDDZ class K5, JDRX class H	100A JDDZ class H5, JDRX class H	125A	150A

The terminal block of the drive can be found under the front cover. It is secured with 2 screws at the bottom of the device. Remove the bottom cover in order to access the connection clamps.

Make sure that all live parts are covered by the housing after installation.

Illustration of the connection clamps exemplarily for all sizes:



L1, L2, L3: 3 phase mains connection

M1, M2, M3: Motor connections

DC+, DC-: DC link voltage

(1) DBR+ und DBR-: Connection of external braking resistor

(2) AUX1, AUX2: only with C3H1xxV4 external supply (AC) for device ventilator L, N

- ◆ All shields must be connected via a cable joint to the cable feedthrough plate.
- ◆ Braking resistor and cable must be shielded if they are not installed in a control cabinet.
- ◆ The standard connection clamps of C3H090V4 and C3H1xxV4 are **not** suitable for flat line bars.

3.5.7. Braking resistor / supply voltage C3H

The energy generated during braking operation is absorbed by the Compax3 storage capacity.

If this capacity is too small, the braking energy must be drained via a braking resistor.

3.5.7.1 Connect braking resistor C3H

Connecting the braking resistor:

PIN	Designation
DBR+	+ Braking resistor
DBR-	- Braking resistor

Braking operation of Compax3HxxxV4

Controller type	H050V4	H090V4	H125V4	H155V4
Capacitance / storable energy	2600 μ F / 602Ws	3150 μ F / 729Ws	5000 μ F / 1158Ws	5000 μ F / 1158Ws
Minimum braking-resistance	24 Ω	15 Ω	8 Ω	8 Ω
Maximum continuous current	30A	45A	83A	83A

Minimum line cross section: 2.5mm²
 Maximum line length: 2m
 Maximum output voltage: 830VDC

3.5.7.2 Power supply voltage DC C3H

DC high voltage supply

PIN	Description
DC+	+ DC high voltage supply
DC-	- DC high voltage supply



"Warning: Do not connect any braking resistor on DC+/DC- !"

3.5.7.3 Connection of the power voltage of 2 C3H 3AC devices

In order to improve the conditions during brake operation, the DC power voltage of 2 servo axes may be connected.

The capacity as well as the storable energy are increased; furthermore the braking energy of one servo axis may be utilized by a second servo axis, depending on the application.



It is not permitted to connect the power voltage in order to use one brake circuit for two servo axes, as this function cannot be ensured reliably.

Note the following:

Caution! In case of non-compliance with the following instructions, the device may be destroyed!

- ◆ You can only connect two similar servo axes (same power supply; same rated currents)
- ◆ Connected servo axes must always be fed separately via the AC power supply.
- ◆ If the external pre-fuse of one of the servo axes takes action, the second servo axis must also be disconnected automatically.

Please connect as follows:

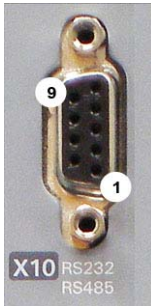
Servo axis 1 DC+ with servo axis 2 DC+
Servo axis 1 DC- with servo axis 2 DC-

3.6 Communication interfaces

In this chapter you can read about:

RS232 / RS485 interface (plug X10)	55
Communication Compax3M	56
Ethernet Powerlink X23, X24 (Option I30).....	58

3.6.1. RS232 / RS485 interface (plug X10)



Interface selectable by contact functions assignment of X10/1:

X10/1=0V RS232

X10/1=5V RS485

PIN X10	RS232 (Sub D)
1	(Enable RS232) 0V
2	RxD
3	TxD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	+5V

RS485 2-wire

PIN X10	RS485 two wire (Sub D) Pin 1 and 9 jumpered externally
1	Enable RS485 (+5V)
2	res.
3	TxD_RxD/
4	res.
5	GND
6	res.
7	TxD_RxD
8	res.
9	+5V

RS485 4-wire

PIN X10	RS485 four wire (Sub D) Pin 1 and 9 externally jumpered
1	Enable RS485 (+5V)
2	RxD
3	TxD/
4	res.
5	GND
6	res.
7	TxD
8	RxD/
9	+5V

USB - RS232 converter

The following USB - RS232 converters were tested:

- ◆ ATEN UC 232A
- ◆ USB GMUS-03 (available under several company names)

3.6.2. Kommunikation Compax3M

In this chapter you can read about:

- PC - Compax3MP (mains module)56
- Communication in the axis combination (connector X30, X31)56
- Adjusting the basic address.....57
- Setting the axis function.....57

3.6.2.1 PC - Compax3MP (mains module)

Connector X3



USB2.0
 Connect your PC to the USB sleeve X3 of the mains module via an USB cable (SSK33/03).

3.6.2.2 Communication in the axis combination (connector X30, X31)

The communication in the axis combination is implemented via a SSK28 cable and double RJ45 sleeves on the device top.
 Beginning with the Compax3MP (mains module) the connection is always made from X30 to X31 of the next device. On the first device (X31) and the last device (X30) in the multi-axis combination, a bus termination plug (BUS07/01) is required.

Orientation to the back side



Orientation to the front plate

Compax3MP (mains module)	
X30	out
X31	in
res.	Reserved
Compax3M (axis)	
X30	out
X31	in
res.	Reserved

3.6.2.3 Adjusting the basic address

On the mains module, the basic address of the device combination is set in steps of 16 with the aid of the first three dip switches.

The mains module contains the set basic address while the axes placed at the right in the combination contain the following addresses.

Switch S1



Address setting

Basic addresses

Switch	Value upon ON
1	16
2	32
3	64

Settings:

left: OFF

right: ON

Settable value range: 0, 16, 32, 48, 64, 80, 96, 112

Address of the 1st Compax3M = basic address+1

The addresses of the axis controllers are newly assigned after PowerOn.

Example:

Basic address = 48; mains module with 6 Compax3M axes in the combination.

1. Axis right: Address = 49

2. Axis right: Address = 50

...

6. Axis right: Address = 54

3.6.2.4 Setting the axis function

Switch S10

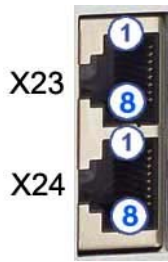


Function setting

The value of switch S10 on the axis controller is stored in object O110.1 and can be evaluated with the aid of a program.

This helps realize a more simple function selection.

3.6.3. Ethernet Powerlink X23, X24 (Option I30)



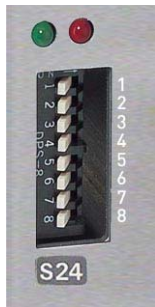
	RJ45 (X23)	RJ45 (X24)
PIN	in	out
1	Tx +	Tx +
2	Tx -	Tx -
3	Rx +	Rx +
4	-	Reserved
5	-	Reserved
6	Rx -	Rx -
7	-	Reserved
8	-	Reserved

Wiring with Ethernet Crossover cable Cat5e (from X24 to X23 of the next device without termination); for this, we recommend our **SSK28** (see page 316, see page 360) interface cable.

Meaning of the RJ45 LEDs

Green LED (top): connection established (RPT_LINK/RX)
 Yellow LED (bottom): Traffic (exchange of data) (Transmit / Receive Data) (RPT_ERR)

3.6.3.1 Adjusting the bus address



Address setting

Values:

1: 2⁰; 2: 2¹; 3: 2²; ... 7: 2⁶; 8: 2⁷

Settings:

left: OFF
 right: ON
 (The address is set to 0 in the illustration)

Range of values: 1 ... 239

3.6.3.2 Meaning of the Bus LEDs (Ethernet Powerlink)

Red LED (right): Ethernet Powerlink error

LED is influenced by the transitions of the NMT - status diagram (for further details, please refer to the **Ethernet Powerlink Specification**

http://www.parker.com/euro_emd/EME/downloads/compax3/EPL/epl2.0-ds-v-1-0-0.pdf)

Error LED	Transition
off => on	NMT_CT11, NMT_GT6, NMT_MT6
on => off	NMT_CT6, NMT_GT2, NMT_CT3, NMT_MT5

Green LED (left): Ethernet Powerlink Status

LED indicates the states of the NMT - status diagram (for further details, please refer to the **Ethernet Powerlink Specification**

http://www.parker.com/euro_emd/EME/downloads/compax3/EPL/epl2.0-ds-v-1-0-0.pdf)

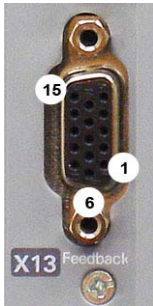
Status LED		status
off	off	NMT_GS_OFF, NMT_GS_INITIALISATION, NMT_CS_NOT_ACTIVE / NMT_MS_NOT_ACTIVE
flickering	flickering	NMT_CS_BASIC_ETHERNET
single flash	Single flash	NMT_CS_PRE_OPERATIONAL_1 / NMT_MS_PRE_OPERATIONAL_1
double flash	Double flash	NMT_CS_PRE_OPERATIONAL_2 / NMT_MS_PRE_OPERATIONAL_2
triple flash	Triple flash	NMT_CS_READY_TO_OPERATE / NMT_MS_READY_TO_OPERATE
on	on	NMT_CS_OPERATIONAL / NMT_MS_OPERATIONAL
blinking	flashing	NMT_CS_STOPPED

3.7 Signal interfaces

In this chapter you can read about:

Resolver / Feedback (connector X13)60
 Analog / Encoder (plug X11).....61
 Digital inputs/outputs (plug X12).....62

3.7.1. Resolver / Feedback (connector X13)



PIN X13	Feedback /X13 High Density /Sub D (depending on the Feedback module)		
	Resolver (F10)	SinCos (F11)	EnDat 2.1 (F12)
1	Reserved	Reserved	Sense -*
2	Reserved	Reserved	Sense +*
3	GND	GND	Reserved
4	REF-Resolver+	Vcc (+8V)	Vcc (+5V) * max. 350mA load
5	+5V (for temperature sensor)		
6	Reserved	Reserved	CLKfbk
7	SIN-	SIN-	SIN- / A- (Encoder)
8	SIN+	SIN+	SIN+ / A+ (Encoder)
9	Reserved	Reserved	CLKfbk/
10	Tmot*	Tmot*	Tmot*
11	COS-	COS-	COS- / B- (Encoder)
12	COS+	COS+	COS+ / B+ (Encoder)
13	Reserved	DATAfbk	DATAfbk
14	Reserved	DATAfbk/	DATAfbk/
15	REF-Resolver-	GND (Vcc)	GND (Vcc)

*X13 Pin10 Tmot may not be connected at the same time as X15 (on Compaxx3M).

Resolver cables (see page 329) can be found in the accessories chapter of the device description.

SinCos (see page 330)® cables (see page 330) can be found in the accessories chapter of the device description.

EnDat cable GBK38 (see page 331) can be found in the accessories chapter of the device description

PIN X13	Feedback /X13 High Density /Sub D
	Direct drives (F12)
1	Sense -*
2	Sense +*
3	Hall1 (digital)
4	Vcc (+5V) * max. 350mA load
5	+5V (for temperature and Hall sensors)
6	Hall2 (digital)
7	SIN-, A- (Encoder) or analog Hall sensor
8	SIN+, A+, (Encoder) or analog Hall sensor
9	Hall3 (digital)
10	Tmot*
11	COS-, B- (Encoder) or analog Hall sensor
12	COS+, B+ (Encoder) or analog Hall sensor
13	N+
14	N-
15	GND (Vcc)

*X13 Pin10 Tmot may not be connected at the same time as X15 (on Compaxx3M).

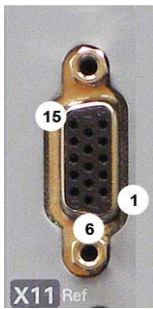
Note on F12:

*+5V (Pin 4) is measured and controlled directly at the end of the line via Sense – and Sense +.
Maximum cable length: 100m

Caution!

- ◆ Pin 4 and Pin 5 must under no circumstances be connected!
- ◆ Plug in or pull out feedback connector only in switched off state (24VDC switched off).

3.7.2. Analog / Encoder (plug X11)



PIN X11	Reference High Density Sub D		
		Encoder	SSI
1	+24V (output) max. 70mA		
2	Ain1 -: analog input - (14Bit; max. +/-10V)		
3	D/A monitor channel 1 (±10V, 8-bit resolution)		
4	D/A monitor channel 0 (±10V, 8-bit resolution)		
5	+5V (output for encoder) max. 150mA		
6	- Input: steps RS422 (5V - level)	A/ (Input / simulation)	Clock-
7	+ Input: steps RS422 (5V - level)	A (Input / simulation)	Clock+
8	+ Input: direction RS422 (5V - level)	B (Input / simulation)	
9	Ain0 +: analog input + (14Bit; max. +/-10V)		
10	Ain1 +: analog input + (14Bit; max. +/-10V)		
11	Ain0 -: analog input - (14Bit; max. +/-10V)		
12	- Input: direction RS422 (5V - level)	B/ (Input / simulation)	
13	Reserved	N/ (Input / simulation)	DATA-
14	Reserved	N (Input / simulation)	DATA+
15	GND		

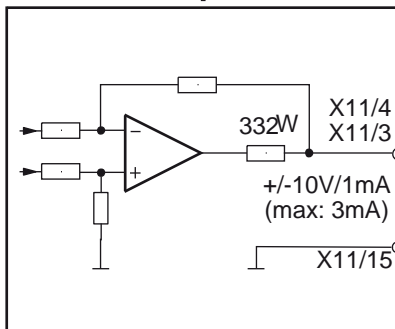
Technical data X11 (see page 374)

3.7.2.1 Wiring of analog interfaces

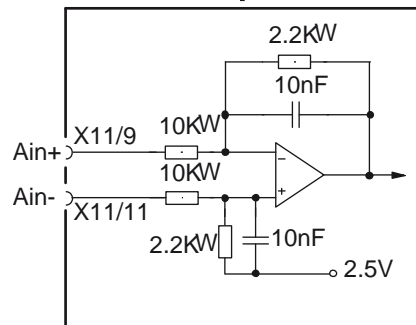
Output

Input

Compax3



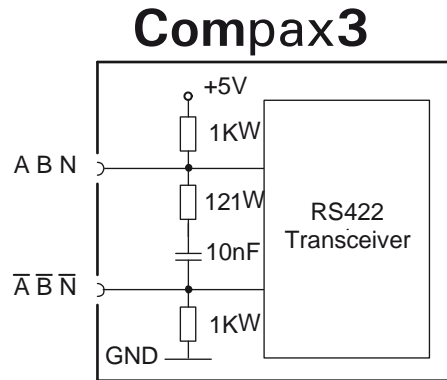
Compax3



Please note: with Ain- on earth and Ain+ open, 2.02V are read in.

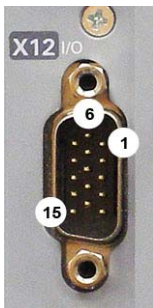
Ain1 (X11/10 and X11/2) has the same wiring!

3.7.2.2 Connections of the encoder interface



The input connection is available in triple (for A & /A, B & /B, N & /N)

3.7.3. Digital inputs/outputs (plug X12)



PIN X12	Input/output	High density/Sub D	
1	Output	+24VDC output (max. 400mA)	Only for "fixed assignment" Functions are available, if "Fixed assignment" was selected for the I/O assignment in the configuration wizard
2	O0	No Error	
3	O1	Position / velocity / gear synchronization reached (max. 100mA)	
4	O2	No power output stage current (max. 100mA)	
5	O3	Motor stationary with current, with setpoint 0 (max. 100mA)	
6	I0="1":	Quit (positive edge) / Energize the motor The address of the current motion set is read in new.	
	I0="0"	Motor deenergized with delay	
7	I1	No stop	
8	I2	JOG +	
9	I3	JOG -	
10	I4	Reg input	
11	E	24V input for the digital outputs Pins 2 to 5	
12	I5	Limit switch 1	
13	I6	Limit switch 2	
14	I7	Machine reference initiator	
15	Output	Gnd 24 V	

All inputs and outputs have 24V level.

Maximum capacitive loading of the outputs: 50nF (max. 4 Compax3-inputs can be connected)

Input-/Output extension (see page 362)

Optimization window display

The display of the digital inputs in the optimization window of the C3 ServoManager does not correspond to the physical status (24Volt=on, 0Volt=off) but to the logic status: If the function of an input or output is inverted (e.g. limit switch, negatively switching), the corresponding display (LED symbol in the optimization window) is OFF with 24Volts at the input and ON with 0 Volts at the input.

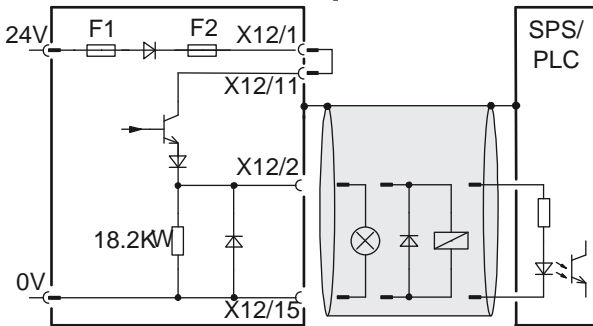
In operation via Ethernet Powerlink the inputs I0 ... I3 as well as the outputs O0 ... O3 can be freely assigned as an option.

Configurable via the C3 ServoManager (configuration: Operating mode / I/O assignment)

3.7.3.1 Connection of the digital Outputs/Inputs

Wiring of digital outputs

Compax3



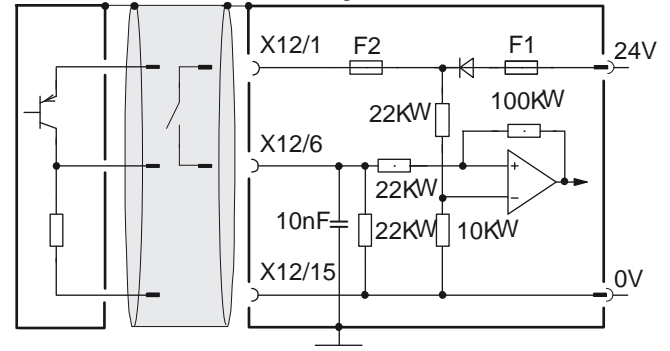
The circuit example is valid for all digital outputs!
The outputs are short circuit proof; a short circuit generates an error.

F1: delayed action fuse

F2: quick action electronic fuse; can be reset by switching the 24VDC supply off and on again.

Status of digital inputs

Compax3



The circuit example is valid for all digital inputs!
Signal level:

- ◆ > 9.15V is detected "1"
- ◆ > 8.05V is detected "0"

3.8 Installation and dimensions Compax3

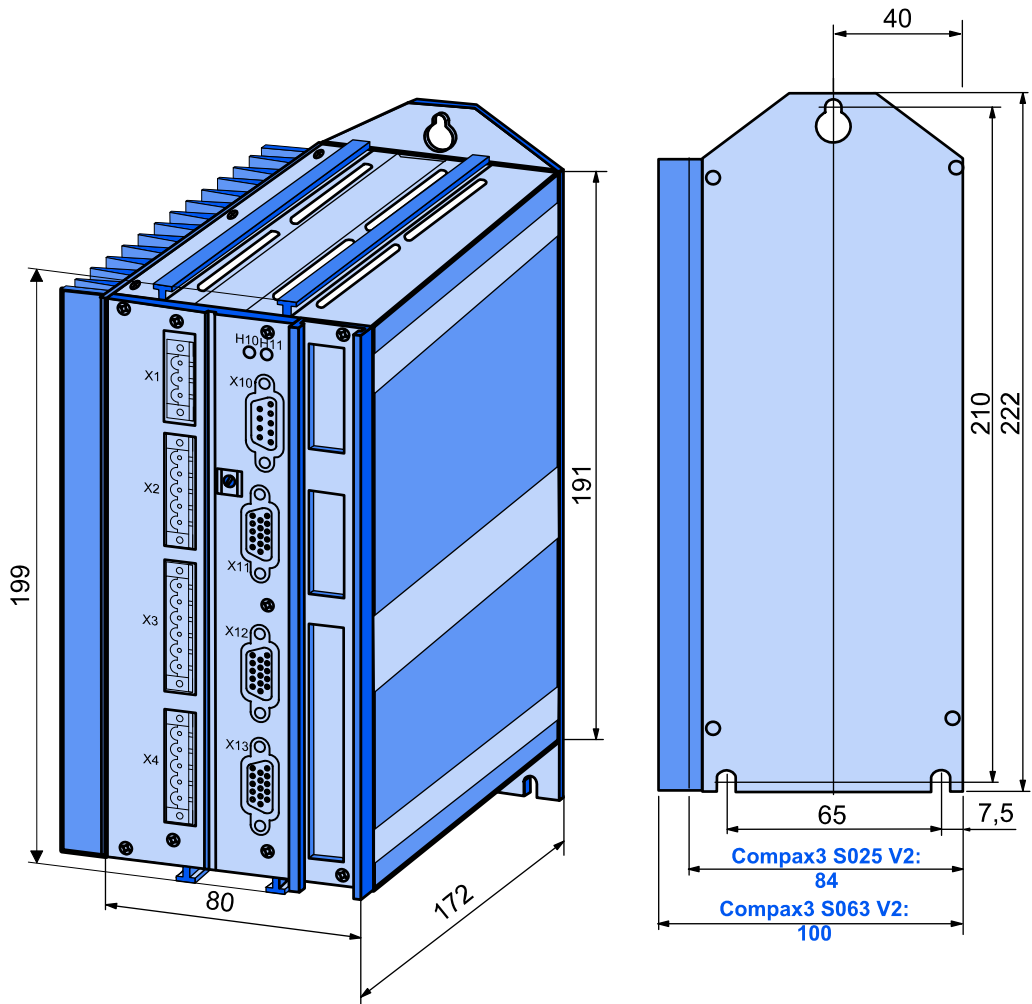
In this chapter you can read about:

Installation and dimensions of Compax3 S0xx V2.....	64
Monting and dimensions Compax3S100V2 and S0xxV4	65
Monting and dimensions Compax3S150V2 and S150V4.....	66
Mounting and dimensions Compax3S300V4.....	67
Mounting and dimensions C3MP/C3M	68
Mounting and dimensions C3H.....	69

3.8.1. Installation and dimensions of Compax3 S0xx V2

Mounting:

3 socket head screws M5



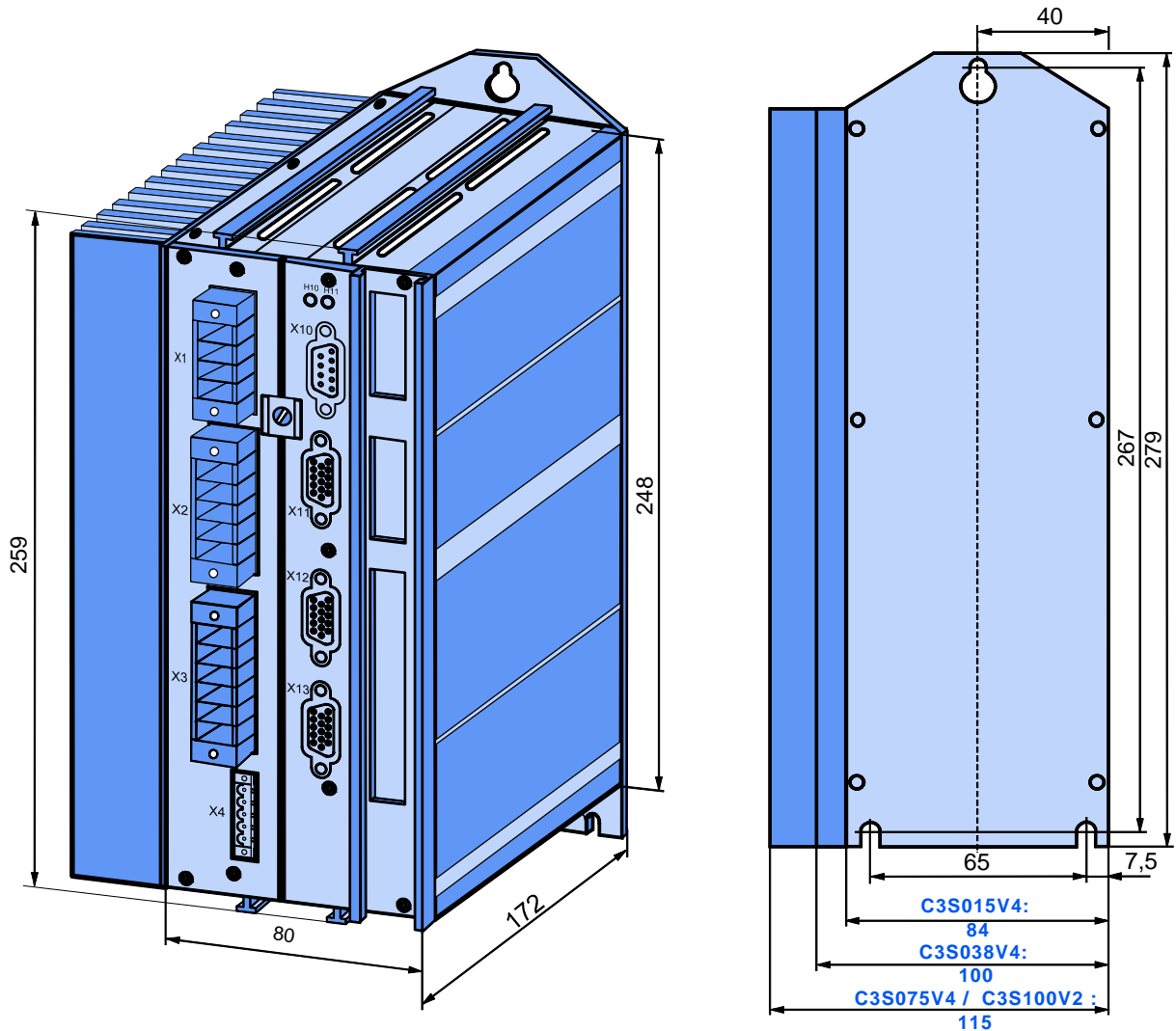
Please respect an appropriate mounting gap in order to ensure sufficient convection:

- ◆ At the side: 15mm
- ◆ At the top and below: at least 100mm

3.8.2. Monting and dimensions Compax3S100V2 and S0xxV4

Mounting:

3 socket head screws M5



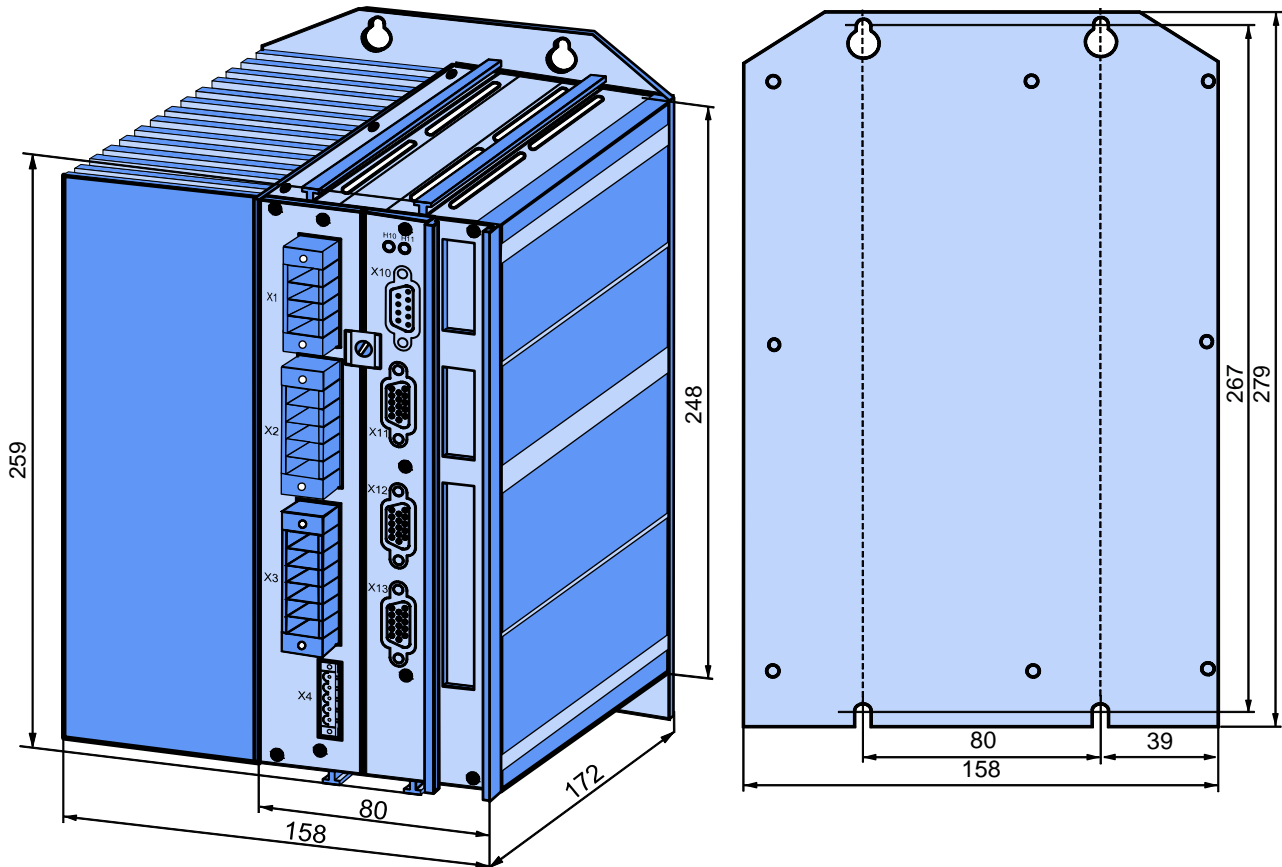
Please respect an appropriate mounting gap in order to ensure sufficient convection:

- ◆ At the side: 15mm
- ◆ At the top and below: at least 100mm

3.8.3. Monting and dimensions Compax3S150V2 and S150V4

Mounting:

4 socket head screws M5



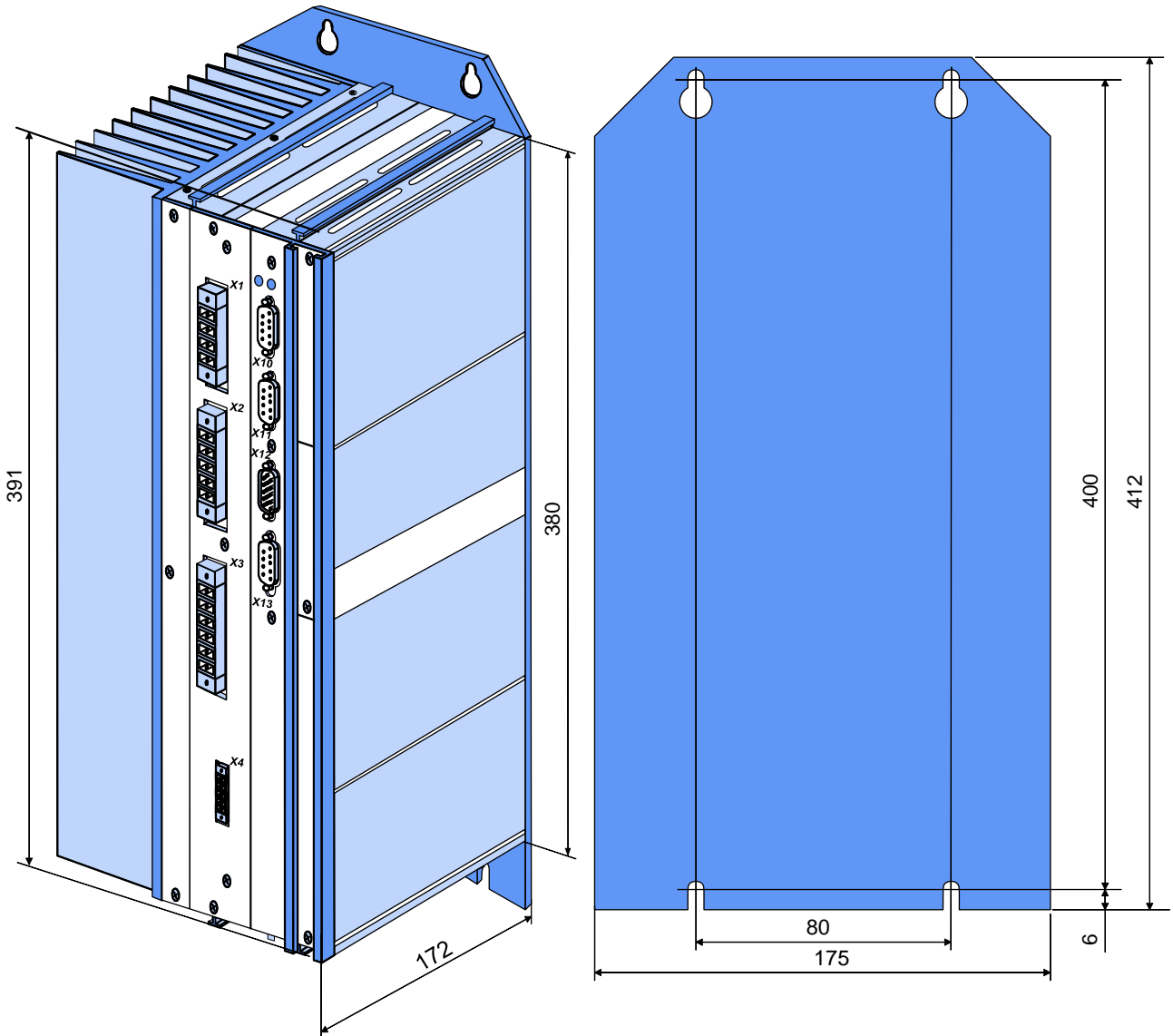
Please respect an appropriate mounting gap in order to ensure sufficient convection:

- ◆ At the side: 15mm
- ◆ At the top and below: at least 100mm

3.8.4. Mounting and dimensions Compax3S300V4

Mounting:

4 socket head screws M5



Please respect an appropriate mounting gap in order to ensure sufficient convection:

- ◆ At the side: 15mm
- ◆ At the top and below: at least 100mm

Compax3S300V4 is force-ventilated via a fan integrated into the heat dissipator!

3.8.5. Mounting and dimensions C3MP/C3M

Ventilation: During operation, the device radiates heat (power loss). Please provide for a sufficient mounting distance below and above the device in order to ensure free circulation of the cooling air. Please do also respect the recommended distances of other devices. Make sure that the mounting plate is not exhibited to other temperature influences than that of the devices mounted on this very plate. The devices must be mounted vertically on a level surface. Make sure that all devices are sufficiently fixed.

Compaxa3MP and Compax3M are force-ventilated via a ventilator fan fixed to the lower part of the heat dissipator!

Mounting spacing: At the top and below: at least 100mm

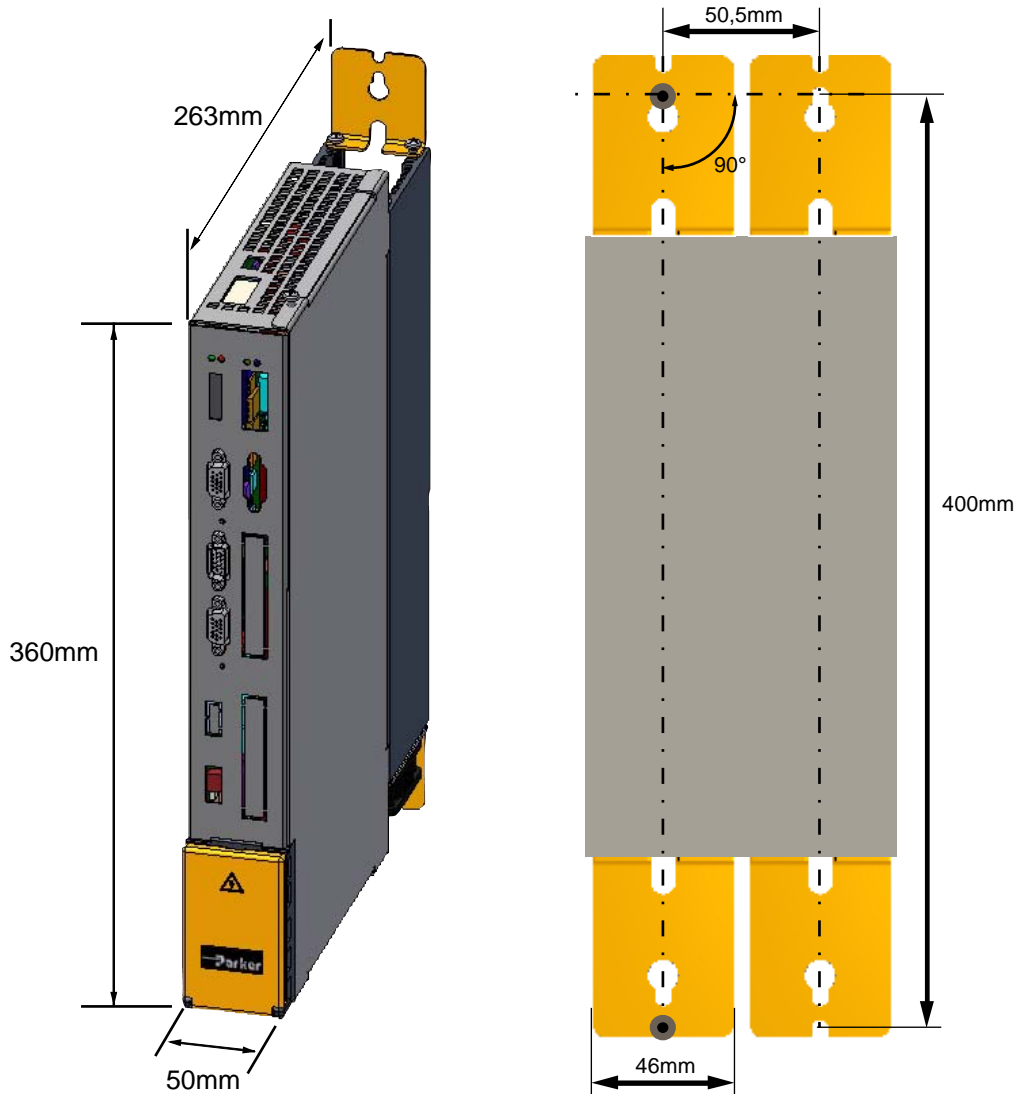
Information on

C3MP (mains module)
C3MP10D6

C3M (axis)
C3M050D6
C3M100D6
C3M150D6

Mounting:

2 socket head screws M5



Tolerances: DIN ISO 2768-f

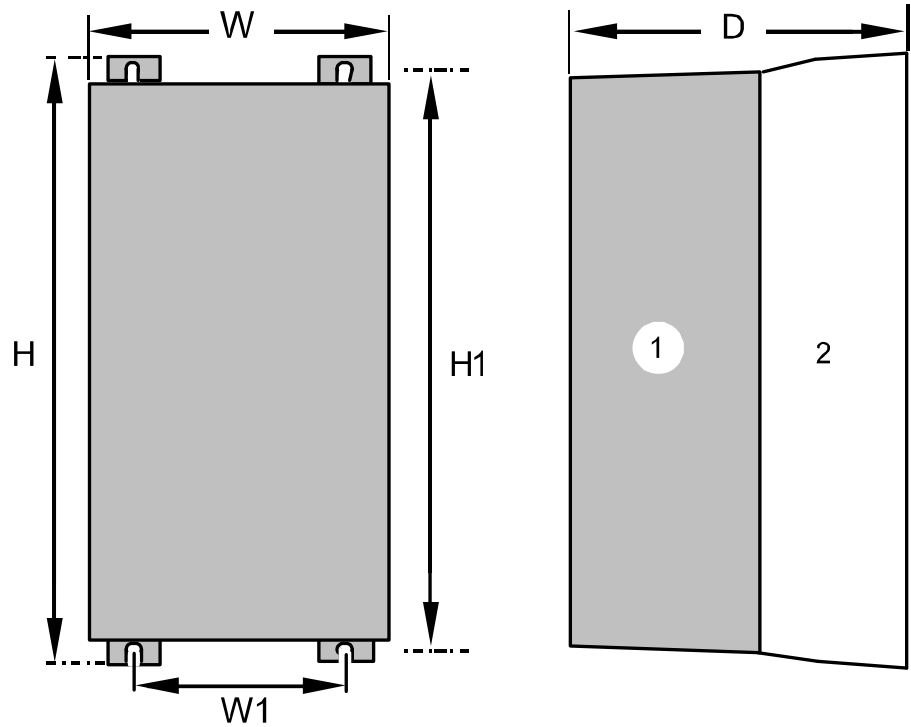
3.8.6. Mounting and dimensions C3H

In this chapter you can read about:

Mounting distances, air currents Compax3H050V470
 Mounting distances, air currents Compax3H090V470
 Mounting distances, air currents Compax3H1xxV471

The devices must be mounted vertically on a level surface in the control cabinet.

Dimensions:



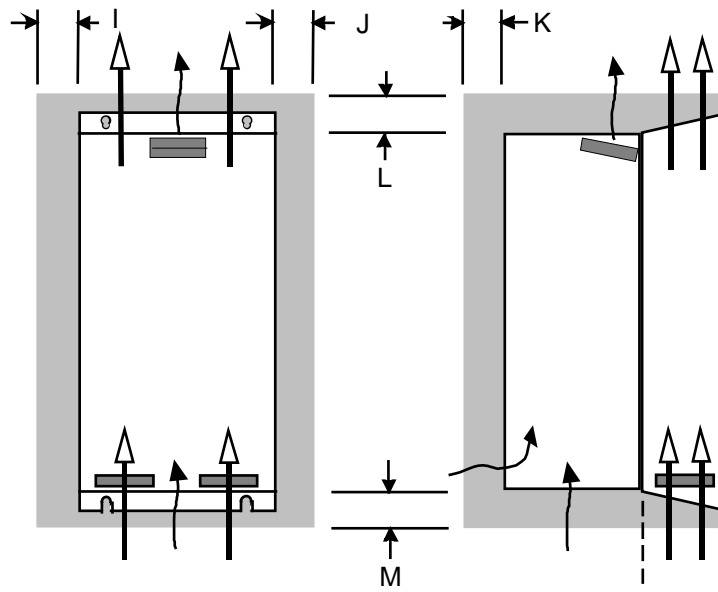
(1): Electronics
 (2): Head dissipator

	H	H1	D	W	W1
C3H050V4	453mm	440mm	245mm	252mm	150mm
C3H090V4	668.6mm	630mm	312mm	257mm	150mm
C3H1xxV4	720mm	700mm	355mm	257mm	150mm

Mounting: 4 screws M6

Ventilation: During operation, the device radiates heat (power loss). Please provide for a sufficient mounting distance below and above the device in order to ensure free circulation of the cooling air. Please do also respect the recommended distances of other devices. Make sure that the mounting plate is not exhibited to other temperature influences than that of the devices mounted on this very plate. If two or more devices are combined, the mounting distances are added.

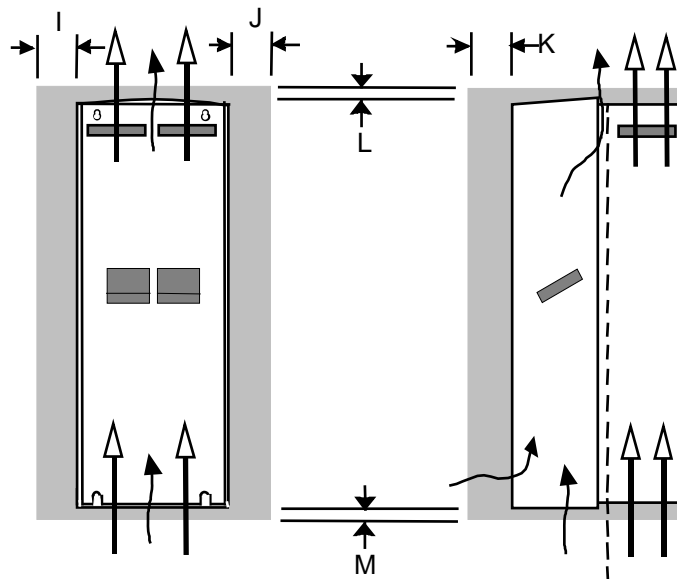
3.8.6.1 Mounting distances, air currents Compax3H050V4



in mm

	I	J	K	L	M
C3H050V4	15	5	25	70	70

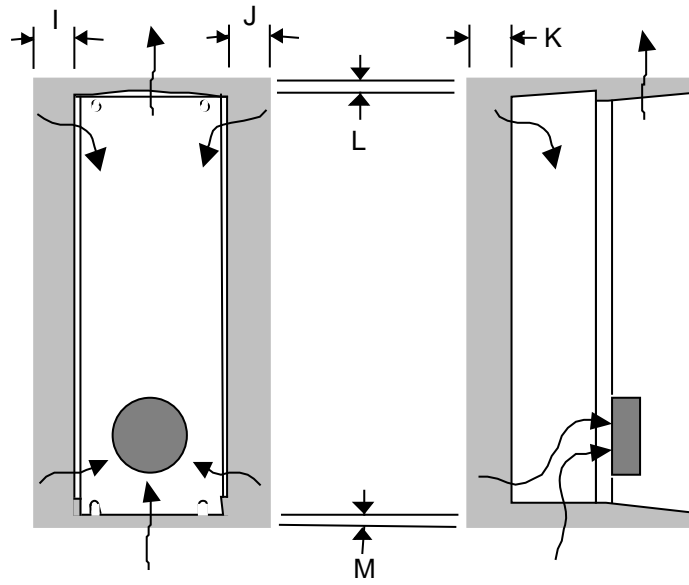
3.8.6.2 Mounting distances, air currents Compax3H090V4



in mm

	I	J	K	L	M
C3H090V4	0	0	25	70	70

3.8.6.3 Mounting distances, air currents Compax3H1xxV4



in mm

	I	J	K	L	M
C3H1xxV4	0	0	25	70	70

3.9 Safety function – safe standstill – Compax3S

In this chapter you can read about:

Safe standstill with Compax3 principle72
 Devices with the "Safe Standstill" safety function73
 Safety instructions for the "safe standstill" function74
 Application example for "safe standstill"75

Compax3S is equipped with the "Safe Standstill" safety feature. The "protection against unexpected start-up" described in EN1037 can be implemented with this feature.

3.9.1. Safe standstill with Compax3 principle

To ensure safe protection against a motor starting up unexpectedly, the flow of current to the motor and thus to the power output stage must be prevented. This is accomplished for Compax3 with two measures independent of each other (Channel 1 and 2), without disconnecting the drive from the power supply:

Channel 1:

Activation of the power output stage can be disabled in the Compax3 controller by means of a digital input or with a fieldbus interface (depending on the Compax3 device type) (deactivation of the energise input).

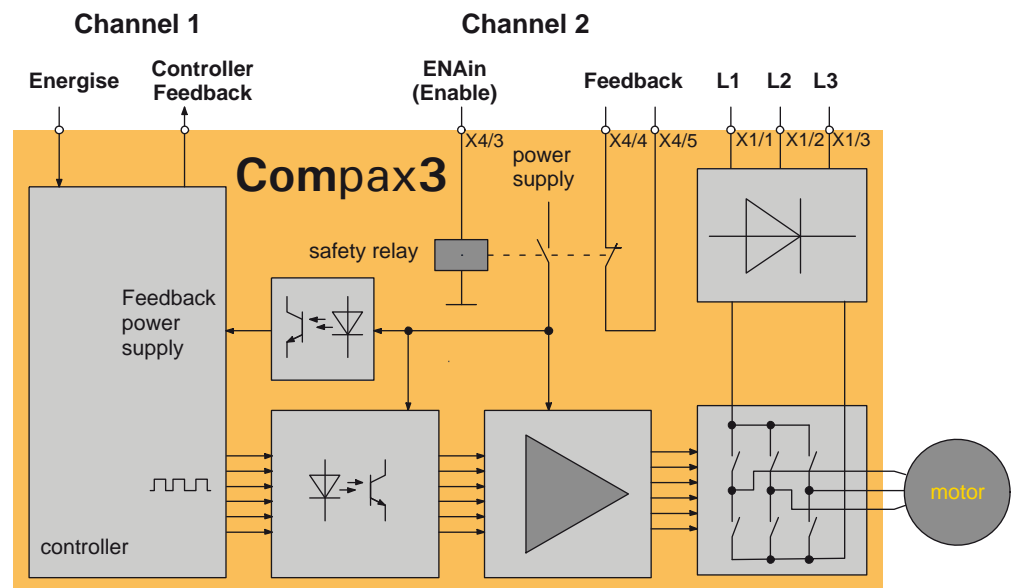
Channel 2:

The power supply for optocouplers and drivers of power output stage signals is disconnected by a safety relay activated by the enable input "ENAIN"(X4/3) and equipped with force-directed contacts. This prevents control signals from being transferred to the power output stage.



The "Safe Standstill" safety function as defined by EN 954-1 Category 3 is only possible if both channels are used.

Circuit diagram illustrating working principle:



Notes

- ◆ In normal operation of Compax3, 24 V DC of power is supplied to the "Enable" input (X4/3). The drive is then controlled by the digital inputs/outputs or the fieldbus.

When used properly, the "Safe standstill" safety function is only used when the motor is at a standstill, since it is not capable of braking a motor or bringing it to a standstill by itself.

3.9.2. Devices with the "Safe Standstill" safety function

The "Safe Standstill" safety function is implemented in the following devices:

Compax3 technology function	Device power
◆ I10T10, I11T11	◆ S025V2, S063V2
◆ I11T30, I20T30, I21T30, I22T30, I30T30	◆ S100V2, S150V2
◆ I11T40, I20T40, I21T40, I22T40, I30T40	◆ S015V4, S038V4
◆ I12T11, I20T11, I21T11, I22T11, I30T11	◆ S075V4, S150V4
◆ C10T11, C10T30, C10T40	◆ S300V4
◆ C13T11, C13T30, C13T40	

and does apply only for the safety switching devices used in the application examples.

3.9.3. Safety instructions for the "safe standstill" function

- ◆ Safety functions must be tested 100%.
- ◆ Only qualified staff members are permitted to install the "Safe Standstill" feature and place it in service.
- ◆ For all applications in which the first channel of the "Safe Standstill" is implemented by means of a PLC, care must be taken that the part of the program that is responsible for current flowing to or not flowing to the drive is programmed with the greatest possible care. The "Safe Standstill" application example of Compax3 with fieldbus should be considered.
The designer and operator responsible for the system and machine must refer programmers who are involved to these safety-related points.
- ◆ Terminal X4/2 (GND 24 V and at the same time the reference point for the safety relay bobbin) must be connected with the PE protective lead. This is the only way to ensure protection against incorrect operation through earth faults (EN60204-1 Section 9.4.3)!
- ◆ All conditions necessary for **CE conform operation** (see page 16) must be observed.
- ◆ It should be noted in connection with the "Safe Standstill" application example illustrated here that after the Emergency Power-off switch has been activated, no galvanic isolation in accordance with EN 60204-1 Section 5.5 is guaranteed. This means that the entire system must be disconnected from the mains power supply with an additional main switch or mains power contactor for repair jobs. Please note in this regard that even after the power is disconnected, dangerous electrical voltages may still be present in the Compax3 drive for about 5 minutes.
- ◆ When using an external Emergency power-off module with adjustable delay time, (as illustrated in the "Safe Standstill" application example), it must be ensured that the delay time cannot be adjusted by persons not authorized to do so (for example by applying a lead seal).
The adjustable delay time on the Emergency Power-off module must be set to a value greater than the duration of the braking ramp controlled by the Compax3 with maximum load and maximum speed.
If the setting range for the specified Emergency power-off module is not sufficient, the Emergency power-off module must be replaced by another comparable module.
- ◆ All safety-related external leads (for example the control lead for the safety relay and feedback contact) must absolutely be laid so they are protected, for example in a cable duct. Short circuits and crossed wires must be reliably excluded!
- ◆ If there are external forces operating on the drive axes, additional measures are required (for example additional brakes). Please note in particular the effects of gravity on suspended loads!
- ◆ If the power fails, the possibility must be considered that for the application with stop category K1, such as is described in the application example, it will no longer be possible to execute the braking ramp controlled to speed 0.
- ◆ It is important to note that if the drive is being activated (Energize) by the RS232 (RS485) interface, it may not be possible to execute switch-off by a controlled braking ramp. For example, this is true when the set-up window of the C3 ServoManager is used. If set-up mode is turned on, the digital I/O interface and fieldbus interface are automatically disabled.

3.9.4. Application example for "safe standstill"

In this chapter you can read about:

Safe standstill with bus option 75

The application example described here corresponds to Stop Category 1 as defined by EN60204-1.

A Stop Category 0 in accordance with EN 60204-1 can be implemented, for example by setting the delay time on the Emergency power-off switch to 0. The Compax3 drive will then be turned off immediately in 2 channels and will not be able to generate any more torque. Please take into consideration that the motor will not brake and a coasting down of the motor may result in hazards. If this is the case, a "Safe Standstill" in the stop category 0 is not permitted.

3.9.4.1 Safe standstill with bus option

In this chapter you can read about:

Note: 75
 Layout: 75
 Circuit example 76
 Description 79

Note:



If the "safe standstill" function of Compax3 is required or used for a machine or system, the errors:

- ◆ "Motor_Stalled" and
- ◆ "Tracking"

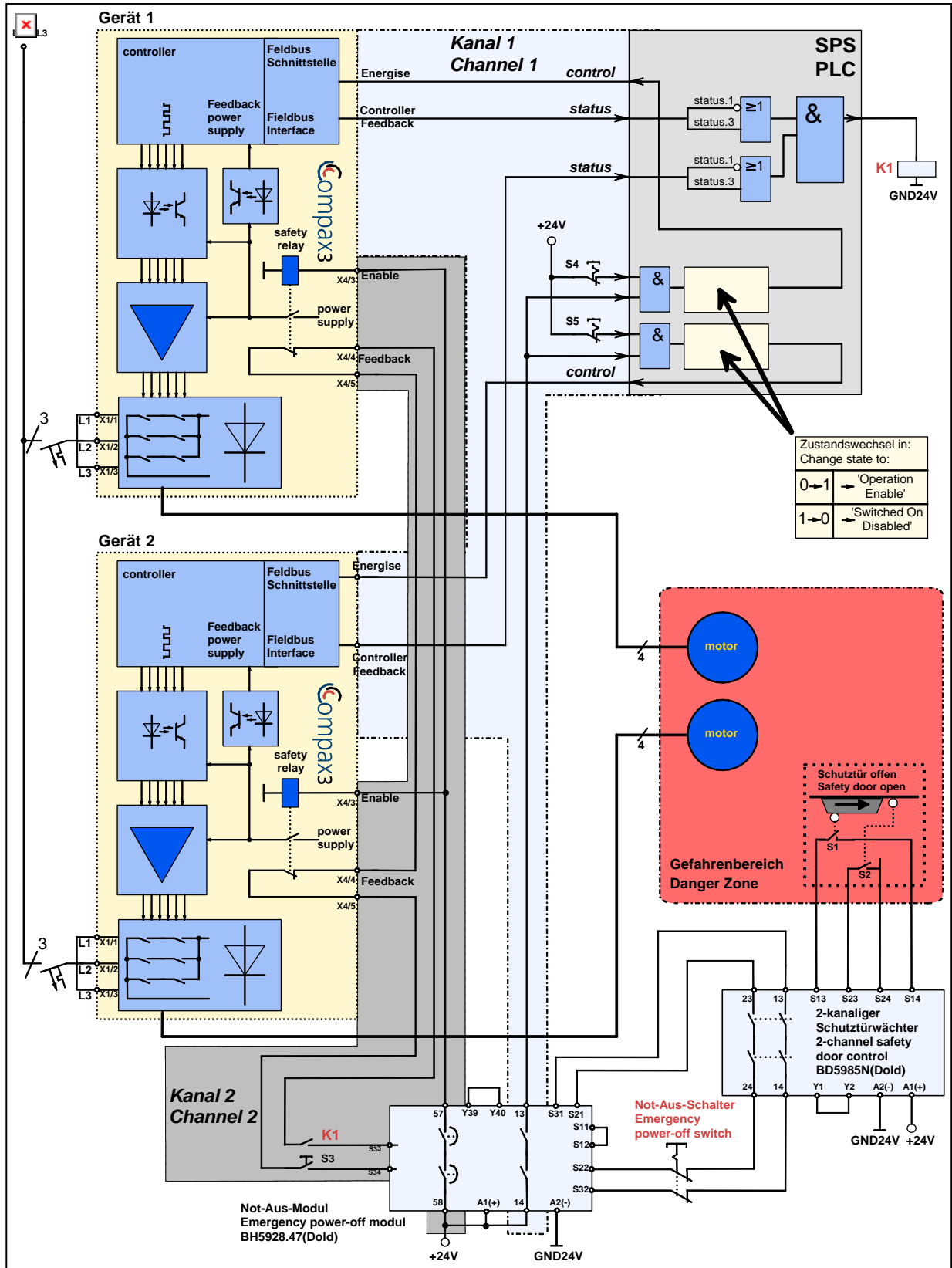
is not to be switched off (see page 132, see page 118).

Layout:

- ◆ 2 Compax3 devices (the circuit example is also valid for one or multiple devices, if it is adapted accordingly)
- ◆ 1 Emergency Power-off module (BH5928.47 manufactured by Dold)
 With adjustable delayed deactivation of the Compax3 enable input.
 The time must be set so that all axes are at a standstill before the Compax3 controllers are deactivated.
- ◆ 1 safety door monitor (BD5985N made by Dold)
 Note: With safety door monitor BD5985N, the safety door must be opened and closed again every time after turning on the 24 V power supply so that the Emergency power-off module can be acknowledged and reset. To avoid this, safety door monitors with an additional simulation entry or a corresponding reset circuit can also be used.
- ◆ 1 Emergency power-off switch
- ◆ Hazardous area accessible via a safety door with safety door switch S1 and S2
- ◆ 3 buttons (S3, S4, S5)
- ◆ 1 Relay (K1)

Circuit example

- ◆ 2 Compax3 devices (the circuit example is also valid for one or multiple devices, if it is adapted accordingly)
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- ◆ 1 Emergency power-off switch
- ◆ Hazardous area accessible via a safety door with safety door switch S1 and S2
- ◆ 3 buttons (S3, S4, S5)
- ◆ 1 Relay (K1)



Compax3 devices disabled by:

Channel 1: Energize deactivated by PLC due to open contacts of the Emergency power-off module (13 -14)

Channel 2: Enable input to "0" through open contacts of Emergency power-off module (57 -58)

Activate Emergency power-off module

Before the Compax3 can be placed in operation, the Emergency Power-off module must be activated by a pulse to Input S33/S34.

Prerequisite:

- ◆ S3 closed
- ◆ Safety door closed: only in this case the safety door monitor enables the emergency power off module via two channels
- ◆ K1 energized via PLC (feedback channel 1: motor not energized)
- ◆ The feedback contact of all Compax3 devices must be closed (channel 2).

If S33 & S34 of the Emergency power-off module are briefly connected (pulse) the contacts will be closed (between 13 & 14 and between 57 & 58).

Energize Compax3 (Motor and power output stage)

- ◆ The PLC enables the Compax3 devices by means of the control word and the Emergency power-off module enables the Compax3 devices by means of the Enable input. (if an error is still pending on Compax3, it must be previously acknowledged/reset)
- ◆ The motors are energized with current.

Summary: Compax3 is only energized if the feedback functions are capable of functioning via two channels.

Switches and buttons:

S1:	Closed when the safety door is closed
S2:	Closed when the safety door is closed
S3:	Activate Emergency power-off module
S4:	Guide Device 1 to a currentless state (error acknowledge)
S5:	Guide Device 2 to a currentless state (error acknowledge)

Description

In this chapter you can read about:

Basic functions:.....	79
Access to the hazardous area	79

Basic functions:

Compax3 devices disabled by:

Channel 1: Energize deactivated by PLC due to open contacts of the Emergency power-off module (13 -14)

Channel 2: Enable input to "0" through open contacts of Emergency power-off module (57 -58)

Activate Emergency power-off module

Before the Compax3 can be placed in operation, the Emergency Power-off module must be activated by a pulse to Input S33/S34.

Prerequisite:

- ◆ S3 closed
- ◆ Safety door closed: only in this case the safety door monitor enables the emergency power off module via two channels
- ◆ K1 energized via PLC (feedback channel 1: motor not energized)
- ◆ The feedback contact of all Compax3 devices must be closed (channel 2).

If S33 & S34 of the Emergency power-off module are briefly connected (pulse) the contacts will be closed (between 13 & 14 and between 57 & 58).

Energize Compax3 (Motor and power output stage)

- ◆ The PLC enables the Compax3 devices by means of the control word and the Emergency power-off module enables the Compax3 devices by means of the Enable input. (if an error is still pending on Compax3, it must be previously acknowledged/reset)

- ◆ The motors are energized with current.

Summary: Compax3 is only energized if the feedback functions are capable of functioning via two channels.

Access to the hazardous area

Activate Emergency power-off switch

The two-channel disconnecting at the emergency power-off switch deactivates the emergency power-off module – the contacts 13 – 14 will open immediately.

The PLC evaluates this and responds as follows:

Channel 1: The Compax3 devices receive via the control word the command to guide the drive to currentless state (vi the ramp for "deenergizing" configured in the C3 ServoManager).

Channel 1 feedback: The Compax3 feedback via the status word is evaluated by the PLC and passed on to the emergency power-off module via K1.

Channel 2: After the delay time set in the Emergency power-off module, (this time must be set so that all drives are stopped after it has elapsed) the contacts between 57 & 58 open, which in turn deactivates the Enable inputs of the Compax3 devices.

Channel 2 feedback: Via the series circuit of all feedback contacts, the "Safe Standstill" status (all Compax3 devices without current) is reported.

Only if the drives are all at a standstill, the safety door may be opened and the hazardous area may be accessed.

If the safety door is opened during operation and the emergency-power-off switch was not triggered before, the Compax3 drives will also trigger the stop ramp.



Caution! The drives may still move.

If danger to life and limb of a person entering cannot be excluded, the machine must be protected by additional measures (e.g. a safety door locking).

4. Setting up Compax3

In this chapter you can read about:

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Configuring the signal Source.....	135
Optimization.....	144

4.1 Configuration

In this chapter you can read about:

Test commissioning of a Compax3 axis	83
Selection of the supply voltage used	83
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Optimize motor reference point and switching frequency of the motor current	84
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Defining jerk / ramps	114
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Encoder Simulation.....	119
I/O Assignment	120
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Reg-related positioning / defining ignore zone	122
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The general proceeding in order to operate an empty-running motor is described **here** (see page 83).

Configuration sequence:**Installation of the C3 ServoManager**

The Compax3 ServoManager can be installed directly from the Compax3 DVD. Click on the appropriate hyperlink or start the installation program "C3Mgr_Setup_V.... .exe" and follow the instructions.

PC requirements**Recommendation:**

Operating system:	MS Windows XP SP2 / MS Windows 2000 as from SP4 / (MS Vista)
Browser:	MS Internet Explorer 6.x
Processor:	Intel Pentium 4 / Intel Core 2 Duo / AMD Athlon class as from >=2GHz
RAM memory:	>= 1024MB
Hard disk:	>= 20GB available memory
Drive:	DVD drive
Monitor:	Resolution 1024x768 or higher
Graphics card:	on onboard graphics (for performance reasons)
Interface:	USB

Minimum requirements:

Operating system:	MS Windows XP SP2 / MS Windows 2000 as from SP4
Browser:	MS Internet Explorer 6.x
Processor:	>= 1.5GHz
RAM memory:	512MB
Hard disk:	10GB available memory
Drive:	DVD drive
Monitor:	Resolution 1024x768 or higher
Graphics card:	on onboard graphics (for performance reasons)
Interface:	USB

Note:

- ◆ For the installation of the software you need administrator authorization on the target computer.
- ◆ Several applications running parallelly, reduce the performance and operability.
- ◆ especially customer applications, exchanging standard system components (drivers) in order to improve their own performance, may have a strong influence on the communication performance or even render normal use impossible.
- ◆ Operation under virtual machines such as Vware Workstation 6/ MS Virtual PC is not possible.
- ◆ Onboard graphics card solutions reduce the system performance by up to 20% and cannot be recommended.
- ◆ Operation with notebooks in current-saving mode may lead, in individual cases, to communication problems.

Connection between PC - Compax3

Your PC is connected with Compax3 via a RS232 cable (**SSK1** (see page 356)). Cable **SSK1** (see page 356) (COM 1/2-interface on the PC to X10 on the Compax3 or via adapter SSK32/20 on programming interface of Compax3H). Start the Compax3 servo manager and make the setting for the selected interface in the menu "**Options Communication settings RS232/RS485...**".

Device Selection

In the menu tree under device selection you can read the device type of the connected device (Online Device Identification) or select a device type (Device Selection Wizard).

Configuration Then you can double click on "Configuration" to start the configuration wizard. The wizard will lead you through all input windows of the configuration.

Input quantities will be described in the following chapters, in the same order in which you are queried about them by the configuration wizard.

4.1.1. Test commissioning of a Compax3 axis

In the device online help, we show you at this place an animation of a test setup with the aim to move an unloaded motor.

- ◆ Simple and independent of the Compax3 device variant*
- ◆ Without overhead for configuration
- ◆ Without special knowledge in programming

* for device specific functions, please refer to the corresponding device description.

Due to continuous optimization, individual monitor displays may have changed. This does however hardly influence the general proceeding.

4.1.2. Selection of the supply voltage used

Please select the mains voltage for the operation of Compax3. This influences the choice of motors available.

4.1.3. Motor Selection

The selection of motors can be broken down into:

- ◆ Motors that were purchased in Europe and
- ◆ Motors that were purchased in the USA.
- ◆ You will find non-standard motors under "Additional motors" and
- ◆ Under "User-defined motors" you can select motors set up with the C3 MotorManager.

For motors with holding brake SMHA or MHA brake delay times can be entered. For this see also **Brake delay times** (see page 268).

Please note the following equivalence that applies regarding terms to linear motors:

- ◆ **Rotary motors / linear motors**
- ◆ **Rotations** \equiv **Pitch**
- ◆ **rotational speed** \equiv **speed**
- ◆ **torque** \equiv **force**
- ◆ **moment of inertia** \equiv **load**

Notes on direct drives (see page 320) (Linear and Torque – Motors)

4.1.4. Optimize motor reference point and switching frequency of the motor current

Optimization of the motor reference point

The motor reference point is defined by the reference current and the reference (rotational) speed.

Standard settings are:

- ◆ Reference current = nominal current
- ◆ Reference (rotational) speed = nominal (rotational) speed

These settings are suitable for most cases.

The motors can, however, be operated with different reference points for special applications.

- ◆ By reducing the reference (rotational) speed, the reference current can be increased. This results in more torque with a reduced speed.
- ◆ For applications where the reference current is only required cyclically with long enough breaks in between, you may use a reference current higher than I_0 . The limit value is however reference current = max. $1.33 \cdot I_0$. The reference (rotational) speed must also be reduced.

The possible settings or limits result from the respective motor characteristics.



Caution!

Wrong reference values (too high) can cause the motor to switch off during operation (because of too high temperature) or even cause damage to the motor.

Optimization of the switching frequency

The switching frequency of the power output stage is preset to optimize the operation of most motors.

It may, however, be useful to increase the switching frequency especially with direct drives in order to reduce the noise of the motors. Please note that the power output stage must be operated with reduced nominal currents in the case of increased switching frequencies.

The switching frequency may only be increased.



Caution!

By increasing the motor current switching frequency, the nominal current and the peak current are reduced.

This must already be observed in the planning stage of the plant!

The preset motor current switching frequency depends on the performance variant of the Compax3 device.

The respective Compax3 devices can be set as follows:

Resulting nominal and peak currents depending on the switching frequency

Compax3S0xxV2 at 1*230VAC/240VAC

Switching frequency*		S025V2	S063V2
16kHz	I_{nominal}	2.5A _{eff}	6.3A _{eff}
	$I_{\text{peak}} (<5s)$	5.5A _{eff}	12.6A _{eff}
32kHz	I_{nominal}	2.5A _{eff}	5.5A _{eff}
	$I_{\text{peak}} (<5s)$	5.5A _{eff}	12.6A _{eff}

Compax3S1xxV2 at 3*230VAC/240VAC

Switching frequency*		S100V2	S150V2
8 kHz	I_{nominal}	-	15A _{eff}
	$I_{\text{peak}} (<5s)$	-	30A _{eff}
16kHz	I_{nominal}	10A _{eff}	12.5A _{eff}
	$I_{\text{peak}} (<5s)$	20A _{eff}	25A _{eff}
32kHz	I_{nominal}	8A _{eff}	10A _{eff}
	$I_{\text{peak}} (<5s)$	16A _{eff}	20A _{eff}

Compax3S0xxV4 at 3*400VAC

Switching frequency*		S015V4	S038V4	S075V4	S150V4	S300V4
8 kHz	I_{nominal}	-	-	-	15A _{eff}	30A _{eff}
	$I_{\text{peak}} (<5s)$	-	-	-	30A _{eff}	60A _{eff}
16kHz	I_{nominal}	1.5A _{eff}	3.8A _{eff}	7.5A _{eff}	10.0A _{eff}	26A _{eff}
	$I_{\text{peak}} (<5s)$	4.5A _{eff}	9.0A _{eff}	15.0A _{eff}	20.0A _{eff}	52A _{eff}
32kHz	I_{nominal}	1.5A _{eff}	2.5A _{eff}	3.7A _{eff}	5.0A _{eff}	14A _{eff}
	$I_{\text{peak}} (<5s)$	3.0A _{eff}	5.0A _{eff}	10.0A _{eff}	10.0A _{eff}	28A _{eff}

Compax3S0xxV4 at 3*480VAC

Switching frequency*		S015V4	S038V4	S075V4	S150V4	S300V4
8 kHz	I_{nominal}	-	-	-	13.9A _{eff}	30A _{eff}
	$I_{\text{peak}} (<5s)$	-	-	-	30A _{eff}	60A _{eff}
16kHz	I_{nominal}	1.5A _{eff}	3.8A _{eff}	6.5A _{eff}	8.0A _{eff}	21.5A _{eff}
	$I_{\text{peak}} (<5s)$	4.5A _{eff}	7.5A _{eff}	15.0A _{eff}	16.0A _{eff}	43A _{eff}
32kHz	I_{nominal}	1.0A _{eff}	2.0A _{eff}	2.7A _{eff}	3.5A _{eff}	10A _{eff}
	$I_{\text{peak}} (<5s)$	2.0A _{eff}	4.0A _{eff}	8.0A _{eff}	7.0A _{eff}	20A _{eff}

The values marked with grey are the pre-set values (standard values)!

*corresponds to the frequency of the motor current

Resulting nominal and peak currents depending on the switching frequency

Compax3HxxxV4 at 3*400VAC

Switching frequency*		H050V4	H090V4	H125V4	H155V4
8 kHz	I_{nominal}	50A _{eff}	90A _{eff}	125A _{eff}	155A _{eff}
	$I_{\text{peak}} (<5\text{s})$	75A _{eff}	135A _{eff}	187.5A _{eff}	232.5A _{eff}
16kHz	I_{nominal}	33A _{eff}	75A _{eff}	82A _{eff}	100A _{eff}
	$I_{\text{peak}} (<5\text{s})$	49.5A _{eff}	112.5A _{eff}	123A _{eff}	150A _{eff}
32kHz	I_{nominal}	19A _{eff}	45A _{eff}	49A _{eff}	59A _{eff}
	$I_{\text{peak}} (<5\text{s})$	28.5A _{eff}	67.5A _{eff}	73.5A _{eff}	88.5A _{eff}

Compax3HxxxV4 at 3*480VAC

Switching frequency*		H050V4	H090V4	H125V4	H155V4
8 kHz	I_{nominal}	43A _{eff}	85A _{eff}	110A _{eff}	132A _{eff}
	$I_{\text{peak}} (<5\text{s})$	64.5A _{eff}	127.5A _{eff}	165A _{eff}	198A _{eff}
16kHz	I_{nominal}	27A _{eff}	70A _{eff}	70A _{eff}	84A _{eff}
	$I_{\text{peak}} (<5\text{s})$	40.5A _{eff}	105A _{eff}	105A _{eff}	126A _{eff}
32kHz	I_{nominal}	16A _{eff}	40A _{eff}	40A _{eff}	48A _{eff}
	$I_{\text{peak}} (<5\text{s})$	24A _{eff}	60A _{eff}	60A _{eff}	72A _{eff}

The values marked with grey are the pre-set values (standard values)!

*corresponds to the frequency of the motor current

Resulting nominal and peak currents depending on the switching frequency

Compax3MxxxD6 at 3*400VAC

Switching frequency*		M050D6	M100D6	M150D6
8 kHz	I_{nominal}	5A _{eff}	10A _{eff}	15A _{eff}
	$I_{\text{peak}} (<5\text{s})$	10A _{eff}	20A _{eff}	30A _{eff}
16kHz	I_{nominal}	3.8A _{eff}	7.5A _{eff}	10A _{eff}
	$I_{\text{peak}} (<5\text{s})$	7.5A _{eff}	15A _{eff}	20A _{eff}
32kHz	I_{nominal}	2.5A _{eff}	3.8A _{eff}	5A _{eff}
	$I_{\text{peak}} (<5\text{s})$	5A _{eff}	7.5A _{eff}	10A _{eff}

Compax3MxxxD6 at 3*480VAC

Switching frequency*		M050D6	M100D6	M150D6
8 kHz	I_{nominal}	4A _{eff}	8A _{eff}	12.5A _{eff}
	$I_{\text{peak}} (<5\text{s})$	8A _{eff}	16A _{eff}	25A _{eff}
16kHz	I_{nominal}	3A _{eff}	5.5A _{eff}	8A _{eff}
	$I_{\text{peak}} (<5\text{s})$	6A _{eff}	11A _{eff}	16A _{eff}
32kHz	I_{nominal}	2A _{eff}	2.5A _{eff}	4A _{eff}
	$I_{\text{peak}} (<5\text{s})$	4A _{eff}	5A _{eff}	8A _{eff}

The values marked with grey are the pre-set values (standard values)!

*corresponds to the frequency of the motor current

4.1.5. Braking Resistor

If the regenerative brake output exceeds the amount **storable energy of the servo controller** (see page 374), an error will be generated. To ensure safe operation, it is then necessary to either

- ◆ reduce the accelerations resp. the decelerations,
- ◆ or you will need an **external braking resistor** (see page 337) .

Please select the connected braking resistor or enter the characteristic values of your braking resistor directly.

Please note that with resistance values greater than specified, the power output from the servo drive can no longer be dissipated in the braking resistor.

4.1.6. General Drive

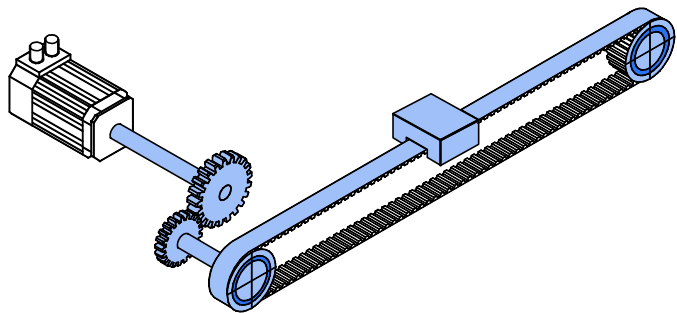
External moment of inertia / load

The external moment of inertia is required for adjusting the servo controller. The more accurately the moment of inertia of the system is known, the better is the stability and the shorter is the settle-down time of the control loop.

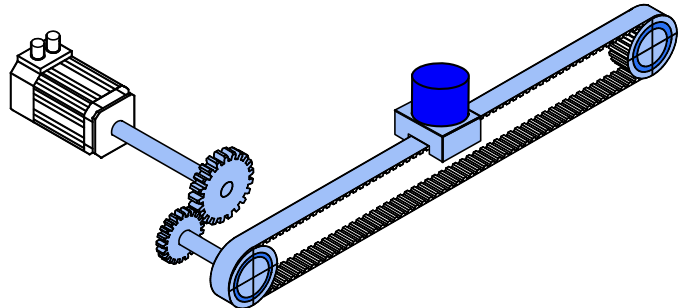
It is important to specify the minimum and maximum moment of inertia for best possible behavior under varying load.

If you do not know the moment of inertia, click on "Unknown: using default values". You have then the possibility to determine the moment of inertia by means of automatic **load identification** (see page 227).

Minimum moment of inertia / minimum load



Maximum moment of inertia / maximum load



Enter minimum = maximum moment of inertia when the load does not vary.

4.1.7. Defining the reference system

The reference system for positioning is defined by:

- ◆ a unit,
- ◆ the travel distance per motor revolution,
- ◆ a machine zero point with true zero,
- ◆ positive and negative end limits.

4.1.7.1 Measure reference

In this chapter you can read about:

You can select from among the following for the unit:

Unit of Travel

- ◆ mm,
- ◆ increments *
- ◆ angle degrees or
- ◆ Inch.

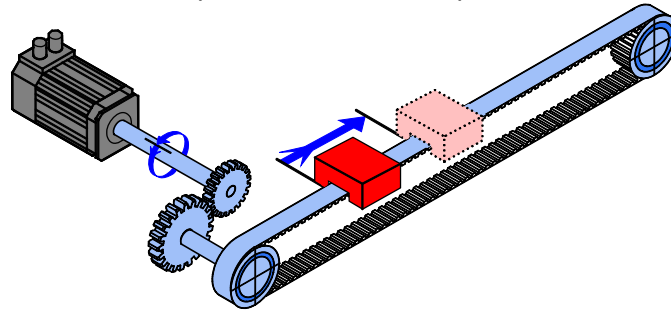
The unit of measure is always [mm] for linear motors.

*

The unit "increments" is valid only for position values. speed, acceleration and jerk are specified in this case in revolutions/s, revolutions/s² and revolutions/s³ (resp. pitch/s, pitch/s², pitch/s³).

Travel distance per motor revolution / pitch

The measure reference to the motor is created with the value: "travel distance per motor revolution / pitch" in the selected unit.

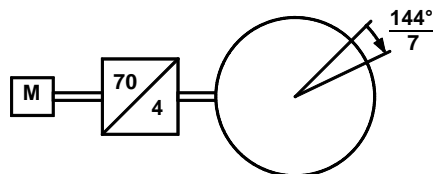


Input as numerator and denominator

You can enter the "travel distance per motor revolution" as a fraction (numerator divided by denominator). This is useful in the case of continuous operation mode or in reset mode if the value cannot be specified as a rational number. This makes it possible to avoid long-term drifts.

Example 1:

Rotary table control



Unit: Degrees

Gear transmission ratio 70:4 => 4 load revolutions = 70 motor revolutions

Travel distance per motor revolution = $4/70 * 360^\circ = 20.571\ 428\ 5 \dots^\circ$ (number cannot be represented exactly)

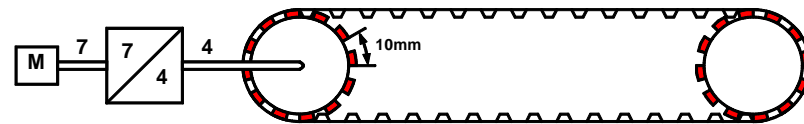
Instead of this number, you have the option of entering it exactly as a numerator and denominator:

Travel distance per motor revolution = 144/7

This will not result in any drift in continuous operation mode or in reset mode, even with relatively long motion in one direction.

Example 2:

Conveyor belt



Unit: mm

Gear transmission ratio 7:4 => 4 load revolutions = 7 motor revolutions

Number of pinions: 12

Tooth separation: 10mm

Travel path per motor revolution = $4/7 * 12 * 10\text{mm} = 68.571\ 428\ 5 \dots \text{mm}$ (this number cannot be expressed exactly)

Instead of this number, you have the option of entering it exactly as a numerator and denominator:

Travel distance per motor revolution = 480/7 mm

For "travel distance per motor revolution" that can be represented exactly, enter 1 as the denominator.

Travel distance per motor revolution / pitch

Numerator

Unit: Unit of Travel	Range: depending on the chosen unit	Standard value: depending on the chosen unit
Resolution: 0.000 000 1 (7 decimal places)		
Unit of Travel	Division	Standard value
Increments*	10 ... 1 000 000	1024
mm	0,010 000 0 ... 2000,000 000 0	1,000 000 0
Degrees	0,010 000 0 ... 720,000 000 0	360,000 000 0
Inch	0,010 000 ... 2000,000 000	1,000 000

Denominator

Unit: -	Range: 1 ... 1 000 000	Standard value: 1
Integer value		

*

The unit "increments" is valid only for position values.

speed, acceleration and jerk are specified in this case in revolutions/s, revolutions/s² and revolutions/s³ (resp. pitch/s, pitch/s², pitch/s³).

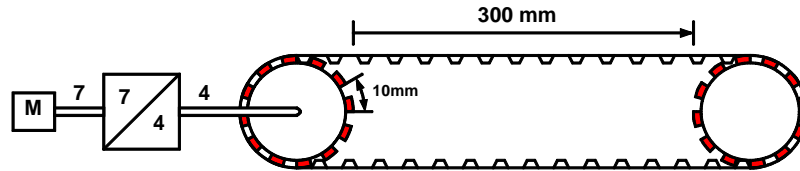
Invert Motor Rotation/Direction Polarity

Unit: -	Range: no/yes	Standard value: no
Reverse direction inverts the sense of rotation, i.e. the direction of movement of the motor is reversed in the case of equal setpoint.		

Reset mode Reset mode is available for applications in which the positioning range repeats; some examples are: Rotary table applications, belt conveyor, After the reset travel distance (can be specified exactly as **numerator and denominator** (see page 89))) the position values in Compax3 are reset to 0.

Example:

Conveyor belt (from the "Conveyor belt" example) with reset path



A reset path of 300 mm can be entered directly with numerator = 300 mm and denominator = 1.

Reset mode is not possible for linear motors.

Reset distance

Numerator

Unit: Unit of Travel	Range: depending on the chosen unit	Standard value: depending on the chosen unit
Unit of Travel	Division	Standard value
Increments	10 ... 1 000 000	0
mm	1 ... 2000	0
Degrees	1 ... 720	0

Denominator

Unit: -	Range: 1 ... 1 000 000	Standard value: 0
Integer value		

Turn off reset mode

Reset mode is turned off for numerator = 0 and denominator = 0.

4.1.7.2 Machine Zero

In this chapter you can read about:

Absolute encoder	93
Operation with MultiTurn emulation	93
Machine zero modes overview	94
Homing modes with home switch (on X12/14)	96
Machine zero modes without home switch	104
Adjusting the machine zero proximity switch	108
Machine zero speed and acceleration	109

The Compax3 machine zero modes are adapted to the CANopen profile for Motion Control CiADS402.

Position reference point Essentially, you can select between operation with or without machine reference. The reference point for positioning is determined by using the machine reference and the machine reference offset.

Machine reference run

In a homing run the drive normally moves to the position value 0 immediately after finding the home switch. The position value 0 is defined via the homing offset.

Positioning after homing run The positioning made after the home switch has been found can be switched off. For this enter in the "machine zero" window in the configuration wizard "no" under "approach MN point after MN run".

A machine reference run is required each time after turning on the system for operation with machine reference.



Please note:

During homing run the software end limits are not monitored.

If the homing mode is active, there will always be a **homing run** (see page 122) with the first start after each configuration download (with the aid of the C3 ServoManager).

Absolute encoder

Using a SinCos® or EnDat Multiturn absolute value sensor as feedback system, the absolute position can be read in over the entire travel range when switching on the Compax3. This means that a machine zero run is not necessary after the switching on (feedback may not be shifted by the absolute range while switched off).

In this case the reference only needs to be established once

- ◆ at initial commissioning time
- ◆ after an exchange of motor / feedback system
- ◆ after a mechanical modification and
- ◆ after an exchange of device (Compax3); does not apply for the "Store absolute position in feedback" function.
- ◆ after a configuration download

by carrying out a machine zero run.

The homing mode 35 "**MN at the current position** (see page 104)" is appropriate for this, because it is therewith possible to operate without proximity switch, but any other homing mode is possible too - if the hardware prerequisites are fulfilled.

When you have once re-established the reference, reset the homing mode to "without homing run".

Operation with MultiTurn emulation

You can simulate the function of a Multiturn over the entire travel distance by the aid of a Multiturn emulation. A resolver or a SinCos® / EnDat Singleturn feedback is sufficient as a feedback signal from the motor.

It differs from the physical Multiturn in the way that the motor may not be moved by more than half a turn if Compax3 (24VDC) is switched off – unless the absolute position is lost.

Besides that, the Multiturn emulation offers the same function as the physical Multiturn feedback.

You can switch on the Multiturn emulation directly in the wizard.

You can assign the maximum permissible motor angle via the Multiturn validity window

If Compax3 states after switching on that this value is not exceeded, then das "Referenziert" gesetzt (Zustandswort Bit 12 oder Ausgang M.A8).

Compax3 restores nevertheless the absolute position, the motor angle is correct, the absolute position is however not correct, if the motor was moved by more than the validity window while currentless.

Machine reference run For a unique machine zero run the same conditions apply as for the use of an absolute encoder (Multiturn).

Machine zero modes overview

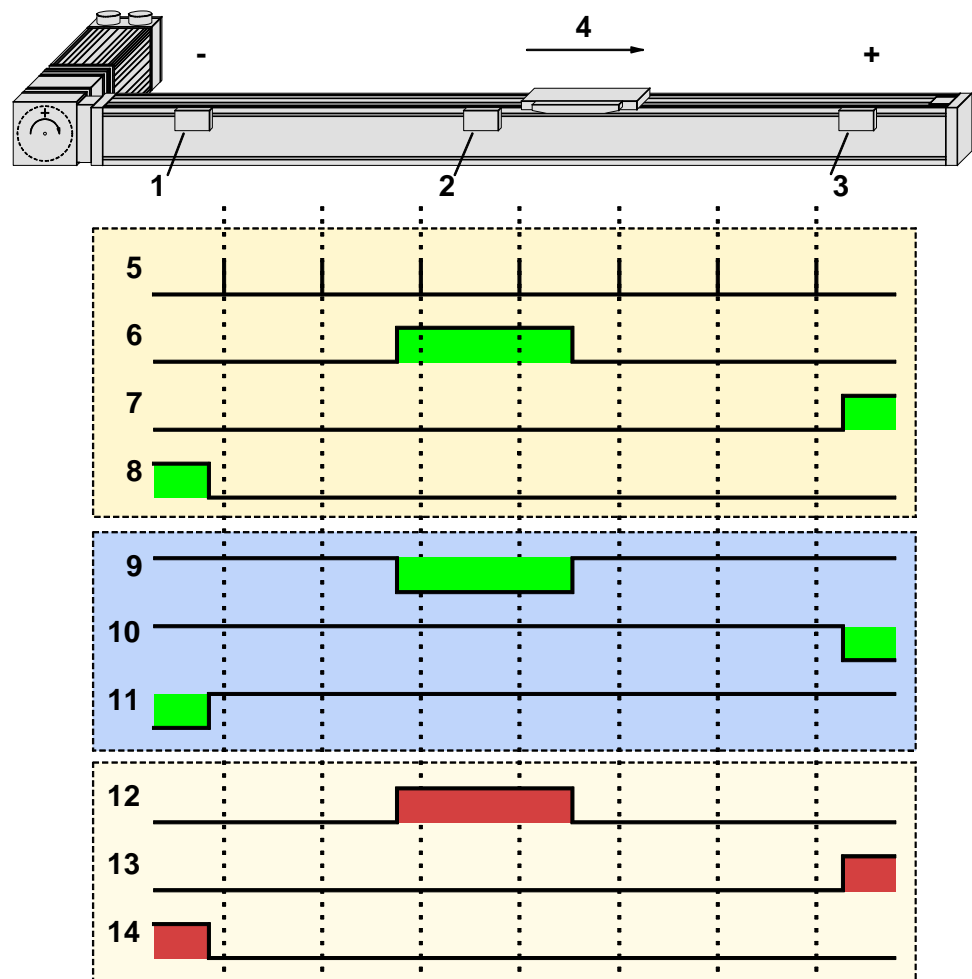
Selection of the machine zero modes (MN-M)

Machine home switch on X12/14: MN-M 3 ... 14, 19 ... 30	Without motor reference point MN-M 19 ...30	without direction reversal switches: MN-M 19, 20 (see page 97), MN-M 21, 22 (see page 98) with reversal switches: MN-M 23, 24, 25, 26 (see page 99), MN-M 27, 28, 29, 30 (see page 100)
	With motor reference point MN-M 3 ... 14	without direction reversal switches: MN-M 3, 4 (see page 101), MN-M 5, 6 (see page 102) with reversal switches: MN-M 7, 8, 9, 10 (see page 103), MN-M 11,12,13, 14 (see page 103)
Without machine zero initiator on X12/14: MN-M 1, 2, 17, 18, 33 .. 35, 128, 129, 130 ... 133	Without motor reference point MN-M 17, 18, 35, 128, 129	MN-M 35: at the current Position (see page 104) MN-M 128, 129: while moving to block (see page 104) With limit switch as machine zero: MN-M 17, 18 (see page 105)
	With motor reference point	Only motor reference: MN-M 33, 34 (see page 106), MN-M 130, 131 (see page 106)
	MN-M 1, 2, 33, 34, 130 ... 133	With limit switch as machine zero: MN-M 1, 2 (see page 107), MN-M 132, 133 (see page 108)

Definition of terms / explanations:

Motor zero point	Zero pulse of the feedback Motor feedback systems such as resolvers or SinCos® / EnDat give one pulse per revolution. Some motor feedback systems of direct drives do also have a zero pulse, which is generated once or in defined intervals. By interpreting the motor zero point (generally in connection with the machine zero initiator) the machine zero can be defined more exactly.
Machine zero initiator:	For creating the mechanical reference Has a defined position within or on the edge of the travel range.
Direction reversal switches:	Initiators on the edge of the travel range, which are used only with a machine zero run in order to detect the end of the travel range. In some cases, the function " direction reversal via Stromschwelle" is also possible, then you will need no initiator, Compax3 detects the end of the travel range via the threshold. Please observe the respective notes. During operation, the direction reversal switches are often used as limit switches.

Example axis with the initiator signals



- 1: Direction reversal / end switch on the negative end of the travel range (the **assignment of the reversal / end switch inputs** (see page 113) to travel range side can be changed).
- 2: Machine zero initiator (can, in this example, be released to 2 sides)
- 3: Direction reversal / end switch on the positive end of the travel range (the **assignment of the reversal / end switch inputs** (see page 113) to travel range side can be changed).
- 4: Positive direction of movement
- 5: Signals of the motor zero point (zero pulse of the motor feedback)
- 6: Signal of the machine zero initiator (**without inversion of the initiator logic** (see page 113)).
- 7: Signal of the direction reversal resp. end switch on the positive end of the travel range (without inversion of the initiator logic).
- 8: Signal of the direction reversal / resp. end switch on the negative end of the travel range (without inversion of the initiator logic).
- 9: Signal of the machine zero initiator (**with inversion of the initiator logic** (see page 113)).
- 10: Signal of the direction reversal / resp. end switch on the positive end of the travel range (with inversion of the initiator logic).
- 11: Signal of the direction reversal / resp. end switch on the negative end of the travel range (with inversion of the initiator logic).
- 12: Logic state of the home switch (independent of the inversion)
- 13: Logic state of the direction reversal resp. end switch on the positive end of the travel range (independent of the inversion)
- 14: Logic state of the direction reversal resp. end switch on the negative end of the travel range (independent of the inversion)

The following principle images of the individual machine zero modes always refer to the logic state (12, 13, 14) of the switches.

Homing modes with home switch (on X12/14)

In this chapter you can read about:

Debouncing the machine zero input (X12/14)	96
Without motor reference point	96
With motor reference point	101

Debouncing the machine zero input (X12/14)

A majority gate is used for debouncing.

The signal is sampled every 0.5ms

The debounce time determines the number of scans the majority gate will perform.

If the level of more than half of the signals was changed, the internal status will change.

The debounce time can be set in the configuration wizard within the range of 0 ... 20ms.

The value 0 deactivates the debouncing.

Without motor reference point

In this chapter you can read about:

Without direction reversal switches	96
With direction reversal switches	99

Without direction reversal switches

In this chapter you can read about:

MN-M 3.4: MN-Initiator = 1 on the positive side	101
MN-M 5.6: MN initiator = 1 on the negative side	102

In this chapter you can read about:

MN-M 19.20: MN-Initiator = 1 on the positive side	97
MN-M 21.22: MN initiator = 1 on the negative side	98

MN-M 19.20: MN-Initiator = 1 on the positive side

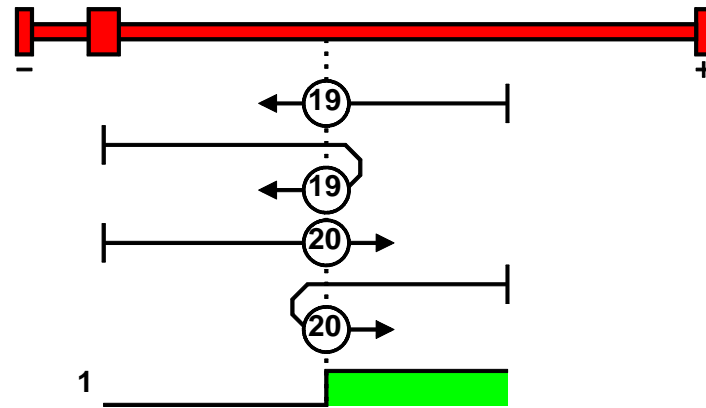
The MN initiator can be positioned at any location within the travel range. The travel range is then divided into 2 contiguous ranges: one range with deactivated MN initiator (left of the MN initiator) and one range with activated MN initiator (right of the MN initiator).

When the MN initiator is inactive (signal = 0) the search for the machine reference is in the positive travel direction.

Without motor zero point, without direction reversal switches

MN-M 19:The negative edge of the MN proximity switch is used directly as MN (home) (the motor zero point remains without consideration).

MN-M 20:The positive edge of the MN proximity switch is used directly as MN (home) (the motor zero point remains without consideration).



1: logic state

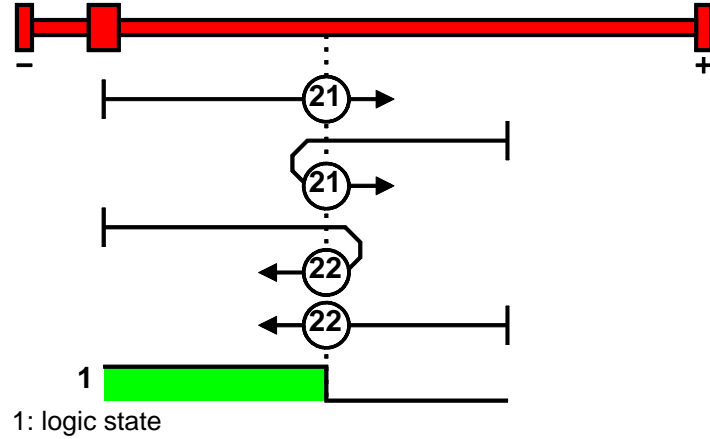
MN-M 21.22: MN initiator = 1 on the negative side

The MN initiator can be positioned at any location within the travel range. The travel range is then divided into 2 contiguous ranges: one range with deactivated MN initiator (positive part of the travel range) and one range with activated MN initiator (negative part of the travel range).
 When the MN initiator is inactive (signal = 0) the search for the machine reference is in the negative travel direction.

Without motor zero point, without direction reversal switches

MN-M 21:The negative edge of the MN proximity switch is used directly as MN (home) (the motor zero point remains without consideration).

MN-M 22:The positive edge of the MN proximity switch is used directly as MN (home) (the motor zero point remains without consideration).



With direction reversal switches

In this chapter you can read about:

MN-M 1.2: Limit switch as machine zero 107
 MN-M 132, 133: Determine absolute position via distance coding with direction reversal switches 108

In this chapter you can read about:

MN-M 7..0.10: Direction reversal switches on the positive side 103
 MN-M 11...14: With direction reversal switches on the negative side 103

In this chapter you can read about:

MN-M 23..0.26: Direction reversal switches on the positive side 99
 MN-M 27..0.30: With direction reversal switches on the negative side 100

Machine zero modes with a home switch which is activated in the middle of the travel range and can be deactivated to both sides.


The **assignment of the direction reversal switches** (see page 113) can be changed.

Function Reversal via <current_following error_threshold>

If no direction reversal switches are available, the reversal of direction can also be performed during the machine zero run via the function "direction reversal via <current_following error_shreshold>"

Here the drive runs towards the mechanical limit mounted at the end of the travel range.

When the settable <current_following error_threshold> is reached, the drive is braked and changes the travel direction.

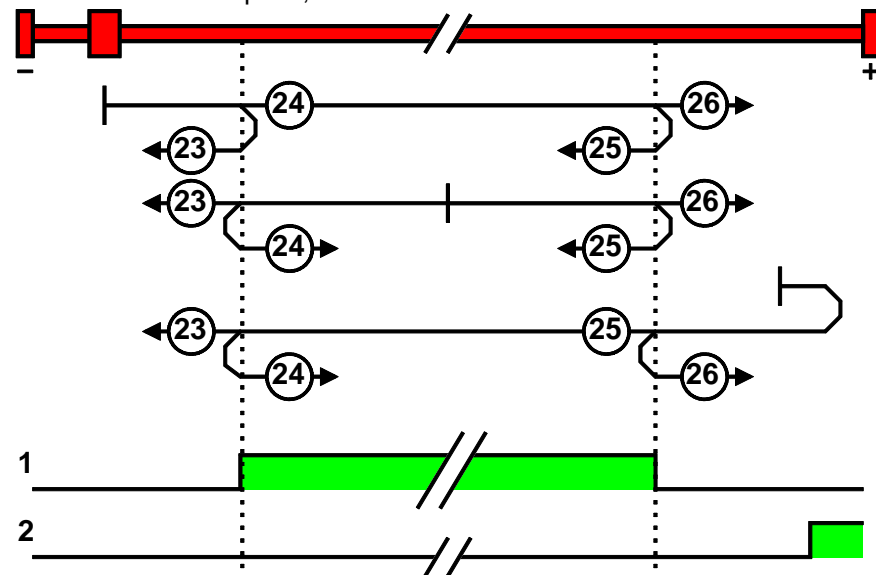
	<p>Caution! Wrong settings can cause hazard for man and machine.</p>
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It is therefore essential to respect the following:

- ◆ Choose a low machine zero speed.
- ◆ Set the machine zero acceleration to a high value, so that the drive changes direction quickly, the value must, however, not be so high that the limit threshold is already reached by accelerating or decelerating (without mechanical limitation).
- ◆ The mechanical limitation as well as the load drain must be set so that they can absorb the resulting kinetic energy.

MN-M 23..0.26: Direction reversal switches on the positive side

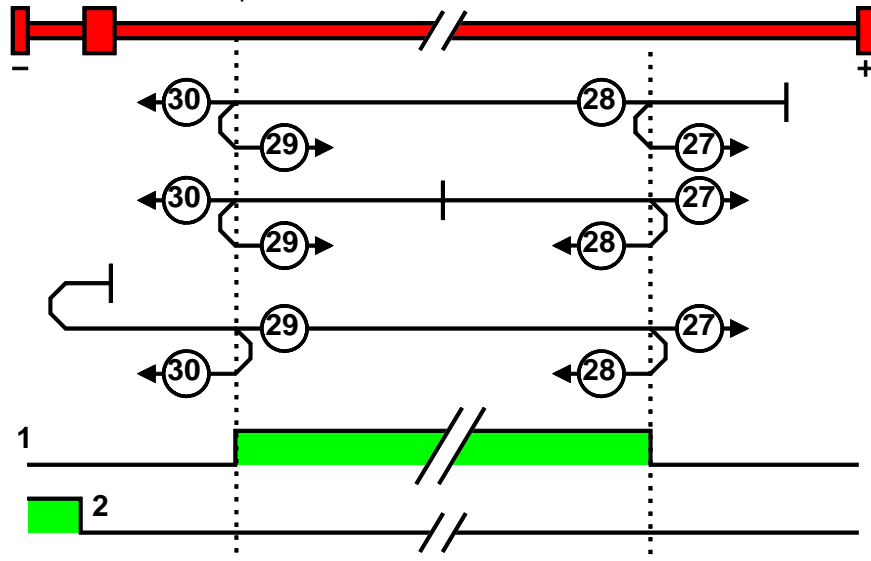
Without motor zero point, with direction reversal switches



1: Logic state of the home switch
 2: Logic state of the direction reversal switch

MN-M 27..0.30: With direction reversal switches on the negative side

Without motor zero point, with direction reversal switches



- 1: Logic state of the home switch
- 2: Logic state of the direction reversal switch

With motor reference point

In this chapter you can read about:

Without direction reversal switches 101
 With direction reversal switches 102

Without direction reversal switches

MN-M 3.4: MN-Initiator = 1 on the positive side

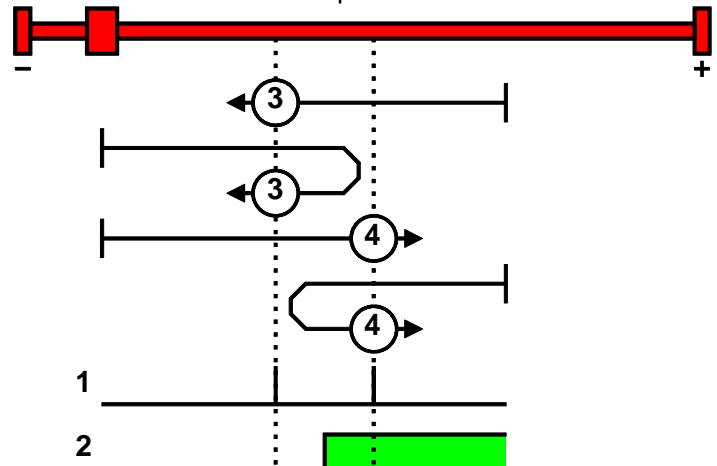
The MN initiator can be positioned at any location within the travel range. The travel range is then divided into 2 contiguous ranges: one range with deactivated MN initiator (left of the MN initiator) and one range with activated MN initiator (right of the MN initiator).

When the MN initiator is inactive (signal = 0) the search for the machine reference is in the positive travel direction.

With motor zero point, without direction reversal switches

MN-M 3: The 1st motor zero point with MN initiator = "1" is used as MN.

MN-M 4: The 1st motor zero point with MN initiator = "1" is used as MN.



- 1: Motor zero point
- 2: Logic state of the home switch

MN-M 5.6: MN initiator = 1 on the negative side

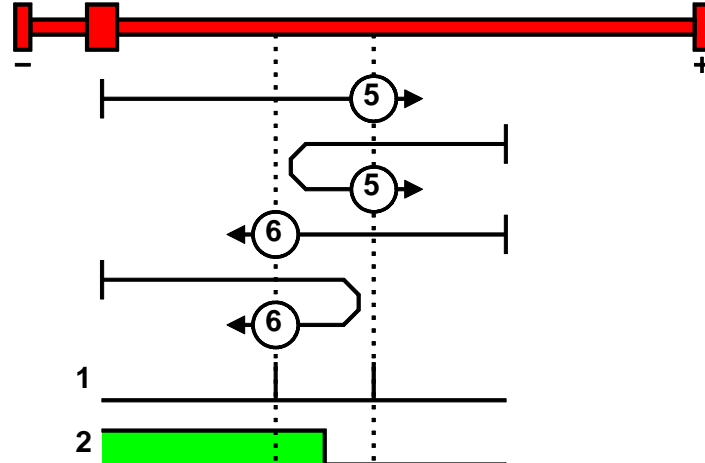
The MN initiator can be positioned at any location within the travel range. The travel range is then divided into 2 contiguous ranges: one range with deactivated MN initiator (positive part of the travel range) and one range with activated MN initiator (negative part of the travel range).

When the MN initiator is inactive (signal = 0) the search for the machine reference is in the negative travel direction.

With motor zero point, without direction reversal switches

MN-M 5: The 1st motor zero point with MN proximity switch = "0" is used as MN.

MN-M 6: The 1st motor zero point with MN initiator = "1" is used as MN.



1: Motor zero point

2: Logic state of the home switch

With direction reversal switches

Machine zero modes with a home switch which is activated in the middle of the travel range and can be deactivated to both sides.

The **assignment of the direction reversal switches** (see page 113) can be changed.

Function Reversal via <current_following error_threshold>

If no direction reversal switches are available, the reversal of direction can also be performed during the machine zero run via the function "direction reversal via <current_following error_shreshold>"

Here the drive runs towards the mechanical limit mounted at the end of the travel range.

When the settable <current_following error_threshold> is reached, the drive is braked and changes the travel direction.

**Caution!**

Wrong settings can cause hazard for man and machine.

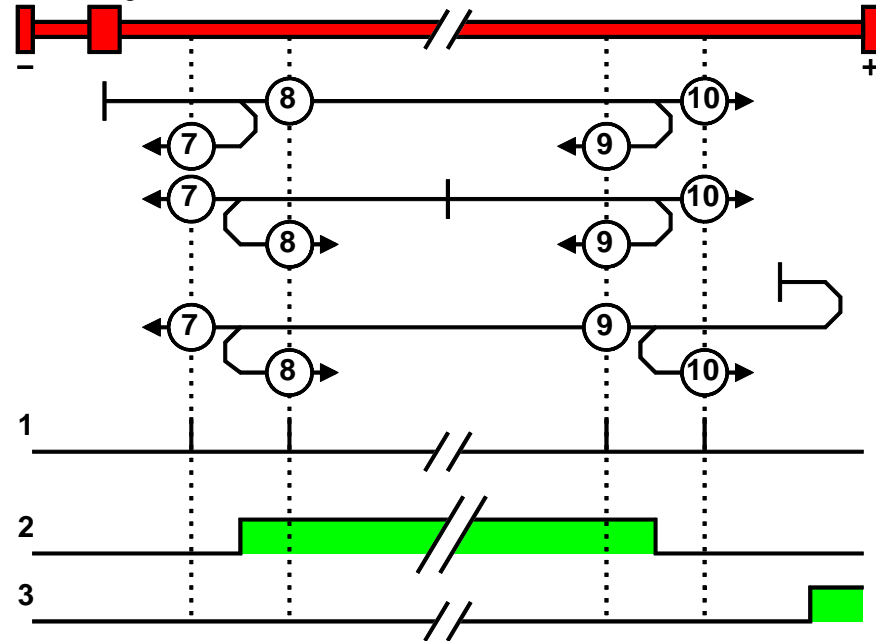
It is therefore essential to respect the following:

- ◆ Choose a low machine zero speed.
- ◆ Set the machine zero acceleration to a high value, so that the drive changes direction quickly, the value must, however, not be so high that the limit threshold is already reached by accelerating or decelerating (without mechanical limitation).
- ◆ The mechanical limitation as well as the load drain must be set so that they can absorb the resulting kinetic energy.

With motor zero point, with direction reversal switches

MN-M 7..0.10: Direction reversal switches on the positive side

Machine zero modes with a home switch which is activated in the middle of the travel range and can be deactivated to both sides.

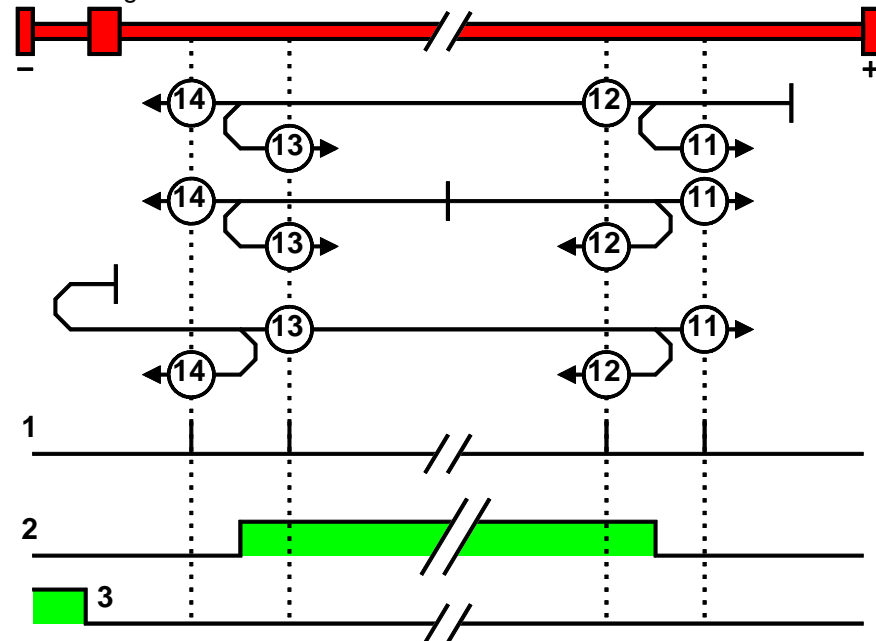


- 1: Motor zero point
- 2: Logic state of the home switch
- 3: Logic state of the direction reversal switch

With motor zero point, with direction reversal switches

MN-M 11...14: With direction reversal switches on the negative side

Machine zero modes with a home switch which is activated in the middle of the travel range and can be deactivated to both sides.



- 1: Motor zero point
- 2: Logic state of the home switch
- 3: Logic state of the direction reversal switch

Machine zero modes without home switch

In this chapter you can read about:

Without motor reference point 104
 With motor reference point 106

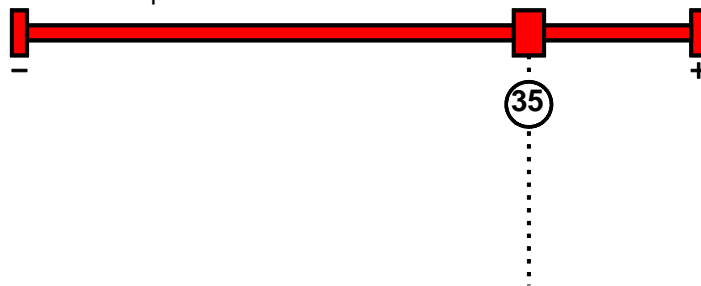
Without motor reference point

In this chapter you can read about:

MN-M 35: MN at the current position 104
 MN-M 128/129: <Current_following_error_threshold> when moving to block 104
 MN-M 17.18: Limit switch as machine zero 105

MN-M 35: MN at the current position

The current position when the MN run is activated is used as an MN.



MN-M 128/129: <Current_following_error_threshold> when moving to block

Without a MN (machine zero) initiator, an end of travel region (block) is used as MN (machine zero).

For this the Stromschwelle> is evaluated if the drive pushes against the end of the travel region. If the limit is exceeded, the MN is set. During the machine zero run (MN), the error reaction "following error" is deactivated.


Please observe: The homing offset must be set so that the home (reference point) for positioning lies within the travel range.

MN-M 128: Travel in the positive direction to the end of the travel region



MN-M 129: Travel in the negative direction to the end of the travel region

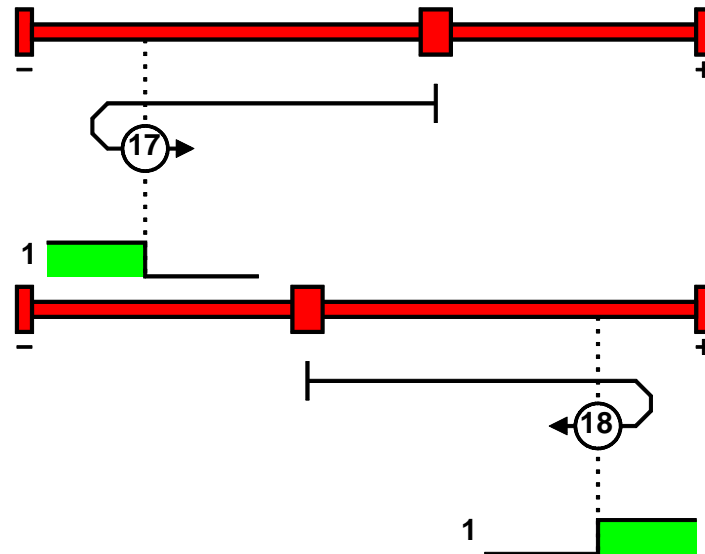


	<p>Caution! Wrong settings can cause hazard for man and machine.</p>
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It is therefore essential to respect the following:

- ◆ Choose a low machine zero speed.
- ◆ Set the machine zero acceleration to a high value, so that the drive changes direction quickly, the value must, however, not be so high that the limit threshold is already reached by accelerating or decelerating (without mechanical limitation).
- ◆ The mechanical limitation as well as the load drain must be set so that they can absorb the resulting kinetic energy.

MN-M 17.18: Limit switch as machine zero



1: Logic state of the direction reversal switch

Function Reversal via <current_following error_threshold>

If no direction reversal switches are available, the reversal of direction can also be performed during the machine zero run via the function "direction reversal via <current_following error_shreshold>"

Here the drive runs towards the mechanical limit mounted at the end of the travel range.

When the settable <current_following error_threshold> is reached, the drive is braked and changes the travel direction.



Caution!

Wrong settings can cause hazard for man and machine.

It is therefore essential to respect the following:

- ◆ Choose a low machine zero speed.
- ◆ Set the machine zero acceleration to a high value, so that the drive changes direction quickly, the value must, however, not be so high that the limit threshold is already reached by accelerating or decelerating (without mechanical limitation).
- ◆ The mechanical limitation as well as the load drain must be set so that they can absorb the resulting kinetic energy.

With motor reference point

In this chapter you can read about:

Machine zero only from motor reference 106
 With direction reversal switches 107

Machine zero only from motor reference

In this chapter you can read about:

MN-M 33,34: MN at motor zero point 106
 MN-M 130, 131: Determine absolute position via distance coding 106

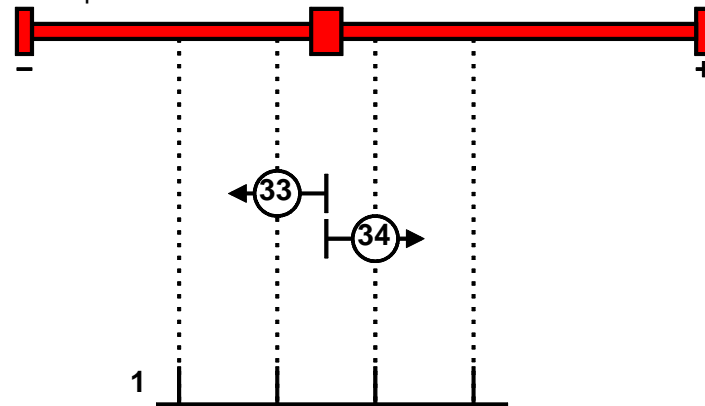
MN-M 33,34: MN at motor zero point

The motor reference point is now evaluated (no MN initiator):

Without home switch

MN-M 33: For a MN run, starting from the current position, the next motor zero point in the negative travel direction is taken as the MN.

MN-M 34: For a MN run, starting from the current position, the next motor zero point in the positive travel direction is taken as the MN.



1: Motor zero point

MN-M 130, 131: Determine absolute position via distance coding

Only for motor feedback with distance coding (the absolute position can be determined via the distance value).

Compax3 determines the absolute position from the distance of two signals and then stops the movement (does not automatically move to position 0).




1: Signals of the distance coding

With direction reversal switches

Machine zero modes with a home switch which is activated in the middle of the travel range and can be deactivated to both sides.
 The **assignment of the direction reversal switches** (see page 113) can be changed.

Function Reversal via <current_following error_threshold>

If no direction reversal switches are available, the reversal of direction can also be performed during the machine zero run via the function "direction reversal via <current_following error_shreshold>"
 Here the drive runs towards the mechanical limit mounted at the end of the travel range.
 When the settable <current_following error_threshold> is reached, the drive is braked and changes the travel direction.

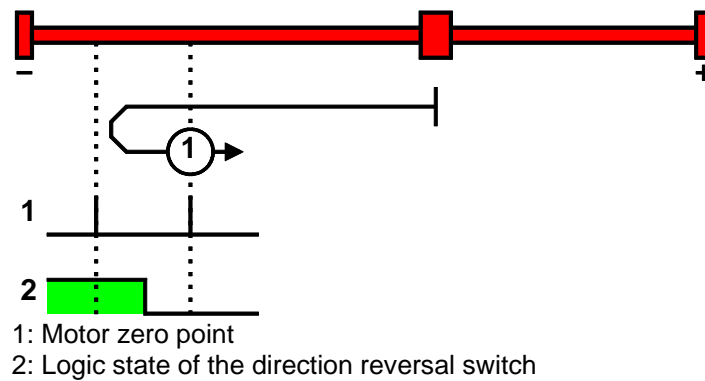
	<p>Caution! Wrong settings can cause hazard for man and machine.</p>
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It is therefore essential to respect the following:

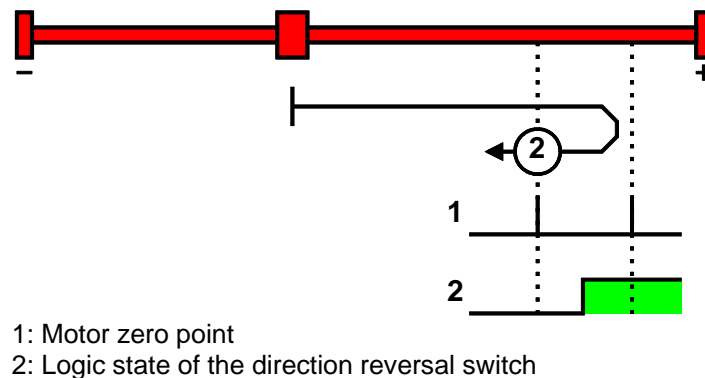
- ◆ Choose a low machine zero speed.
- ◆ Set the machine zero acceleration to a high value, so that the drive changes direction quickly, the value must, however, not be so high that the limit threshold is already reached by accelerating or decelerating (without mechanical limitation).
- ◆ The mechanical limitation as well as the load drain must be set so that they can absorb the resulting kinetic energy.

MN-M 1.2: Limit switch as machine zero

End switch on the negative side



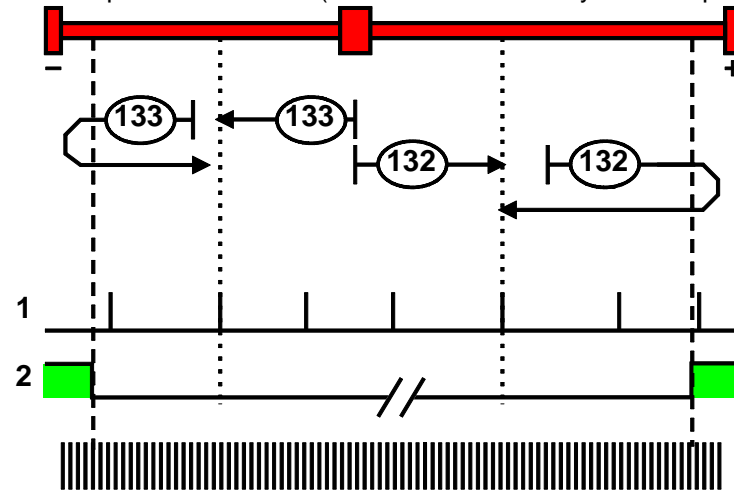
End switch on the positive side:



MN-M 132, 133: Determine absolute position via distance coding with direction reversal switches

Only for motor feedback with distance coding (the absolute position can be determined via the distance value).

Compax3 determines the absolute position from the distance of two signals and then stops the movement (does not automatically move to position 0).

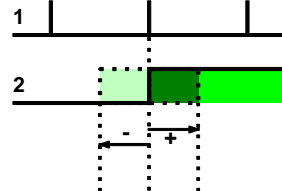


1: Signals of the distance coding
2: Logic state of the direction reversal switches

Adjusting the machine zero proximity switch

This is helpful in some cases with homing modes that work with the home switch and motor reference point.

If the motor reference point happens to coincide with the position of the MN initiator, there is a possibility that small movements in the motor position will cause the machine reference point to shift by one motor revolution (to the next motor reference point).



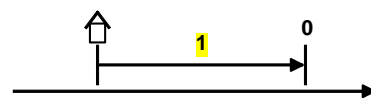
1: Motor zero point
2: Logic state of the home switch

A solution to this problem is to move the MN initiator by means of software. This is done using the value initiator adjustment.

Initiator adjustment

Unit: Motor angle in degrees	Range: -360 ... 360	Standard value: 0
Move the machine reference initiator using software		

Machine reference offset



1: MaschinezeroOffset

The machine reference offset is used to determine the actual reference point for positioning.

That is: Zero point = Machine zero + Machine zero offset

Note: If the machine zero proximity switch is at the positive end of the travel range, the machine zero offset must be = 0 or negative.

A change in the machine reference offset does not take effect until the next machine reference run.

Machine zero speed and acceleration

With these values you can define the motion profile of the machine zero run.

4.1.7.3 Travel Limit Settings

Software end limits

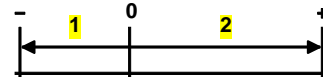
The error reaction when reaching the software end limits can be set:
Possible settings for the error reaction are:

- ◆ No response
- ◆ downramp / stop
- ◆ Downramp / stromlos schalten (standard setting)

If "no reaction" was set, no software limits must be entered.

Software end limits:

The travel range is defined via the negative and positive end limits.

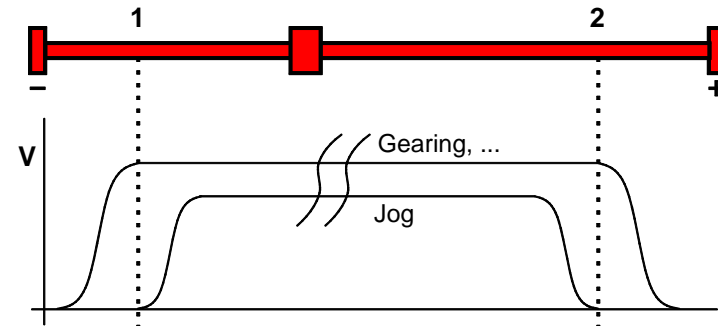


- 1: negative end limit
2: positive end limit

Software end limit in absolute operating mode

The positioning is restricted to the range between the travel limits.

A positioning order aiming at a target outside the travel range is not executed.



- 1: negative end limit
2: positive end limit

The reference is the position reference point that was defined with the machine reference and the machine reference offset.

Software end limits in reset mode

The reset mode does not support software end limits

Software end limit in continuous mode

Each individual positioning is confined within the travel limits.
 A positioning order aiming at a target outside the software end limits is not executed.
 The reference is the respective current position.

Error when disregarding the software end limits

A software end limit error is triggered, if the position value exceeds an end limit.
 For this, the position setpoint value is evaluated in energized state; in currentless state, the actual position value is evaluated.

Hysteresis in disabled state:

If the axis stands currentless at an end limit, another error may be reported due to position jitter after acknowledging the end limit error. To avoid this, a hysteresis surrounding the end limits was integrated (size corresponds to the size of the positioning window).
 Only if the distance between axis and the end limits was larger than the positioning window, another end limit error will be detected

Error codes (see page 312) of the end limit errors:

- 0x7323 Error when disregarding the positive software end limit.
- 0x7324 Error when disregarding the negative software end limit.

Activating / deactivating the end limit error:

In the C3 ServoManager under configuration: End limits, the error can be (de)activated.
 For IEC-programmable devices with the "C3_ErrorMask" module.

Behavior after the system is turned on

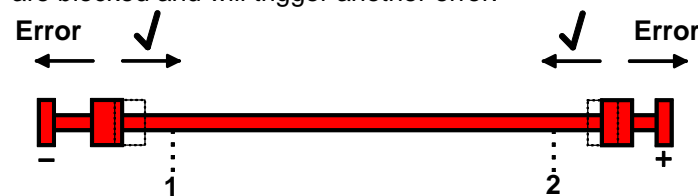
The end limits are not active after switching on. The end limits do not refer to the position reference point until after a machine reference run.
 During homing run the end limits are not monitored.
 With a Multiturn encoder or with active Multiturn emulation, the limit is valid immediately after switching on.

Behavior outside the travel range

1. If the software end limit errors are deactivated, all movements are possible.

2. if the software end limit errors are activated:

After disregarding the software end limits, an error is triggered. First of all, this error must be acknowledged.
 Then a direction block is activated: only motion commands in the direction of the travel range are executed. These will not trigger another error.
 Motion commands inciting a movement in the opposite direction of the travel range are blocked and will trigger another error.



- 1: negative end limit
- 2: positive end limit

Notes on special feedback systems (Feedback F12)

During automatic commutation, the end limit monitoring is deactivated!

Behavior with software end limits of a referenced axis

	Position within target outside	Position outside target outside and aiming in the opposite direction of the travel range	Position outside target within or aiming in the direction of the travel range
JOG +/-	<ul style="list-style-type: none"> ◆ Positioning up to the end limits ◆ No Error 	<ul style="list-style-type: none"> ◆ No positioning ◆ No Error 	<ul style="list-style-type: none"> ◆ Positioning
MoveAbs, MoveRel, RegSearch, RegMove	<ul style="list-style-type: none"> ◆ No positioning ◆ Error 	<ul style="list-style-type: none"> ◆ No positioning ◆ Error 	<ul style="list-style-type: none"> ◆ Positioning
Gearing	<ul style="list-style-type: none"> ◆ Positioning up to the end limits ◆ Error 	<ul style="list-style-type: none"> ◆ No positioning ◆ Error 	<ul style="list-style-type: none"> ◆ No positioning ◆ Error
Velocity	<ul style="list-style-type: none"> ◆ Positioning up to the end limits ◆ Error 	<ul style="list-style-type: none"> ◆ No positioning ◆ Error 	<ul style="list-style-type: none"> ◆ Positioning

Hardware end limits

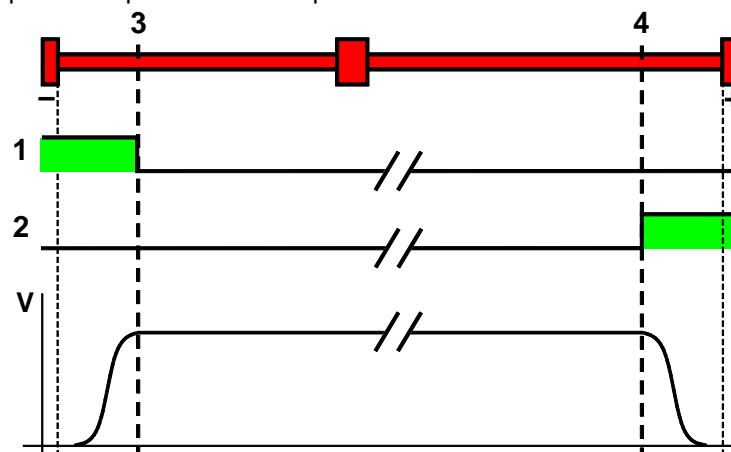
The error reaction when reaching the hardware end limits can be set:
Possible settings for the error reaction are:

- ◆ No response
- ◆ downramp / stop
- ◆ Downramp / stromlos schalten (standard setting)

Hardware end limits are realized with the aid of end switches.

These are connected to X12/12 (input 5) and X12/13 (input 6) and can be (de)activated separately in the C3 ServoManager under Configuration: End limits. After a limit switch has been detected, the drive decelerates with the ramp values set for errors (error code 0x54A0 at X12/12 active, 0x54A1 at X12/13 active) and the motor is switched to currentless.

Please make sure that after the detection of the end switch there is enough travel path left up to the limit stop.



- 1: Limit switch E5 (X12/12)
- 2: Limit switch E6 (X12/13)
- 3: Limit switch position E5 (X12/12)
- 4: Limit switch position E6 (X12/13)

The **assignment of the end switches** (see page 113) can be changed!

Please note: The limit switches must be positioned so that they cannot be released towards the side to be limited.

Limit switch / direction reversal switch
Behavior in the case of an active limit switch

Limit switches functioning as direction reversal switches during homing run, will not trigger a limit switch error.

The error can be acknowledged with activated limit switch.
 The drive can then be moved out of the end switch range with a normal positioning.
 The direction of the movement is verified!
 Only the direction towards the travel range is allowed.

Debouncing the limit switches

A majority gate is used for debouncing.
 The signal is sampled every 0.5ms
 The debounce time determines the number of scans the majority gate will perform.
 If the level of more than half of the signals was changed, the internal status will change.
 The debounce time can be set in the configuration wizard within the range of 0 ... 20ms.
 The value 0 deactivates the debouncing.

4.1.7.4 Change assignment direction reversal / limit switches

If this function is not activated, the direction reversal / end switches are assigned as follows:

Direction reversal / limit switch on E5 (X12/12): negative side of the travel range
 Direction reversal / limit switch on E6 (X12/13): Direction reversal / limit switch on E6 (X12/13):

Change assignment of direction reversal / limit switch is activated

If this function is activated, the direction reversal / limit switches are assigned as follows:

Direction reversal / limit switch on **E5** (X12/12): **positive side** of the travel range
 Direction reversal / limit switch on **E6** (X12/13): **negative side** of the travel range

4.1.7.5 Change initiator logic

The initiator logic of the limit switches (this does also apply for the direction reversal switches) and the machine zero initiator can be changed separately.

- ◆ Limit switch E5 low active
- ◆ Limit switch E6 low active
- ◆ Home switch E7 low active

In the basic settings the inversion is deactivated, so that the signals are "high active".

With this setting the inputs I5 to I7 can even be switched within their logic, if they are not used as direction reversal/limit switches or machine zero.

4.1.8. Defining jerk / ramps

In this chapter you can read about:

Speed for positioning	114
Acceleration for positioning and velocity control.....	114
Acceleration / deceleration for positioning	114
Jerk limit for positioning	114
Ramp upon error and de-energize.....	115
Jerk for STOP, JOG and error	116

4.1.8.1 Speed for positioning

Standard speed for all positionings and motion functions.
The value can be changed during operation via the bus or via the motion sets.
This setting is not relevant for the "rotation speed" operating mode.

4.1.8.2 Acceleration for positioning and velocity control

Standard acceleration for all positionings and motion functions.
The value can be changed during operation via the bus or via the motion sets.

4.1.8.3 Acceleration / deceleration for positioning

Standard deceleration for all positionings and motion functions.
The value can be changed during operation via the bus or via the motion sets.
If "0" is entered, the acceleration value is accepted as deceleration.

4.1.8.4 Jerk limit for positioning

Standard jerk for all positionings and motion functions.
The value can be changed during operation via the bus or via the motion sets.

In the operating modes:

- ◆ Speed control
- ◆ Velocity and
- ◆ Gearing

the jerk is not limited.

Jerk

The jerk (marked with "4" in the drawing below) describes the change in acceleration (derivation of the acceleration)

The maximum change in acceleration is limited via the jerk limitation.
A motion process generally starts from a standstill, accelerates constantly at the specified acceleration to then move at the selected speed to the target position.
The drive is brought to a stop before the target position with the delay that has been set in such a manner as to come to a complete stop at the target position. To reach the set acceleration and deceleration, the drive must change the acceleration (from 0 to the set value or from the set value to 0).

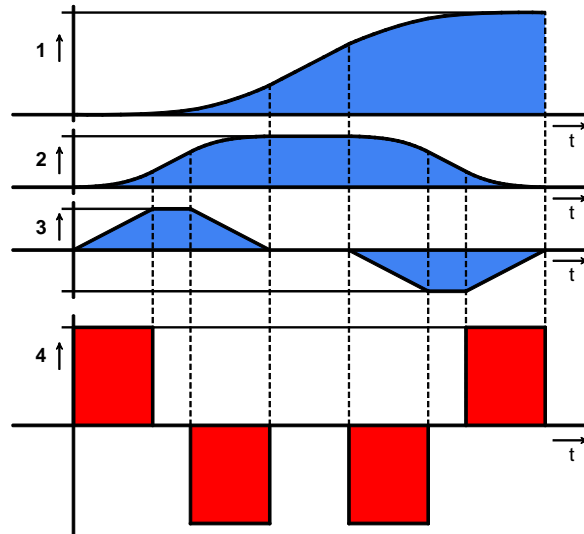
This change in speed is limited by the maximum jerk.

**Without jerk
according to
VDI2143**

According to VDI2143 the jerk is defined (other than here) as the jump in acceleration (infinite value of the jerk function).

This means that positionings with Compax3 are without jerk according to VDI2143, as the value of the jerk function is limited.

Motion sequence



- 1: Position
- 2: Velocity
- 3: Acceleration
- 4: Jerk

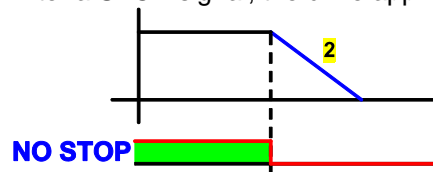
High changes in acceleration (high jerks) often have negative effects on the mechanical systems involved. There is a danger that mechanical resonance points will be excited or that impacts will be caused by existing mechanical slack points. You can reduce these problems to a minimum by specifying the maximum jerk.

Jerk

Unit: Length unit/s ³	Range: 0 ... 10 000 000	Standard value: 1 000 000
----------------------------------	-------------------------	------------------------------

Deceleration on STOP

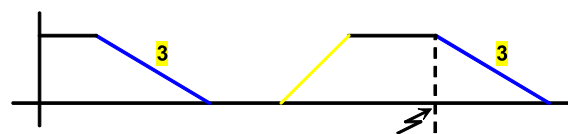
After a STOP signal, the drive applies the brakes with the delay that is set (2).



NO STOP: control.3 = "0" (Quick Stop: Transition 11 of the **Status machine** (see page 286))

4.1.8.5 Ramp upon error and de-energize

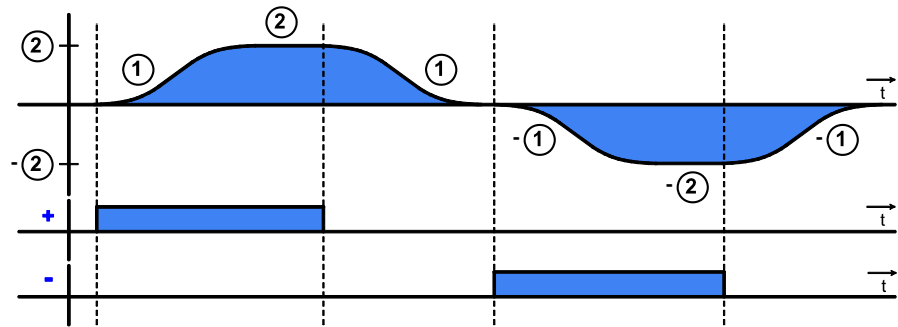
Ramp (delay) upon error and "De-energize"



3: Deceleration on error (status.3 = "1"), Disable Voltage (control.1 = "0" transition 9 of the status machine) and Enable Operation (CW.3 = "0" transition 5 of the status machine).

JOG acceleration/deceleration and speed control

You can set the motion profile for moving with JOG+ or JOG- here.



1: Manual acceleration / -deceleration

2: Manual speed

+: Manual+ (control.4 = "1")

-: Manual- (control.5 = "1")

Only in "manual" operating mode (Ethernet Powerlink-No.EPL No. 0x6060 (object 1100.5) = -1)

4.1.8.6 Jerk for STOP, JOG and error

The jerk set here applies for:

- ◆ the STOP ramp
- ◆ Manual motion
- ◆ The ramp for the machine reference run

Description of jerk (see page 114)

Jerk

Unit: Length unit/s ³	Range: 0 ... 10 000 000	Standard value: 1 000 000
----------------------------------	-------------------------	------------------------------

4.1.9. Limit and Monitoring Settings

In this chapter you can read about:

Current (Torque) Limit	116
Positioning window - Position reached	117
Following error limit.....	118
Maximum operating speed	118

4.1.9.1 Current (Torque) Limit

The current required by the speed controller is limited to the current limit.

4.1.9.2 Positioning window - Position reached

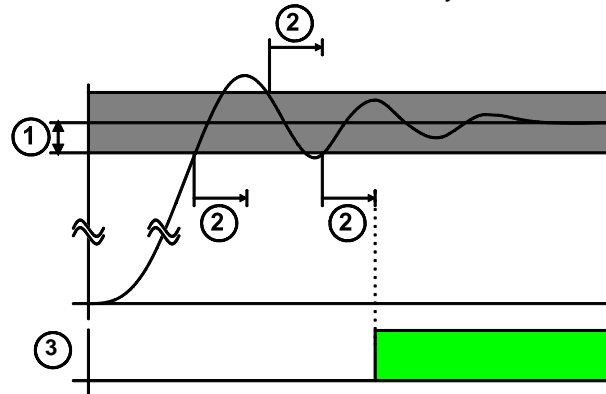
Position reached indicates that the target position is located within the position window.

In addition to the position window, a position window time is supported. If the actual position goes inside the position window, the position window time is started. If the actual position is still inside the position window after the position window time, "Position reached" is set.

If the actual position leaves the position window within the position window time, the position window time is started again.

When the actual position leaves the position window with Position reached = "1", Position reached is immediately reset to "0".

Position monitoring is active even if the position leaves the position window because of measures taken externally.



1: Positioning window

2: positioning window time

3: Setpoint position reached (state / status word 1 Bit 10 = "1") and O1 (X12/3)

Linkage to the setpoint value

The signal "position reached" can be linked to the setpoint value (can be configured in the ServoManager).

In addition, the internal setpoint value generation is evaluated.

The positioning window is only evaluated with a constant internal setpoint value.

4.1.9.3 Following error limit

The error reaction upon a following error can be set:

Possible settings for the error reaction are:

- ◆ No response
- ◆ downramp / stop
- ◆ Downramp / stromlos schalten (standard setting)

The following error is a dynamic error.

The dynamic difference between the setpoint position and the actual position during a positioning is called the following error. Do not confuse this with the static difference which is always 0; the target position is always reached exactly.

The change of position over time can be specified exactly using the parameters jerk, acceleration and speed. The integrated Setpoint value generator calculates the course of the target position. Because of the delay in the feedback loop, the actual position does not follow the setpoint position exactly. This difference is referred to as the following error.

Disadvantages caused by a following error

In joint operation of several servo controllers (e.g. master controller and slave controller), following errors lead to problems due to the dynamic position differences, and a large following error can lead to positioning overshoot.

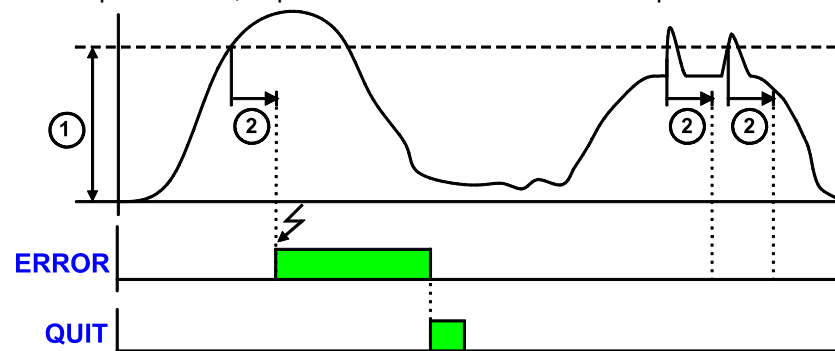
Error message

If the following error exceeds the specified following error limit, the "following error time" then expires. If the following error is even greater than the following error limit at the end of the following error time, an error is reported.

If the following error falls short of the following error limit, a new following error time is then started.

Minimizing the following error

The following error can be minimized with the help of the extended (advanced) control parameters, in particular with the feed forward parameters.



1: Tracking error limit

2: Tracking error time

ERROR:Malfunction (state - / status word 1 Bit 3) and O0 (X12/2)

QUIT:Control word 1 Bit 7 or I0 (X12/6)

4.1.9.4 Maximum operating speed

The speed limitation is derived from the maximum operating speed. In order to ensure control margins, the speed is limited to a higher value.

The speed setpoint value is actively limited to 1.1 times the given value.

If the speed actual value exceeds the preset maximum speed by 21% (= "switching off limit speed"), error 0x7310 is triggered.

4.1.10. Encoder Simulation

You can make use of a permanently integrated encoder simulation feature to make the actual position value available to additional servo drives or other automation components.

Caution!

- ◆ The encoder simulation is not possible at the same time as the encoder input resp. the step/direction input or the SSI interface.
The same interface is used here.
- ◆ A direction reversal configured in the C3 ServoManager does not affect the encoder simulation.
The direction of rotation of the encoder simulation can, however, be changed via the feedback direction in the MotorManager.

Simulated Encoder Output Resolution

Unit: Increments per revolution / pitch	Range: 4 - 16384	Standard value: 1024
Any resolution can be set		
Limit frequency: 620kHz i. e. for:		
Increments per revolution	Max. speed	
1024	36000 min ⁻¹	
4096	9000 min ⁻¹	
16384	2250 min ⁻¹	

4.1.10.1 Encoder bypass with Feedback module F12 (for direct drives)

If the feedback module F12 is used, the encoder signals can be placed directly (Bypass) to the encoder interface (X11: same assignment as encoder simulation) for further use. Sine/Cosine signals are directly converted into encoder signals, however without zero pulse.

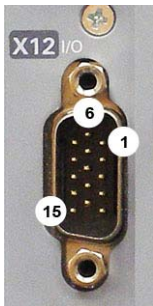
The advantage is, that the limit frequency is 5MHz instead of 620kHz.

The direction of rotation is only defined via the encoder wiring; a direction inversion configured in the C3 ServoManager does not have any consequence.

4.1.11. I/O Assignment

- ◆ For intra-device inputs I0 .. I3 as well as the outputs O0 ... O3 you can choose between fixed or free assignment (see below).
- ◆ Control via Ethernet Powerlink does not require an M option (M10 / M12).
- ◆ If an M option is available, 12 inputs/outputs (ports) are freely assignable. These can be configured as inputs or outputs by groups of four and be activated resp. read via Object 121.2 and Object 133.3.
- ◆ The signal inputs I4 ... I7 are fixedly assigned
If the respective functions are not needed, these inputs can also be used for control.
I5 and I6 can, for example, be used as free inputs if the limit switch function is deactivated.

Assignment of the intra-device inputs and outputs



PIN X12	Input/output	High density/Sub D	
1	Output	+24VDC output (max. 400mA)	
2	O0	No Error	Only for "fixed assignment" Functions are available, if "Fixed assignment" was selected for the I/O assignment in the configuration wizard
3	O1	Position / velocity / gear synchronization reached (max. 100mA)	
4	O2	No power output stage current (max. 100mA)	
5	O3	Motor stationary with current, with setpoint 0 (max. 100mA)	
6	I0="1":	Quit (positive edge) / Energize the motor The address of the current motion set is read in new.	
	I0="0"	Motor deenergized with delay	
7	I1	No stop	
8	I2	JOG +	
9	I3	JOG -	
10	I4	Reg input	
11	E	24V input for the digital outputs Pins 2 to 5	
12	I5	Limit switch 1	
13	I6	Limit switch 2	
14	I7	Machine reference initiator	
15	Output	Gnd 24 V	

All inputs and outputs have 24V level.

Maximum capacitive loading of the outputs: 50nF (max. 4 Compax3-inputs can be connected)

Input-/Output extension (see page 362)

Optimization window display

The display of the digital inputs in the optimization window of the C3 ServoManager does not correspond to the physical status (24Volt=on, 0Volt=off) but to the logic status: If the function of an input or output is inverted (e.g. limit switch, negatively switching), the corresponding display (LED symbol in the optimization window) is OFF with 24Volts at the input and ON with 0 Volts at the input.

For intra-device inputs I0 .. I3 as well as the outputs O0 ... O3 you can choose between fixed or free assignment.

With fixed assignment of the intra-device inputs I0 ... I3, the respective

functions can either be triggered via the inputs or via Ethernet Powerlink
It applies:

With "guiding via interface" (control word 1 bit 11 = "0")

- ◆ Enable Voltage: I0 = "1" **AND** control word 1 Bit 1 = "1"
- ◆ Ackn is triggered via control word 1 bit 7 - ackn via I0 is not possible.
- ◆ Stop is active, if I1 = "0"
- ◆ Manual+ and Manual- Inputs I2, I3 do not have a function.

With " No guiding via interface" (control word 1 bit 11 = "1")

Control word is not effective:

- ◆ Energize motor / ackn: I0 = "1"
- ◆ Stop is active, if I1 = "0"
- ◆ Manual+ and Manual- via Inputs I2, I3.

Status word

- ◆ The status word is always updated
- ◆ O0 corresponds to status word 1 Bit 3
- ◆ O1 corresponds to status word 1 bit 10
- ◆ O3 corresponds to the status "operation enable"

4.1.12. Position mode in reset operation

In reset operation (activated by the configured reset distance), additional positioning functions are possible for absolute positionings:

All directions	Standard positioning mode
Positive direction	Positioning only in positive direction
Shortest path	Positioning on the shortest path
Negative direction	Positioning only in negative direction
Actual direction	Positioning by keeping the actual direction of travel

Dynamic positioning

In dynamic positioning, a decision concerning the positioning travel is not taken on the basis of the actual position, but on the basis of the braking position resulting from the motion parameters.

Please observe:

- ◆ In the event of positioning specifications below zero and higher than or equal to the reset distance, this function is deactivated.
- ◆ The positioning functions are neither effective in test movements nor in a positioning after homing travel.
- ◆ In the event of "shortest path" the motion is not defined for a positioning by half the reset distance.

4.1.12.1 Examples in the help file

In the help file you can find here examples for the functioning of the individual positioning modes.

4.1.13. Reg-related positioning / defining ignore zone

These settings are only required in connection with the function "reg-related positioning" (see page 125)

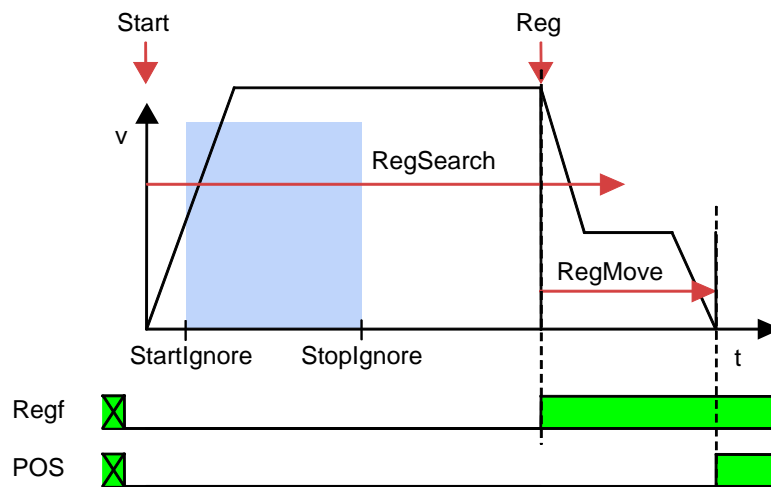
Within the reg window a reg signal will be ignored.

The reg window is defined by

- ◆ beginning of the ignore zone and
- ◆ End of Registration lock-out zone (StopIgnore)

Beginning and end of the ignore zone are absolute values and therefore are also valid with negative position values.

This reg window is valid for all reg position sets.



- Start** Start signal for reg positioning
- RegSearch:** Positioning for reg search
- RegMove:** Positioning according to reg
- StartIgnore:** Reg window: Beginning of Registration lock-out zone (StartIgnore)
- StopIgnore:** Reg window: End of Registration lock-out zone (StopIgnore)
- Reg:** Reg signal
- Regf** Signal: Reg mark detected (Status word 1 Bit 15)
- POS:** Signal: Position reached (Ausgang A1: X12/3 oder Zustandswort 1 Bit 9)

4.1.14. Write into set table

The motion sets are stored in a set table.

The table rows define always one motion set, in the columns the respective motion parameters of a motion set are stored.

	Motion parameters				
Machine reference run					
Set 1					
set no. 2					
...					
Set 31					

exact description (see page 284).

31 motion sets are possible.

The motion set to be executed is selected via Statuswort 2.

For the motion sets different motion functions with different motion parameters are available:

- ◆ **Empty:** empty motion set
- ◆ **MoveAbs (see page 124):** absolute positioning
- ◆ **MoveRel (see page 124):** relative Positioning
- ◆ **Gearing (see page 131):** electronic gearbox
- ◆ **RegSearch (see page 125):** Registration mark-related positioning
(uses 2 motion sets: RegSearch and RegMove)
- ◆ **Velocity (see page 132):** velocity control
- ◆ **Stop:** Stop movement

For each motion set you can define programmable status bits (PSBs), which will then be put out after the termination of the motion set.

Machine reference run

A start signal at address = 0 (motion set 0) triggers a machine zero run.

4.1.14.1 Programmable status bits (PSBs)

The successful execution of a motion set can be queried via the PSBs.
PSBs: Bit 12, 13 and 14 of status word 2.

Definition of the pattern:

The settings for the PSBs are made in the respective motion set

You can set 3 assignments for the respective bits:

- X: No change Output / Bit is not influenced
- 0: Inactive Output / Bit is set to 0
- 1: Active Output / Bit is set to 1 resp. 24VDC

Storage of the **PSBs** (see page 284).

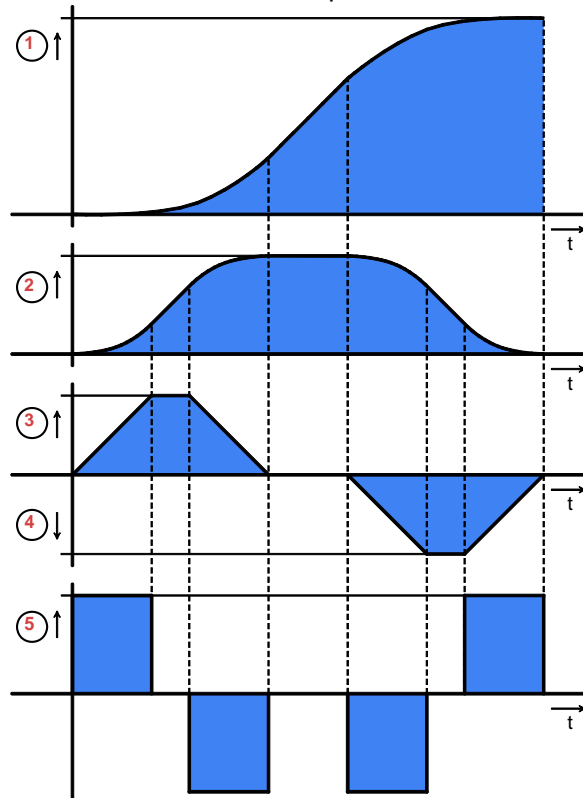
4.1.15. Motion functions

In this chapter you can read about:

MoveAbs and MoveRel.....	124
Reg-related positioning (RegSearch, RegMove).....	125
Electronic gearbox (Gearing).....	131
Speed specification (Velocity).....	132
Stop command (Stop).....	132

4.1.15.1 MoveAbs and MoveRel

A motion set defines a complete motion with all settable parameters.



- 1: Target position
- 2: Travel speed
- 3: Maximum acceleration
- 4: Maximum deceleration
- 5: Maximum **Jerk** (see page 114)

Motion functions	MoveAbs: Absolute positioning. MoveRel: Relative positioning
Target position / distance	Target position of the choesen unit of measure. Distance with MoveRel
Velocity	Speed in length unit/s
Acceleration	Acceleration in length unit/s ²
Deceleration	Deceleration in length unit/s ²
Jerk	Jerk in unit of measure/s ³

You can optimize the motion profile data with the "**ProfilViewer**" (see page 266) software tool!

4.1.15.2 Reg-related positioning (RegSearch, RegMove)

For registration mark-related positioning, 2 motions are defined.

RegSearch Search movements: Relative positioning in order to search for an external signal - of a reg
This may, for example, be a reg on a product.

RegMove The external signal interrupts the search movement and the second movement by the predefined offset follows without transition. The drive comes to a standstill at the position of the mark signal + the configured offset.

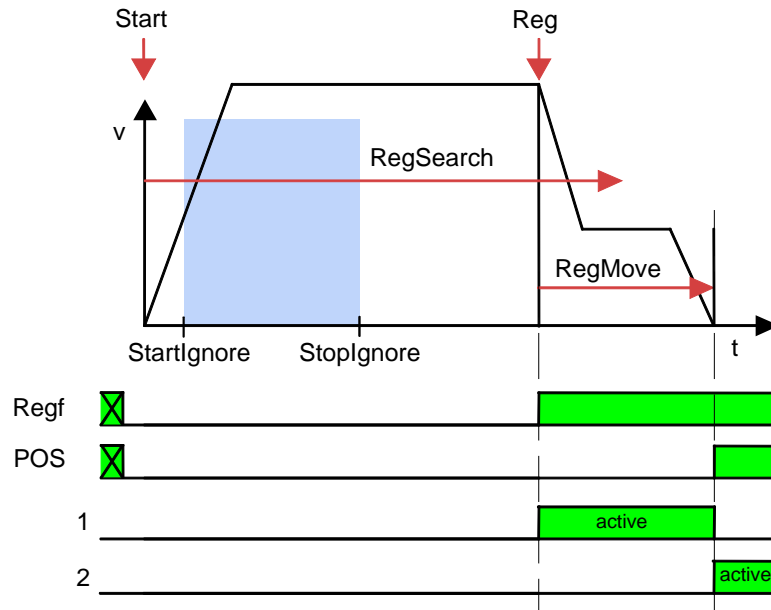
Accuracy of the reg detection: <1μs

Please note:

The reg restriction window is the same for all reg motion sets!

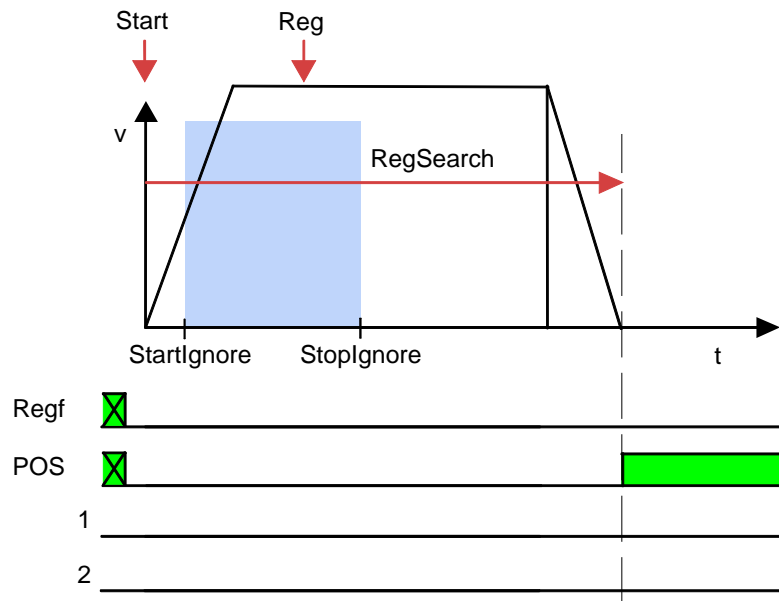
Example 1: Reg comes after the reg restriction window

Example 1: Reg comes after the reg restriction window



- Start** Start signal for reg positioning (Control word 1 Bit 4)
- RegSearch:** Positioning for reg search
- RegMove:** Positioning according to reg
- StartIgnore:** **Reg ignore window:** (see page 122) beginning of the registration lockout zone
- StopIgnore:** Reg ignore window: End of Registration lock-out zone (StopIgnore)
- Reg:** Reg signal (I4 on X12/10)
- Regf:** Signal: Reg mark detected (Status word 1 Bit 15)
- POS:** Signal: Position reached (Ausgang A1: X12/3 oder Zustandswort 1 Bit 9)
- 1** Programmable status bits of RegSearch (only for positioning with set selection)
- 2** Programmable status bits of RegMove (only for positioning with set selection)

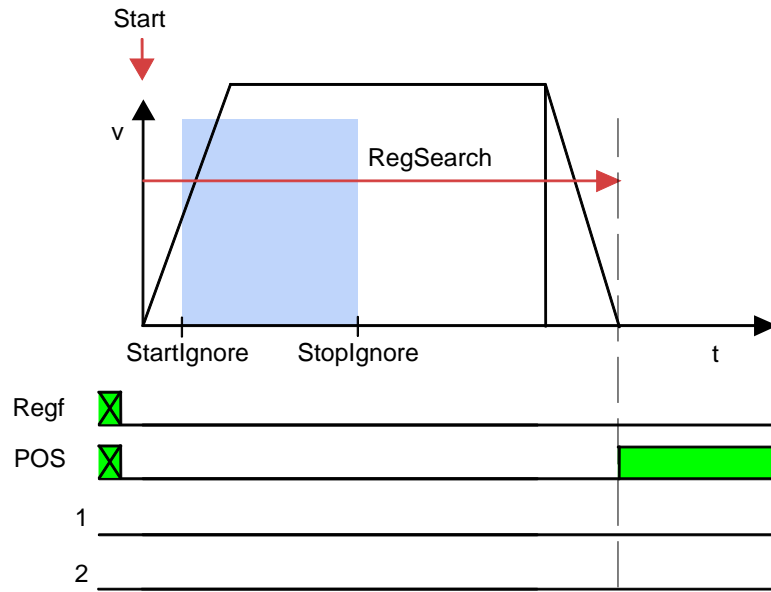
Example 2: Reg within the reg restriction window



- Start** Start signal for reg positioning (Control word 1 Bit 4)
- RegSearch:** Positioning for reg search
- RegMove:** Positioning according to reg
- StartIgnore:** **Reg ignore window:** (see page 122) beginning of the registration lockout zone
- StopIgnore:** Reg ignore window: End of Registration lock-out zone (StopIgnore)
- Reg:** Reg signal (I4 on X12/10)
- Regf:** Signal: Reg mark detected (Status word 1 Bit 15)
- POS:** Signal: Position reached (Ausgang A1: X12/3 oder Zustandswort 1 Bit 9)
- 1** Programmable status bits of RegSearch (only for positioning with set selection)
- 2** Programmable status bits of RegMove (only for positioning with set selection)

The reg is ignored; the drive moves to the target position from the RegSearch motion set.

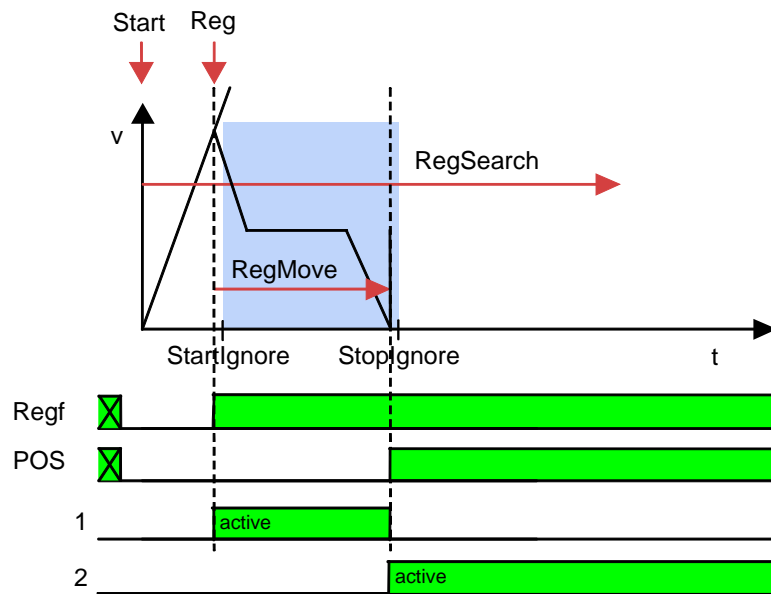
Example 3: Reg is missing or comes after termination of the RegSearch motion set



- Start** Start signal for reg positioning (Control word 1 Bit 4)
- RegSearch:** Positioning for reg search
- RegMove:** Positioning according to reg
- StartIgnore:** **Reg ignore window:** (see page 122) beginning of the registration lockout zone
- StopIgnore:** Reg ignore window: End of Registration lock-out zone (StopIgnore)
- Reg:** Reg signal (I4 on X12/10)
- Regf:** Signal: Reg mark detected (Status word 1 Bit 15)
- POS:** Signal: Position reached (Ausgang A1: X12/3 oder Zustandswort 1 Bit 9)
- 1** Programmable status bits of RegSearch (only for positioning with set selection)
- 2** Programmable status bits of RegMove (only for positioning with set selection)

The drive moves to the target position from the RegSearch motion set

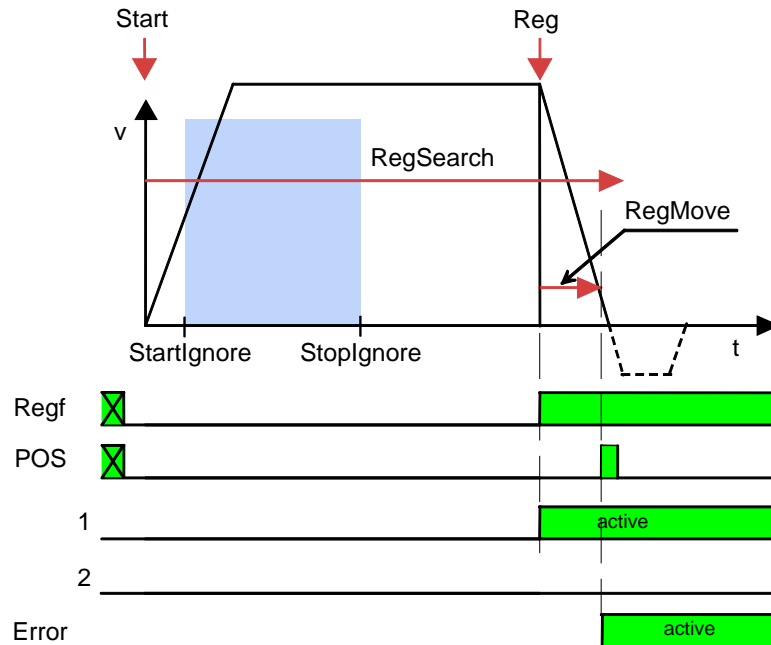
Example 4: Reg comes before the reg restriction window



- Start** Start signal for reg positioning (Control word 1 Bit 4)
- RegSearch:** Positioning for reg search
- RegMove:** Positioning according to reg
- StartIgnore:** **Reg ignore window:** (see page 122) beginning of the registration lockout zone
- StopIgnore:** Reg ignore window: End of Registration lock-out zone (StopIgnore)
- Reg:** Reg signal (I4 on X12/10)
- Regf:** Signal: Reg mark detected (Status word 1 Bit 15)
- POS:** Signal: Position reached (Ausgang A1: X12/3 oder Zustandswort 1 Bit 9)
- 1** Programmable status bits of RegSearch (only for positioning with set selection)
- 2** Programmable status bits of RegMove (only for positioning with set selection)

As from the mark, the drive moves on relatively by the offset defined in RegMove and then stops at that position (same behavior as in example 1).

Example 5: The registration mark comes after the reg retriiction window, registration mark can, however, not be reached without direction reversal



- Start** Start signal for reg positioning (Control word 1 Bit 4)
- RegSearch:** Positioning for reg search
- RegMove:** Positioning according to reg
- StartIignore:** **Reg ignore window:** (see page 122) beginning of the registration lockout zone
- StopIignore:** Reg ignore window: End of Registration lock-out zone (StopIignore)
- Reg:** Reg signal (I4 on X12/10)
- Regf:** Signal: Reg mark detected (Status word 1 Bit 15)
- POS:** Signal: Position reached (Ausgang A1: X12/3 oder Zustandswort 1 Bit 9)
- 1** Programmable status bits of RegSearch (only for positioning with set selection)
- 2** Programmable status bits of RegMove (only for positioning with set selection)
- Error** Output A0: X12/2 or Status word 1 Bit 3

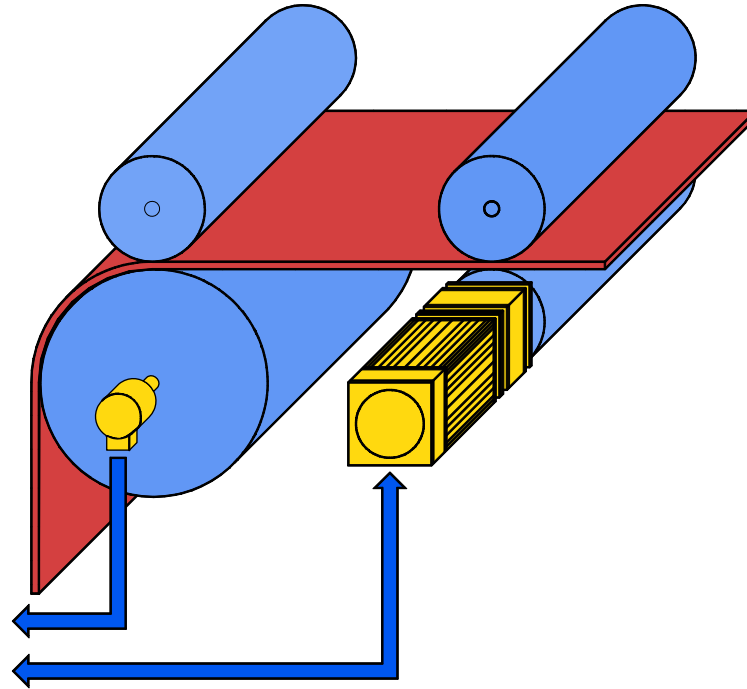
Position reached can be activated for a short period, if the position window was not linked to the command value.

4.1.15.3 Electronic gearbox (Gearing)

The motion function "Gearing" (electronic gearbox) moves Compax3 synchronously with a leading axis.

A 1:1 synchrony or any transmission ratio can be selected via the gear factor. A negative sign – which means reversal of direction – is permitted.

Function Electronic gearbox (Gearing)



The position of a master axis can be detected via:

- ◆ +/-10V analog input
- ◆ Step / direction input (X11/6, 7, 8, 12)
- ◆ the encoder input (X11/6, 7, 8, 12) or
- ◆ HEDA, if Compax3 is used as master drive.

The master signal detection is configured under synchronization.

Settings of the "Gearing" motion function

Gearing numerator / Gearing denominator:

Transmission ratio slave / master

The transmission ratio (gear factor) can be entered in "Gearing numerator" (at "Gearing denominator" = 1).

You will obtain an exact image of a non-integral transmission ratio by entering the value integrally as a fraction with numerator and denominator. This helps to avoid long-term drifts

That is:

$$\frac{\text{Slave}}{\text{Master}} = \frac{\text{Gearing numerator}}{\text{Gearing denominator}}$$

Acceleration

Here you can define the acceleration for the drive to reach the desired synchrony.

Dynamic change of the gear factor

You can switch dynamically between 2 gearing motion sets with different gear factors.

The set acceleration counts as deceleration if the gear factor is reduced.

Dynamic switching between the gearing motion function and positioning functions (MoveAbs, MoveRel, RegSearch) is possible.

Synchronicity: with the "Gear reached" signal (Ausgang A1: X12/3 oder Zustandswort 1 Bit 9) the reaching of the synchronicity is displayed.
The signal "Gear reached" is reset if the synchronicity is exited.
The programmable status bits (PSBs) are activated via the signal "Gear reached"

Limiting effects If the synchronicity is lost temporarily due to limitations, the resulting position difference is made up afterwards.

Note: Jerk is not limited.

4.1.15.4 Speed specification (Velocity)

This motion function is defined by velocity and acceleration.

An active motion set is interrupted by:

- ◆ Stop or
- ◆ Start of a different set.

As soon as the setpoint speed is reached, "speed reached" (Ausgang A1: X12/3 oder Zustandswort 1 Bit 9) as well as the defined status bits (PSBs) are activated.

Note: Position control is active, i.e. the following error caused by limitations will be made up.
Jerk is not limited.

4.1.15.5 Stop command (Stop)

The Stop set interrupts the current motion set (Stop with interruption).

This motion function is defined by the deceleration and the jerk of the drive when coming to a standstill.

As soon as the drive is at standstill "position reached" (Ausgang A1: X12/3 oder Zustandswort 1 Bit 9) as well as the defined status bits (PSBs) are activated.

Note: The stop command (as motion function) is not effective during the machine zero run.

4.1.16. Error response

Under "configuring: Under "configuration: error reaction" you can change the error reaction for individual **errors** (see page 312) (the error no. which can be influenced is displayed).

Possible settings for the error reaction are:

- ◆ No response
- ◆ downramp / stop
- ◆ Downramp / stromlos schalten (standard setting)

Note on Compax3H:

The error reaction upon the "low voltage DC" error (0x32229 is fixed to "downramp/deenergize" for Compax3H.

4.1.17. Configuration name / comments

Here you can name the current configuration as well as write a comment. Then you can download the configuration settings or, in T30 or T40 devices, perform a complete Download (with IEC program and curve).

**Caution!**

Deactivate the drive before downloading the configuration software!

N.B.!

Incorrect configuration settings entail danger when activating the drive. Therefore take special safety precautions to protect the travel range of the system.

**Mechanical limit values!**

Observe the limit values of the mechanical components!

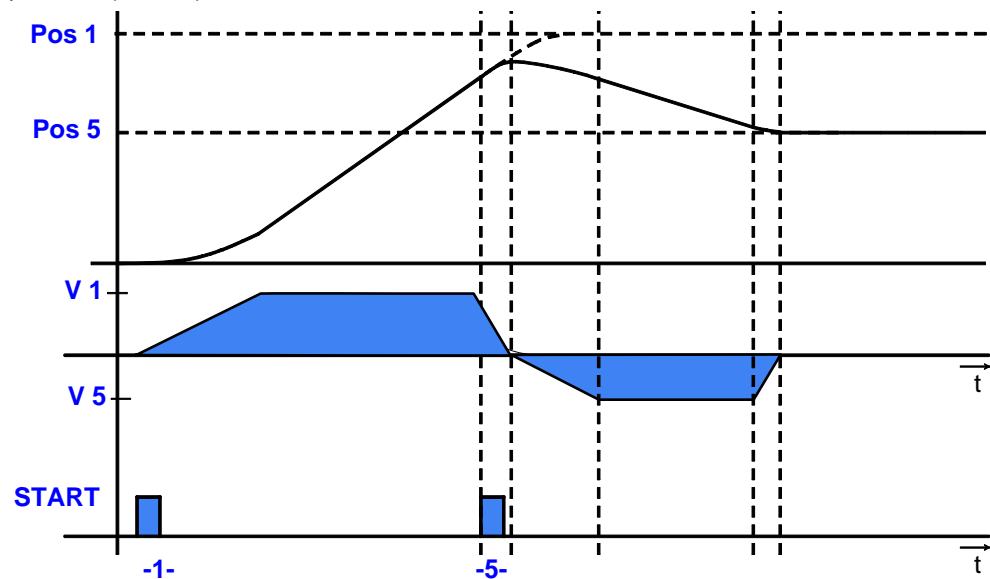
Ignoring the limit values can lead to destruction of the mechanical components.

4.1.18. Dynamic positioning

You can change over to a new motion set during a positioning process. Thereby the following conditions apply:

- ◆ Acceleration and deceleration remain constant independent of the values predefined in the new motion set.
- ◆ The jerk, too, remains constant.
- ◆ The velocity of the new motion set is activated.
- ◆ The drive moves to the target position defined in the new motion set.
- ◆ The new motion set address must not equal 0.

Example: MoveAbs (Target position POS1) is interrupted by a new MoveAbs with target position (POS 5)



The following dynamic transitions are supported:

Motion function in progress	Possible dynamic change to the motion function:
MoveAbs, MoveRel, RegSearch, RegMove, Velocity	MoveAbs, MoveRel, Velocity, RegSearch, Gearing
Gearing	MoveAbs, MoveRel, RegSearch, Gearing (other gearing factor)
Stop	-

Prerequisite: Prerequisite for dynamic positioning is:
Control word 1 Bit 5 = "1" (Change Set immediately)

4.2 Configuring the signal Source

In this chapter you can read about:

Select signal source for Gearing..... 135
 Load control..... 139

4.2.1. Select signal source for Gearing

In this chapter you can read about:

Signal source HEDA 136
 Encoder A/B 5V, step/direction or SSI feedback as signal source 136
 +/-10V analog speed setpoint value as signal source 138

Here the signal source is configured for the motion function "Gearing" (electronic gearbox).

Available are:

Gearing input signal source

- ◆ The HEDA real-time bus (M10 or M11 option) directly from a Compax3 master axis
- ◆ an encoder signal A/B 5V
- ◆ a step/direction signal 5V or
- ◆ a velocity as analog value +/-10V

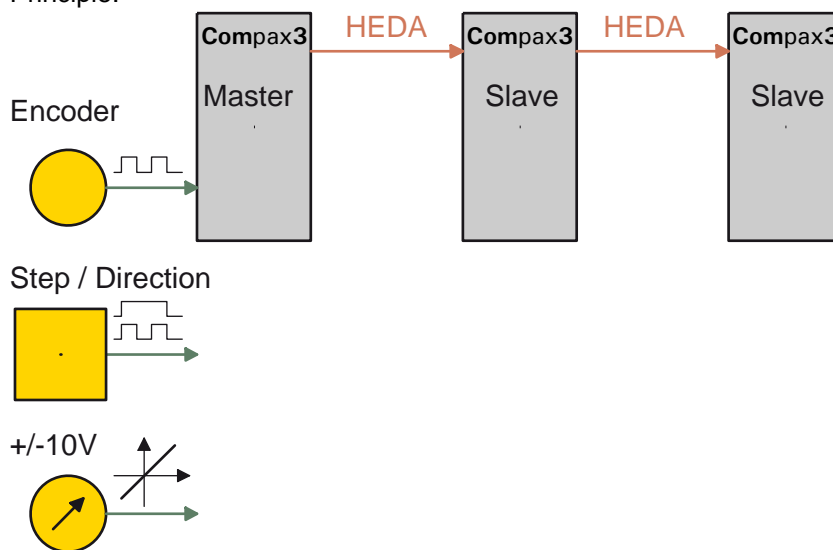
HEDA operating mode HEDA as Master

Under signal source gearing "not configured" must be set!

If an existing HEDA option (M10 or M11) is not used as signal source, you can transmit the following signals for a slave axis via HEDA:

- ◆ Process - setpoint position (Object 2000.1)
- ◆ Process - actual position (Object 2200.2)
- ◆ Position from external setpoint (object 2020.1)
 Signal read in via analog output 0, encoder input or step / direction input in the master.

Principle:





Attention in the case of a configuration download with master-slave coupling (electronic gearbox, cam)

Switch Compax3 to currentless before starting the configuration download: Master and Slave axis

4.2.1.1 Signal source HEDA

Signal source is a Compax3 master axis in which the HEDA operating mode "HEDA master" is set.

Please enter besides the desired error reaction an individual HEDA axis address in the range from 1 ...32.

The dimensional reference to the master is established via the following settings:

- ◆ Travel path per motor revolution master axis numerator
With denominator = 1 the value can be entered directly.
Long-term drift can be avoided by entering non-integral values integrally as a fraction with numerator and denominator.
- ◆ Travel distance per motor revolution master axis denominator
If required the direction of rotation of the master axis read in can be changed.

4.2.1.2 Encoder A/B 5V, step/direction or SSI feedback as signal source

Caution!

- ◆ The encoder simulation is not possible at the same time as the encoder input resp. the step/direction input or the SSI interface.
The same interface is used here.
- ◆ A direction reversal configured in the C3 ServoManager does not affect the encoder simulation.
The direction of rotation of the encoder simulation can, however, be changed via the feedback direction in the MotorManager.

The dimensional reference to the master is established via the following settings:

- ◆ Travel path per motor revolution master axis numerator
With denominator = 1 the value can be entered directly.
Long-term drift can be avoided by entering non-integral values integrally as a fraction with numerator and denominator.
- ◆ Travel distance per motor revolution master axis denominator
- ◆ Increments per revolution of the master axis

If required the direction of rotation of the master axis read in can be changed.

Example: Electronic gearbox with position detection via encoder

Reference to master axis The reference to the master axis is established via the increments per revolution and the travel path per revolution of the master axis (corresponds to the circumference of the measuring wheel).
The rule for this is:

$$\text{MasterPos} = \frac{\text{Master_I}}{\text{I_M}} * \frac{\text{Travel Distance per Master Axis revolution (M_Units/rev)}}{\text{Travel Distance per Master Axis revolution - Denominator}} \quad (1)$$

MasterPos: Master Position
Master_I: master increments read in
I_M: Increments per revolution of the master axis

External signal source Encoder with 1024 increments per master revolution and a circumference of the measuring wheel of 40mm.

Settings: Travel path per revolution of the master axis numerator = 40
Travel path per revolution of the master axis denominator = 1
Increments per revolution of the master axis = 1024

Configuration wizard: Reference system of Slave axis: Unit of measure [mm]
Travel path per revolution numerator = 1
Travel path per revolution denominator = 1

Gearing: Gearing numerator = 2
Gearing denominator = 1

This results in the following interrelations:

If the measuring wheel moves by 40mm (1 master revolution), the slave axis will move by 80mm.

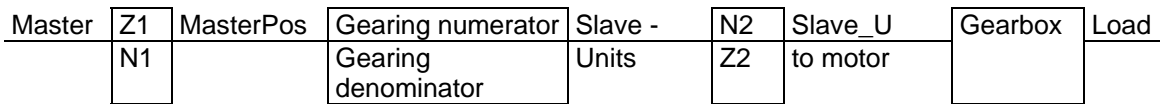
$$\text{Slave unit} = \text{MasterPos} * \frac{\text{Gearing numerator}}{\text{Gearing denominator}} \quad (2)$$

(1) set into (2) and with numerical values results with 1024 increments read in (=1 Master revolution):

$$\text{Slave unit} = 1024 * \frac{1}{1024} * \frac{40\text{mm}}{1} * \frac{2}{1} = 80\text{mm}$$

Master - Position = +40mm => Slave - Position = +80mm

Structure:



Detailed structure image with:

$$MD = \frac{Z1}{N1} * \frac{\text{Travel Distance per Master Axis revolution (M_Units/rev)}}{\text{Travel Distance per Master Axis revolution - Denominator}}$$

Entry in the "configuration of the signal source" wizard

$$SD = \frac{Z2}{N2} * \frac{\text{Travel path per revolution slave axis numerator}}{\text{Travel path per revolution slave axis denominator}}$$

Entry in the "configuration of the signal source" wizard

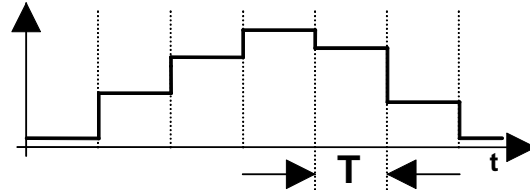
- MD:** Feed of the master axis
- SD:** Feed of the slave axis

4.2.1.3 +/-10V analog speed setpoint value as signal source

The velocity of the master is read in via the analog channel 0 (X11/9 and X11/11). From this value a position is internally derived, from which then the motion of the drive is derived with reference to the transmission ratio. Without limitation effect applies:
 Velocity of the master * (Gearing numerator / gearing denominator) = velocity of the slave
 The reference to the master is established with the velocity at 10V.
 If required the direction of rotation of the master axis read in can be changed.

Zeitraster Signalquelle Master

Averaging and a following filter (interpolation) can help to avoid steps caused by discrete signals.
 If the external signal is analog, there is no need to enter a value here (Value = 0). For discrete signals e.g. from a PLC, the scanning time (or cycle time) of the signal source is entered.



This function is only available if the analog interface +/-10V is used!

4.2.2. Load control

In this chapter you can read about:

Configuration of load control.....	141
Error: Position difference between load mounted and motor feedback too high	142
Load control signal image.....	142

The load control can be activated via an additional feedback system for the acquisition of the actual position of the load.

This helps for example compensate the slip between material and roller or non-linearities of the mechanic parts.

The load position is set to the demand position.

Please note:

- ◆ This function is not available in the C3I10T10 and C3I11T11 devices.
- ◆ As a sensor signal, **Encoder** (see page 379) with A/B track, Step/Direction signal or SSI - sensor is supported.
- ◆ This controller structure improves the stationary precision at the load after the decay of all control movements.
An increase of the dynamic precision (faster transient response) can in general not be reached with the "load control" structure variant.

Notes on the SSI sensor

- ◆ With Multiturn: Number of sensor rotations with absolute reference
- ◆ Word length: Gives the telegram length of the sensor.
- ◆ Baud rate/step: Max. transmission rate of the path measurement system.
- ◆ Gray code: Sensor gray code coded yes/no (if no binary coded).

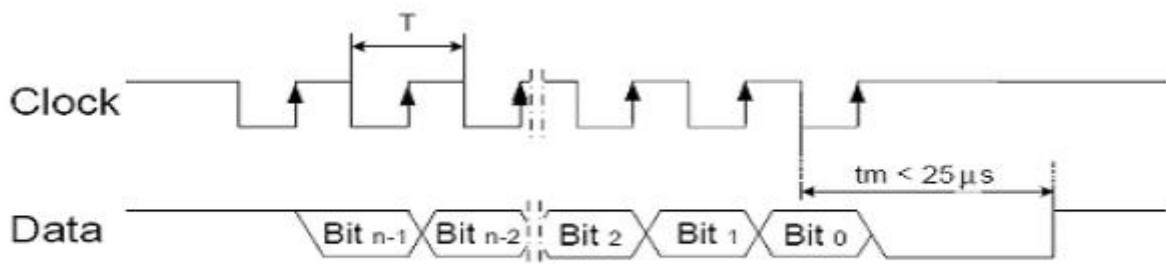
Note:

The absolute position is not evaluated!

It is available in the objects 680.24 (load position) and 680.25 (master position) (C3T30, C3T40).

General requirements for supported SSI feedbacks

- ◆ Baud rate: 350k ... 5MBaud
- ◆ Word length: 8 ... 32 Bit
- ◆ Binary or gray code (start value = 0)
- ◆ Initialization time after PowerOn: < 1.1s
- ◆ Signal layout:



The most significant bit must be transmitted the first!

Caution! Feedback systems, transmitting data containing error or status bits are not supported!

- ◆ Examples of supported SSI feedback systems:

- ◆ IVO / GA241 SSI;
- ◆ Thalheim / ATD 6S A 4 Y1;
- ◆ Hübner Berlin / AMG75;
- ◆ Stegmann / ATM60 & ATM90;
- ◆ Inducoder / SingleTurn: EAS57 & Multiturn: EAMS57

4.2.2.1 Configuration of load control

Configuration in the "configure signal source" wizard under "load feedback system":

- ◆ The selection of the feedback signal activates the acquisition and the signals are available as **Status values** (see page 142).
- ◆ Rotatory or linear feedback systems are supported.
- ◆ Input values for rotatory feedback systems:
 - ◆ Increments per feedback revolution (physical, without quadruplication)
 - ◆ Direction reversal

Attention! With wrong sense of direction and active load control, you will get a positive feedback; the motor will accelerate in an uncontrolled way
Solution: Before the load control is activated, the signals must be checked with the aid of the **status values** (see page 142) and secure against a wrong sense of direction with the aid of a "maximum difference to motor position.
 - ◆ Load travel per feedback revolution: Is used for establishing the measure reference between load- and motor position.
The value can be configured very precisely by entering numerator and denominator.
- ◆ Input values for linear feedback system
 - ◆ Feedback resolution (physical, without quadruplication)
Position difference, which corresponds to a cycle duration of the feedback signal.
 - ◆ Direction reversal

Attention! With wrong sense of direction and active load control, you will get a positive feedback; the motor will accelerate in an uncontrolled way
Solution: Before the load control is activated, the signals must be checked with the aid of the **status values** (see page 142) and secure against a wrong sense of direction with the aid of a "maximum difference to motor position.
 - ◆ Scaling factor for an additional adaptation of the feedback signal (is normally not required = 1)
 - ◆ Maximum difference to the motor position
Upon exceeding this value, Compax3 will report **error 7385hex** (see page 142) (29573dez)
 - ◆ Activate / Deactivate load control

!Attention!

**The load control is active immediately after the configuration download!
Therefore do only activate if the load position signal (scaling, direction, value) was verified before.**

Alignment of the load control:

There is an **Alignment of the position values** of motor and load under the following operating conditions (Load position = Motor position):

- ◆ During a **Machine zero run** the load control is deactivated until the position value 0 (defined via the machine zero offset) was approached.
Then an alignment of the position values is performed and the load control is activated.
- ◆ After switching on Compax3.
- ◆ When writing "1" into object 2201.2
- ◆ When activating the load control.

Continuous mode

Object for the load control (overview)

No.	Object name	Object	Format	PD	Valid beginning
410.6	C3.LimitPosition_LoadControlMaxPosDiff	Position difference load-motor (error threshold)	C4_3	no	VP
680.23	C3.StatusPosition_LoadControlActual	Actual position of the load	C4_3	no	-
680.20	C3.StatusPosition_LoadControlDeviation	Position difference load-motor (unfiltered)	C4_3	no	-
680.22	C3.StatusPosition_LoadControlDeviationFiltered	Position difference load-motor (filtered)	C4_3	no	-
680.21	C3.StatusPosition_LoadControlDeviationMax	Maximum position difference load-motor	C4_3	no	-
681.20	C3.StatusSpeed_LoadControl	Speed of the load feedback (unfiltered)	C4_3	no	-
681.21	C3.StatusSpeed_LoadControlFiltered	Speed of the load feedback (filtered)	C4_3	no	-
2201.2	C3Plus.LoadControl_Command	Load control command mode	I16	no	Immediately
2201.1	C3Plus.LoadControl_Enable	Enable load control	I16	no	Immediately
2201.11	C3Plus.LoadControl_FilterDenominator	Time constant of position difference filter	U32	no	VP
2201.3	C3Plus.LoadControl_Status	Load control status bits	I16	no	-
2201.12	C3Plus.LoadControl_VelocityFilter	Time constant of the load-speed filter for the load feedback	I16	no	VP

Objects for load control

Detailed information on the topic of "objects for load control" can be found in the online help of the device.

4.3 Optimization

In this chapter you can read about:

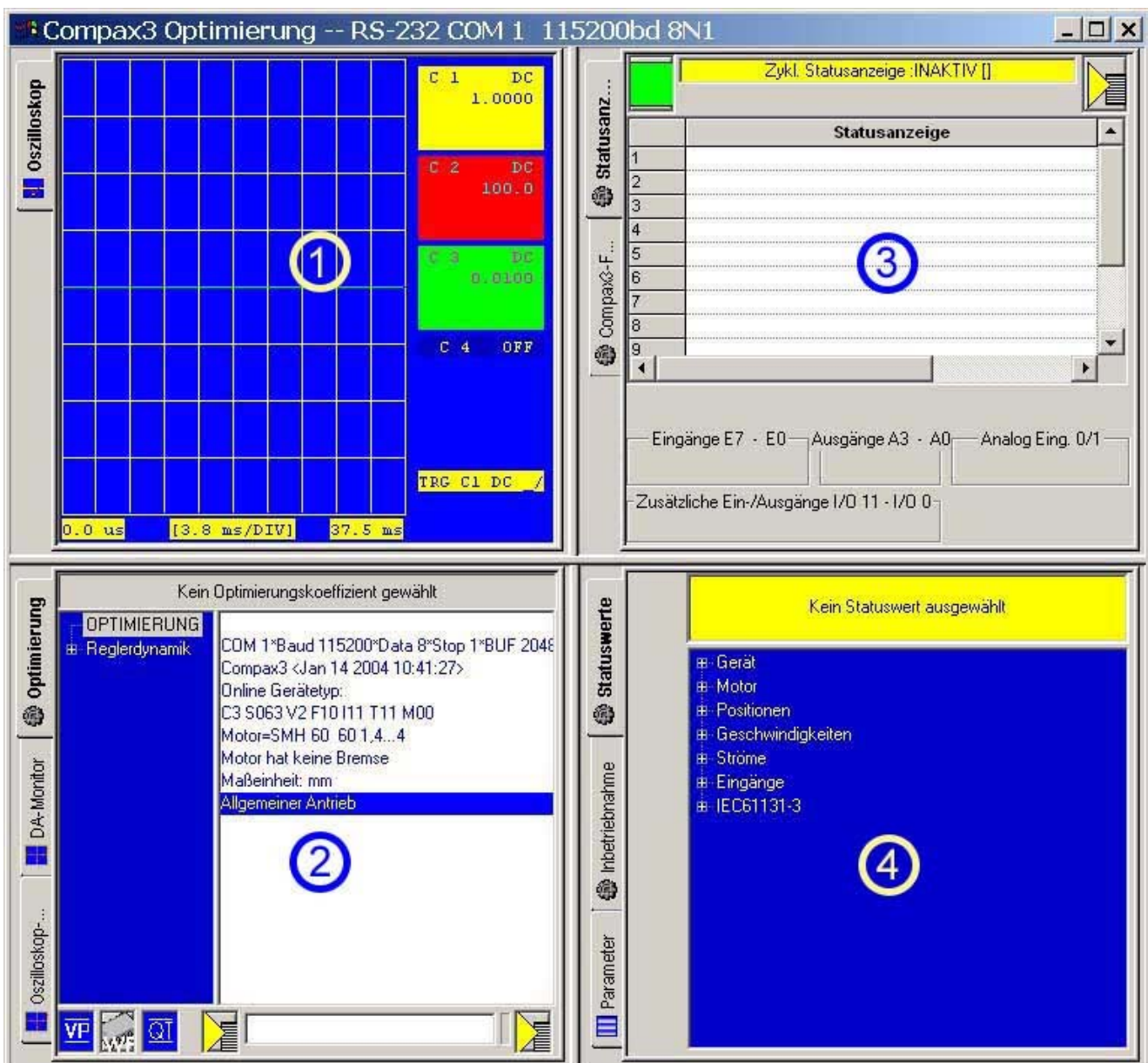
Optimization window	145
Scope	146
Controller optimization	155
Signal filtering with external command value	221
Input simulation	222
Setup mode	224
Load identification	227
Alignment of the analog inputs	229
C3 ServoSignalAnalyzer	231
ProfileViewer for the optimization of the motion profile	266
Turning the motor holding brake on and off	268

- ◆ Select the entry "**Optimization**" in the tree.
- ◆ Open the optimization window by clicking on the "**Optimization Tool**" button.

4.3.1. Optimization window

Layout and functions of the optimization window

Segmentation	Functions (TABs)
Window 1:	◆ Scope (see page 146)
Window 2:	◆ Optimization: Controller optimization
	◆ D/A Monitor (see page 311): Output of status values via 2 analog outputs
	◆ Scope Settings
Window 3:	◆ Status Display
	◆ Compax3 Error History
Window 4:	◆ Status values
	◆ Commissioning: Setup mode (see page 224) with load identification (see page 227)
	◆ Parameters for commissioning, test movements (relative & absolute) and for load identification.



4.3.2. Scope

In this chapter you can read about:

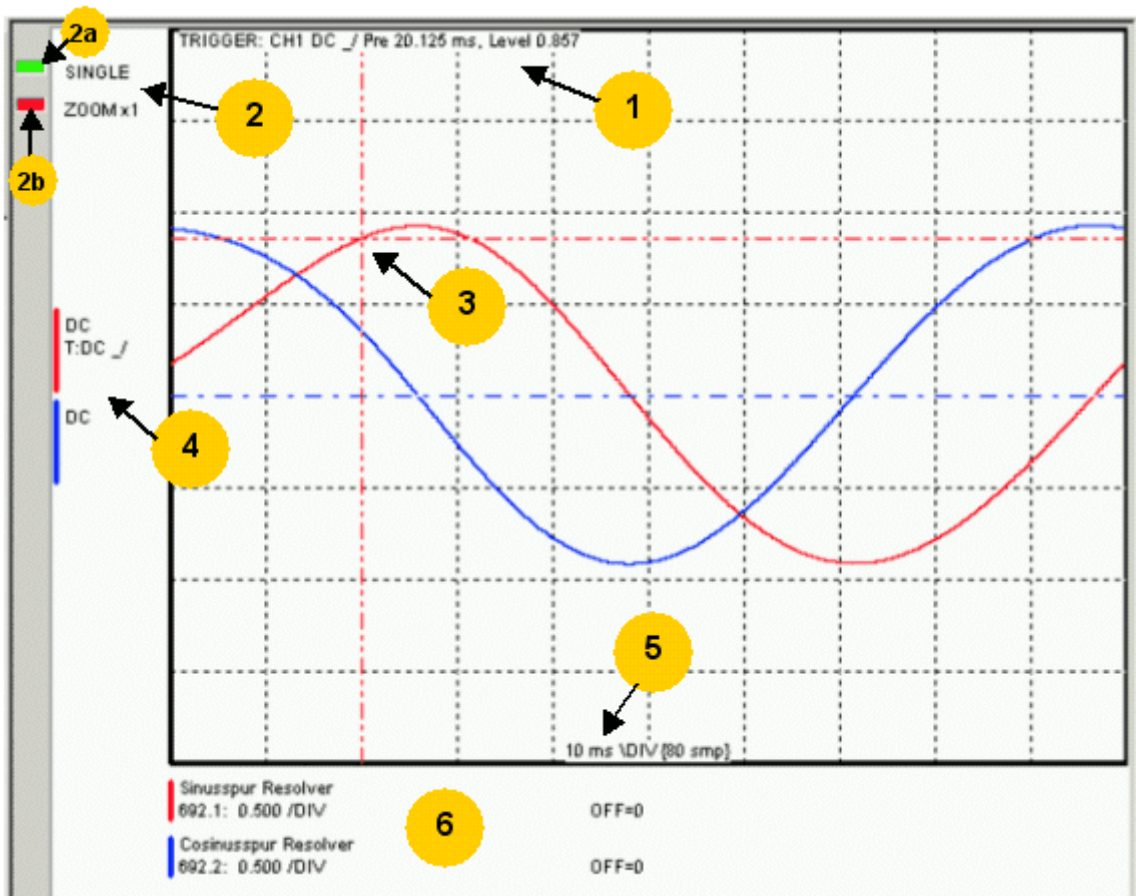
Monitor information	147
User interface	148
Example: Setting the Oscilloscope	153

The integrated oscilloscope function features a 4-channel oscilloscope for the display and measurement of signal images (digital and analog) consisting of a graphic display and a user interface.

Special feature:

in the single mode you can close the ServoManager after the activation of the measurement and disconnect the PC from Compax3 and upload the measurement into the ServoManager later.

4.3.2.1 Monitor information



- 1: Display of the trigger information
- 2: Display of the operating mode and the zoom setting
- ◆ 2a: Green indicates, that a measurement is active (a measurement can be started or stopped by clicking here).
- ◆ 2b: Active channel: the active channel can be changed sequentially by clicking here (only with valid signal source).
- 3: Trigger point for Single and Normal operating mode
- 4: Channel information: Type of display and trigger setting
- 5: X-DIV: X deviation set
- 6: Single channel sources

Cursormodes/ -functions

Depending on the operating mode, different cursor functions are available within the osci monitor.

The functions can be changed sequentially by pressing on the right mouse button.

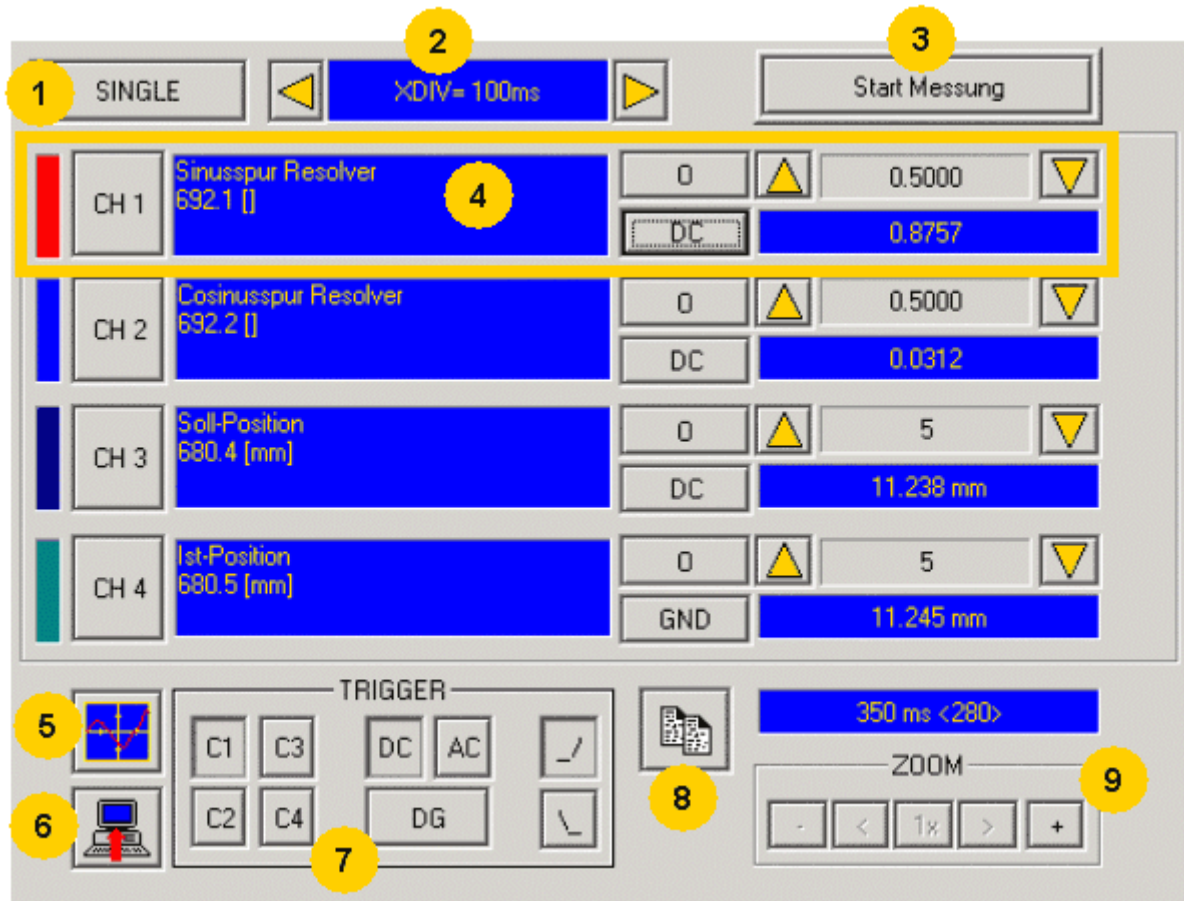
Cursor Symbol	Function
	Set Marker 1 the measurement values of the active channel as well as the y difference to marker 2 are displayed
	Set Marker 2
	Delete and hide marker
	Move offset of the active channel. The yellow symbol indicates that the scrolling is active.
	Set trigger level and pretrigger

In the ROLL operating mode, marker functions and set trigger level positions are not available.

4.3.2.2 User interface

In this chapter you can read about:

Oscilloscope operating mode switch:	149
Setting the time basis XDIV	149
Settings for channels 1..4	150
Trigger settings	151
Special functions	151



- 1: **Operating mode switch** (see page 149) (Single / Normal / Auto / Roll)
- 2: **Setting the time basis** (see page 149)
- 3: Starting / Stopping the measurement (prerequisites are valid channel sources and if necessary valid trigger settings.)
- 4: **Setting channel** (see page 150) (Channels 1 ...4)
- 5: **Special functions** (see page 151) (Color settings; memorizing settings and measurement values)
- 6: Loading a measurement from Compax3: in the single mode you can close the ServoManager after the activation of the measurement and disconnect the PC from Compax3 and upload the measurement later.
- 7: **Setting triggering** (see page 151)
- 8: Copy osci display to clipboard
- 9: Zoom of the osci display (1, 2, 3, 8, 16 fold) with the possibility to move the zoom window (<,>)

Oscilloscope operating mode switch:

Oscilloscope operating mode switch:



Selection of the desired operating mode: SINGLE, NORMAL; AUTO and ROLL by clicking on this button.

Changing the operating mode is also permitted during a measurement. The current measurement is interrupted and started again with the changed settings.

The following operating modes are possible:

Operating mode	Short description
SINGLE	Single measurements of 1-4 channels with trigger on a freely selectable channel
NORMAL	Like Single, but after each trigger event, the measurement is started again.
AUTO	No Trigger. Continuous measuring value recording with the selected scanning time or XDIV setting
ROLL	Continuous measuring value recording of 1 .. 4 channels with selectable scanning time and a memory depth of 2000 measuring values per channel.

With SINGLE / NORMAL / AUTO, the measurement is made in Compax3 and is then loaded into the PC and displayed.

With ROLL, the measuring values are loaded into the PC and displayed continuously.

Setting the time basis XDIV

Setting the time basis XDIV



Depending on the selected operating mode, the time basis can be changed via the arrow keys.

For the operating modes SINGLE, NORMAL and AUTO, the following XDIV time settings are possible:

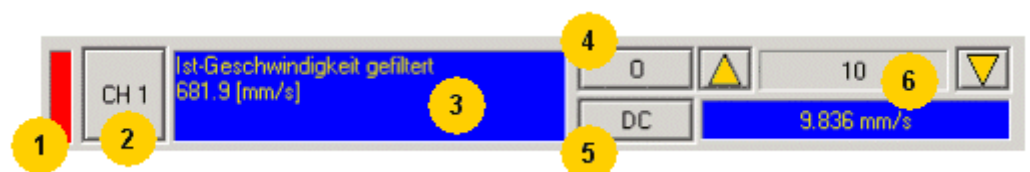
XDIV	Mode	Scanning time	Samples DIV/TOTAL	Measuring time
0.5ms	1	125 μ s	4/40	5ms
1.0ms	2	125 μ s	8/80	10ms
2.0ms	3	125 μ s	16/160	20ms
5.0ms	4	125 μ s	40/400	50ms
10.0ms	5	125 μ s	80/800	100ms
20.0ms	6	250 μ s	80/800	200ms
50.0ms	7	625 μ s	80/800	500ms
100.0ms	8	1.25ms	80/800	1s
200.0ms	9	2.50ms	80/800	2s
500.0ms	10	6.25ms	80/800	5s
1s	11	12.50s	80/800	10s
2s	12	25.00ms	80/800	20s
5s	13	62.50ms	80/800	50s
10s	14	125.00ms	80/800	100s

For the operating ROLL, the following XDIV time settings are possible:

XDIV	Mode	Scanning time	Samples DIV/TOTAL
2 ms	54	125 μ s	200/2000
2ms	54	125 μ s	200/2000
4ms	55	125 μ s	200/2000
10ms	56	125 μ s	200/2000
20ms	57	125 μ s	200/2000
40ms	58	125 μ s	200/2000
100ms	59	250 μ s	200/2000
200ms	60	625 μ s	200/2000

Changing the time basis is also permitted during an OSCI measuring sequence. This means, however, that the current measurement is interrupted and started again with the changed settings.

Settings for channels 1..4



1: Select channel color

2: Open menu for channel-specific settings

- ◆ **Reset Channel CH 1..4** all channel settings are deleted.
Please note: Channels can only be filed with sources one after the other. It is, for example, not possible to start a measurement which has only a signal source for channel 2!
- ◆ **Select channel color:** Here you can change the color of the channel..
- ◆ **show/hide channel:** Hide/show display of the channel.
- ◆ **Change logic display mask:** Mask bits in logic display.
- ◆ **auto scaling** Calculation of YDIV and Offset: The program calculates the best settings for YDIV and channel offset in order to display the complete signal values optimally.

3: Set signal source with object name, number and if necessary unit

- ◆ Define source: Draw the desired status object with the mouse (drag & drop) from the "Status value" window (right at the bottom) into this area.

4: Set Channel offset to 0

5: Select channel display (GND, DC, AC, DIG)

- ◆ **DC:** Display of the measurement values with constant component
- ◆ **AC:** Display of the measurement values without constant component
- ◆ **DIG:** Display of the individual bits of an INT signal source.
The displayed bits can be defined via the logic display mask.
- ◆ **GND:** A straight line is drawn on the zero line.

6: Set Y-amplification (YDIV)

Change of the Y amplification YDIV in the stages 1,2,5 over all decades.
Arrow upwards increases YDIV, arrow downwards diminishes YDIV.
the standard value is 1 per DIV.
The measurement value of the channel at the cursor cross is displayed.

Trigger settings




Select trigger channel: Buttons C1, C2, C3, C4

Select trigger mode: DC, AC, DG

Select trigger edge: rising_/ or falling _

the pretrigger as well as the trigger level are set by clicking on the trigger cursor

() directly in the OSCI display.

Special functions



Menu with special oscilloscope functions such as memorizing or loading settings.

Functions:

- ◆ **Select background color:** Adapt background color to personal requirements.
- ◆ **Select grid color:** Adapt grid color to personal requirements.
- ◆ **Memorize OSCI settings in file:** The settings can be memorized in a file on any drive. The file ending is *.OSC.
- ◆ The format corresponds to an INI file and is presented in the appendix.
- ◆ **open OSCI settings from file.** Loading a memorized set of settings. The file ending is *.OSC.
- ◆ **Memorizing OSCI settings in the project:** Up to four sets of OSCI settings can be memorized in the current C3 ServoManager project. .
- ◆ **open OSCI settings from project.** If settings were memorized in the project, they can be read in again.
- ◆ **Memorize OSCI measurement in file:** Corresponds to memorizing the setting; the measurement values of the measurement are stored in addition. Thus it is possible to memorize and read measurements completely with settings. The file ending is *.OSM.
- ◆ **Exporting measurement values into a CSV file:** e.g. for reading into Excel.

4.3.2.3 Example: Setting the Oscilloscope

SINGLE measurement with 2 channels and logic trigger on digital inputs

The order of the steps is not mandatory, but provides a help for better understanding.
 As a rule, all settings can be changed during a measurement. This will lead to an automatic interruption of the current measurement and to a re-start of the measurement with the new settings:

Assumption: A test movement in the commissioning mode is active.



3.) Select channel 1 signal source digital inputs 120.2 from status tree with the aid of Drag & Drop

4.) Select channel 2 (filtered actual speed) via "Drag and drop" from the status tree

5.) Set trigger to channel 1 and DG.

Input of the mask in HEX
 Triggering a rising edge to input I1.
 BIT 0 (value 1) = I0
 BIT 1 (value 2) = I1
 BIT 2 (value 4) = I2 etc.

Trigger to input	I0	I1	I2	I3	I4	I5	I6	I7
Trigger mask in hex	1	2	4	8	10	20	40	80

The masks can also be combined so that the trigger is only active, if several inputs are active. Example: Triggering to I2 and I5 and I6 -> 4h + 20h + 40h = 64h
 The mask for input I1 is in this case 2.

select rising edge.

Note: If the trigger mask DG (digital) is selected for a channel, the display mode of the trigger channel is automatically set to DIG display.

6.) Start measurement

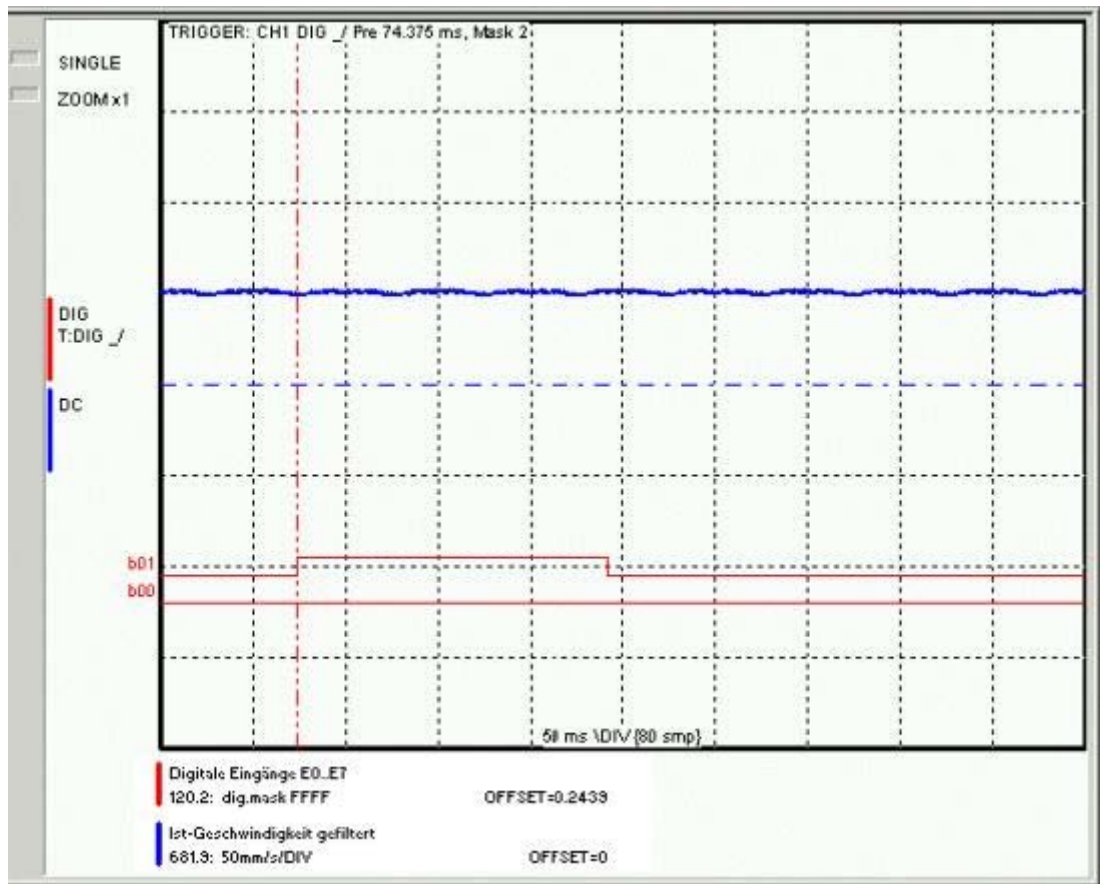
7.) Set pretrigger in the OSCI window

Note: There is no level for the DIG trigger The the event limit determines the mask
 If a trigger event occurs, the measurement values are captured until the measurement is completed.

Afterwards, the measurement values are read from the Compax3 and displayed.
 The display mask of trigger channel 1 was not yet limited, therefore it shows all 16 bit tracks (b0...b15). In order to limit it to 8 bit tracks, you must call up the menu for channel 1 via [CH1] and select "change logic of display mask [H].

Limit the display mask to 8 bit tracks with Mask FFh.
 In the display the bit tracks b0 to b7 are now shown:

Example: Only b0 and b1 are to be displayed: Set display mask to 03



4.3.3. Controller optimization

In this chapter you can read about:

Introduction	156
Configuration	159
Automatic controller design	174
Setup and optimization of the control	187

4.3.3.1 Introduction

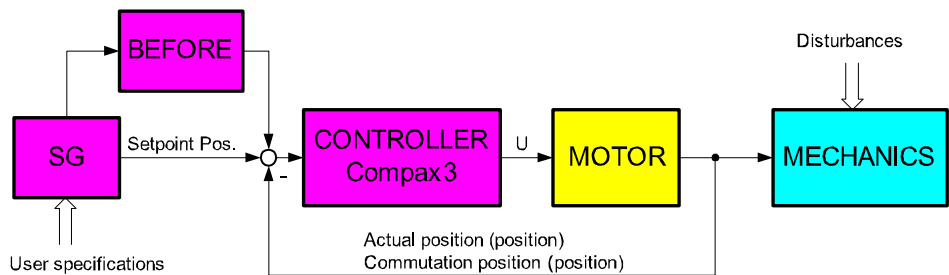
In this chapter you can read about:

Basic structure of the control with Compax3 156
 Proceeding during configuration, setup and optimization 156
 Software for supporting the configuration, setup and optimization 157

Basic structure of the control with Compax3

Compax3 is an intelligent servo drive for different applications and dynamic motion sequences.

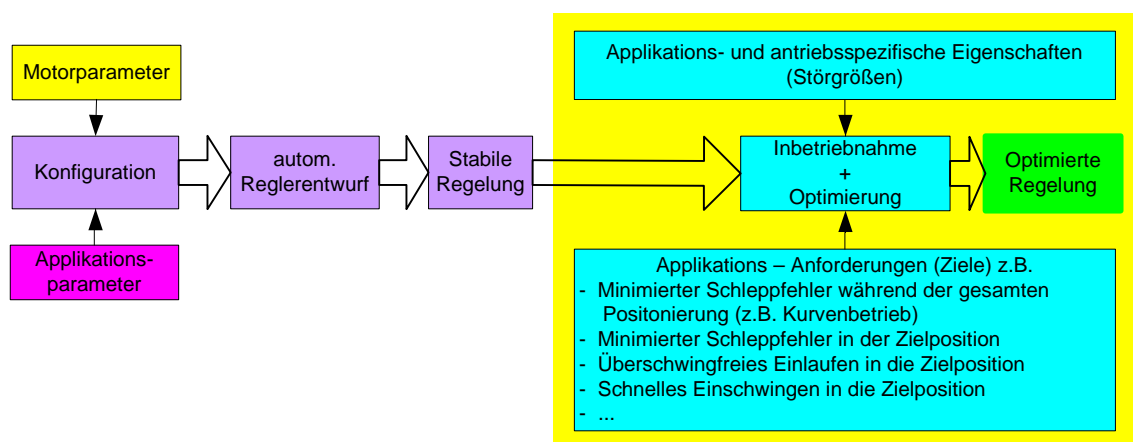
Basic structure of a control with the Compax3 servo drive



SG: Command value generator
BEFORE: Feed Forward

As shown in the above figure, the programmed motion sequences are generated by the internal Compax3 setpoint generator. The setpoint position as well as the other status values of the feedforward control are made available to the position controller in order to keep the following error as small as possible. For the control, Compax3 requires on the one hand the actual position and on the other hand the commutation position, which represents the reference between the mechanic feedback position and the motor magnet.

Proceeding during configuration, setup and optimization



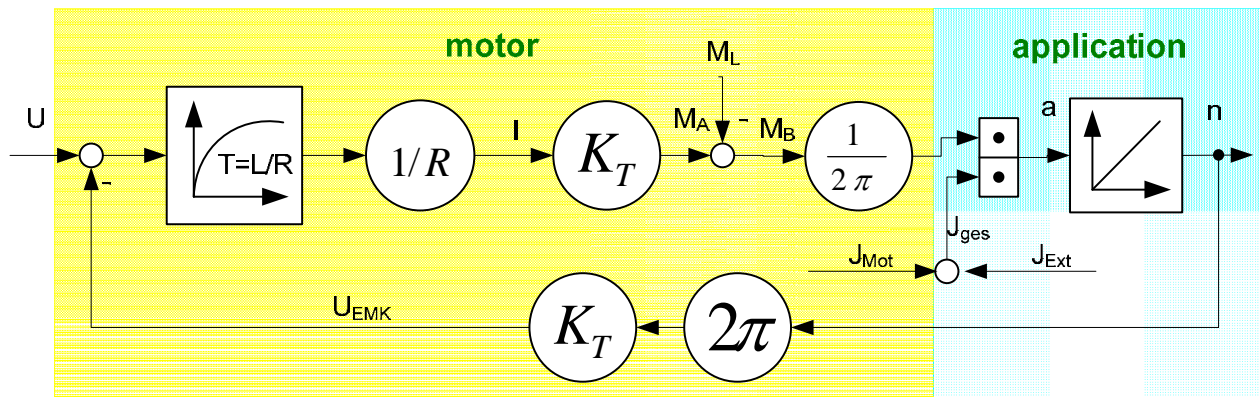
4.3.3.2 Configuration

In this chapter you can read about:

Control path 159
 Motor parameters relevant for the control..... 160
 Mass inertia 160
 Nominal point data 160
 Saturation values 162
 Quality of different feedback systems 162
 Typical problems of a non optimized control 163
 Feedback error compensation 164
 Commutation settings 166
 I²t - monitoring of the motor 166
 Relevant application parameters 169

Control path

For the motors, the knowledge of the mathematical model is a prerequisite.
 Mathematically idealized model of the control path:



U:	Cotrol voltage
U _{EMC} :	electromagnetically generated voltage in the motor
T:	electric time constant of the motor winding
L:	Winding Inductance
R:	Winding Resistance
M _A :	Drive torque of the motor
M _L :	Load torque
M _B :	Acceleration torque
I:	Actual current r.m.s. (torque-producing)
K _T :	Torque constant
J _{mot} :	Motor mass moment of inertia
J _{ext} :	External mass moment of inertia
J _{total} :	Total mass moment of inertia
a:	Acceleration
n:	Velocity

Explanation:

The motor is controlled by the servo drive with control voltage U . During motion of the motor, an internal back e.m.f U_{EMC} is induced. This antagonizes the control voltage and is therefore deduced in the motor model. The difference is available for the acceleration of the motor.

The first order delay component represents the delaying property of the motor winding with the time constant $T=L/R$. According to Ohm's Law, a current $I=U/R$ results.

The drive torque of the motor is calculated by multiplying the current with the motor torque constant K_T . This is antagonized by the load torque of the machine.

The remaining acceleration torque accelerates the motor.

The resulting acceleration depends on the total mass moment of inertia (= motor + load moment of inertia).

The integration of the acceleration (sum of the acceleration over time) results in the velocity of the motor, which influences the amplitude of the induced EMC voltage.

Motor parameters relevant for the control

All motor parameters relevant for the control quality will be explained below. Wizard guided entry of the motor parameters in the MotorManager.

Electromotoric countercheck EMC

A non-energized synchronous motor induces an induction voltage, the so-called EMC voltage during an armature movement.

The EMC constant (motor EMC) states the value of the induced voltage subject to velocity.

The EMC constant corresponds to the motor torque constant K_T , which represents the correlation between the torque-producing current and the drive torque, however in a different unit.

The EMC voltage antagonizes the control voltage of the servo drive.

As the control voltage of the drive is not unlimited, it must be taken into consideration that the drive may approach the voltage limit at high velocities and therefore high EMC voltages.

The EMC constant is important with respect to the velocity control design.

The motor EMC is entered in the "motor characteristics" wizard window of the MotorManager. You may choose between different units. Please note the information on the motor type specification plate.

Mass inertia

The mass moment of inertia (moment of inertia) is also an important motor parameter for the design of the velocity control loop. For the velocity control design, this parameter is effective in correlation with the external mass moment of inertia of the load. The external load is entered in the C3 ServoManager. With the "load identification" function of the C3 ServoManager, the mass inertia can be determined, if it is not yet known.

Nominal point data**In this chapter you can read about:**

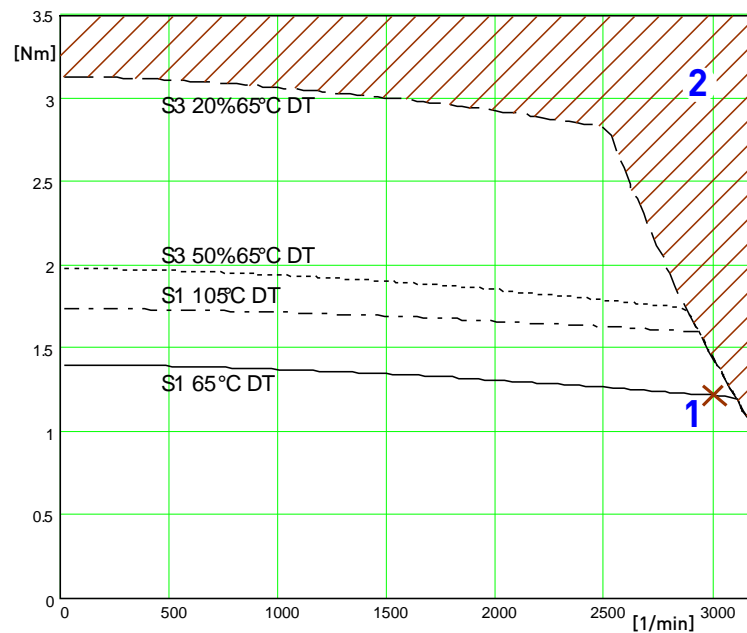
Motor characteristic line of a synchronous servo motor (torque via velocity) 161

Calculation of the reference current from the characteristic line..... 161

The nominal point data can be found in the velocity characteristic line of the motor. the prespecified nominal point can be changed in the 2nd wizard page of the C3 ServoManager configuration with the aid of "activate change of reference point" via the reference velocity and the reference current.

Motor characteristic line of a synchronous servo motor (torque via velocity)

SMH 60 30 1,4 ...2ID...4: 3000rpm at 400VAC



[Motorkennlinie.emf /.jpg]

1: Nominal point

2: Forbidden range

Calculation of the reference current from the characteristic line.

$$I = \frac{M[Nm]}{EMK} \cdot 85,5 = \frac{M[Nm]}{K_T}$$

or for linear motors

$$I = \frac{M[Nm]}{EMK_v} \cdot \frac{\sqrt{2}}{\sqrt{3}} = \frac{M[Nm]}{K_f}$$

In the MotorManager, a motor can be defined for different operating modes (230V, 400V and 480V) without having to create several entities.

Additional parameters of a motor are:

◆ Standsill current [mA_{r.m.s.}]

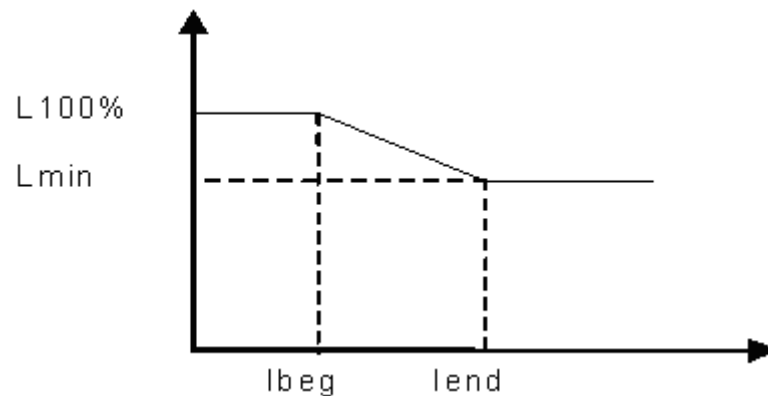
◆ Pulse current [in % of the nominal current]

The pulse current can be provided by the Compax3 for the duration of the pulse current time (as far as the device current permits). The thermal pulse load of the motor rises due to the pulse current. This pulse load is monitored by the i^2t monitoring in the Compax3.

Saturation values

A motor may show a saturation behavior at higher currents due to iron saturation. This results in the reduction of the winding inductance at higher currents. As the inductance value of the winding enters directly into the P term of the current controller, the saturation at higher currents will result in too fast current control. This behavior can be countersteered with saturation values (entered in the "motor characteristics" wizard window of the MotorManager).

Consideration of the saturation values with the aid of a linear characteristic line



L 100%	Entered value of the nominal inductance
Lmin	Minimum winding inductance [% of the nominal inductance]. Value to which the inductance of the winding sinks at Ifinal.
Ibeg	End of the saturation [% of the nominal inductance].
Ifinal	Beginning of the saturation [% of the nominal inductance].

For the determination of the saturation values please see chapter 0.

Quality of different feedback systems

In this chapter you can read about:

Interface.....	162
Resolution.....	163
Noise.....	163

The controller quality depends to a great extent on the signal quality of the position feedback and its signal acquisition. It is therefore important to select a suitable measurement system for the individual application.

In the rotary range, a resolver is mostly used for reasons of economics. The single pole resolver provides one sine/cosine period per revolution. In very demanding applications, the performance of the resolver is often not satisfactory, so that a SinCos feedback with a higher resolution must be used. The typical resolution of a SinCos feedback is 1024 periods/revolution.

Other position feedbacks which are often used in the linear range, differ with respect to the reading principle. High-quality optical position measuring systems offer the highest resolution and accuracy.

Interface

An additional distinctive feature is the electric interface between servo controller and feedback. Analog sine/cosine signals or digital encoder signals (RS422 standard) are used to transmit the incremental position information. Due to the high interpolation rate (approx. 14 bits) of the Compax3 servo controller, an analog sine/cosine signal is in most cases preferable to digital encoder signals.

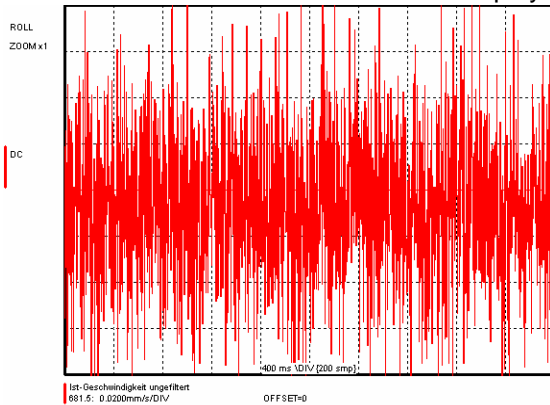
Resolution

The less precise the resolution, the higher the quantization noise on the velocity signal.

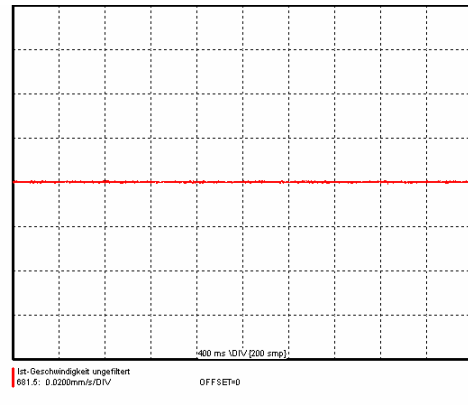
Noise

The feedbacks have different levels of analog noise, which have a negative effect on the control. The noise can be dampened with the aid of filters in the actual value acquisition, however at the cost of the controller bandwidth.

For comparison, the noise of the actual velocity value at standstill of two different feedbacks is displayed.



Resolver: 1 period/revolution



SinCos: 1024periods/revolution

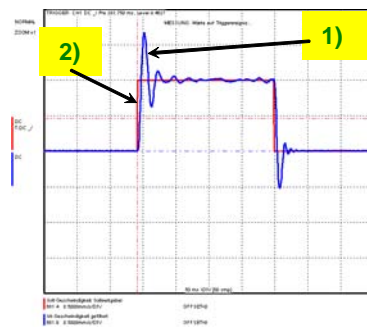
Typical problems of a non optimized control

In this chapter you can read about:

Too high overshoot on velocity 163
 Increased following error 164
 Instable behavior 164

Upon first setup of a control, the controller is normally not able to meet all application requirements at once. Typical problems may be:

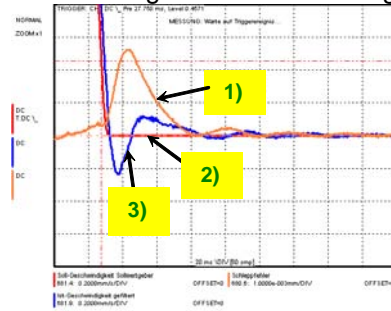
Too high overshoot on velocity



- 1) Actual velocity
- 2) Setpoint velocity

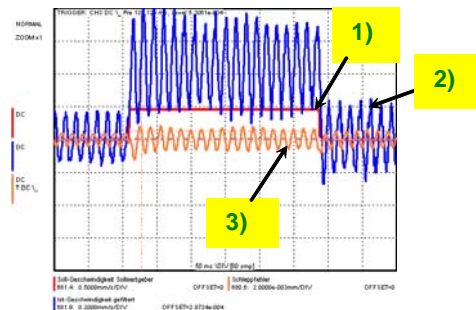
Increased following error

Increased following error when approaching the target position or the reduction of the following error takes too long



- 1) Following error
- 2) Setpoint velocity
- 3) Actual velocity

Instable behavior



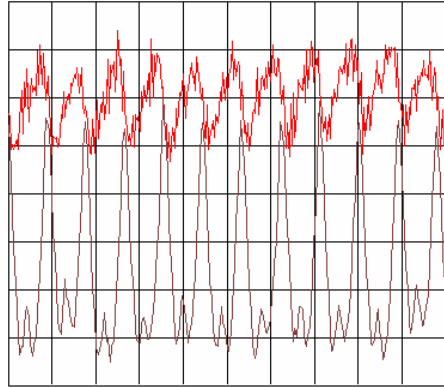
- 1) Setpoint velocity
- 2) Actual velocity
- 3) Following error

Feedback error compensation

Feedbacks with sine/cosine tracks may have different errors. The feedback error compensation supported by Compax3 eliminates offset and gain errors on both tracks online.

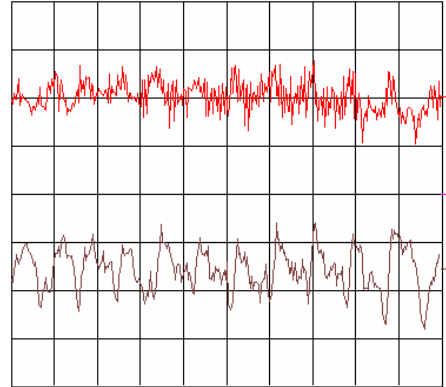
The feedback error compensation is activated in the MotorManager: "Feedback system" wizard under "feedback error compensation".

Without compensation



top:
bottom:

With compensation



Scale:
Current = 50mA/Div
Speed = 0.2mm/s/Div
Time = 3.8ms/Div

Type of motor: Parker LMDT 1200-1 ironless linear motor
Linear encoder: Renishaw RGH 24B with 20 μ m resolution
Servo controller: Compax3

In order to accept the changes in the MotorManager in the project, the individual configuration pages must be clicked through. In order to make the changes made in the MotorManager effective in the device, the configuration download in the C3Manager must be executed.

In the event of formal errors, the feedback error compensation may however be disadvantageous; therefore it is switched off as a default.

Commutation settings

Another prerequisite for a good control quality is the correct motor commutation. This comprises several settings.

- ◆ The commutation angle describes the relation of the feedback position with respect to the motor pole pair position.
- ◆ Commutation direction reversal describes the correlation between the position of the feedback and the commutation position.
- ◆ Feedback direction reversal describes the direction correlation between the defined positive direction of the drive and the feedback position.
- ◆ If the commutation direction does not match the defined direction of rotation, this will result in a subsequent error with the error message "following error" or "motor stalled".
- ◆ A faulty commutation angle value results in increased current and following error. Therefore the voltage limit is reached faster. If the value of the commutation error exceeds 90°, the motor will spin due to the positive feedback effect.

These 3 settings can be automatically acquired with the MotorManager. With the aid of the automatic commutation acquisition, the commutation settings can be determined and plausibility checks can be made. You will be guided through the individual wizard pages and the MotorManager will issue a prompt to define the positive direction of the drive. The wizard pages supporting the user depend on the feedback system as well as from the motor type (linear or rotary).

This function is activated in the MotorManager:
"Feedback system" wizard under "automatic commutation settings".

Hint The motor should be operated without load (=> no load torque e.g. weight force of a z-axis).

Additional setting of the commutation for incremental feedback:
This function is activated in the MotorManager:
"Feedback system" wizard under "feedback resolution".

In the event of an incremental feedback (Sine/cosine or RS424 encoder) the commutation must be defined in addition, in order to find the position reference to the winding.

- ◆ Automatic commutation with movement
- ◆ Commutation with digital hall sensors

I²t - monitoring of the motor

In this chapter you can read about:

Motor continuous usage	167
Motor pulse usage	168
Reference point 2: Increased torque thanks to additional cooling	169

With the I²t - monitoring, the motor is protected against overload or thermal destruction. For this, knowledge on the load bearing capacity of the motor is required. This information can be taken from the manufacturer documentation (motor parameters). Compax3 monitored:

- ◆ Continuous usage of the motor (motor usage)
- ◆ Pulse usage of the motor (motor pulse usage)

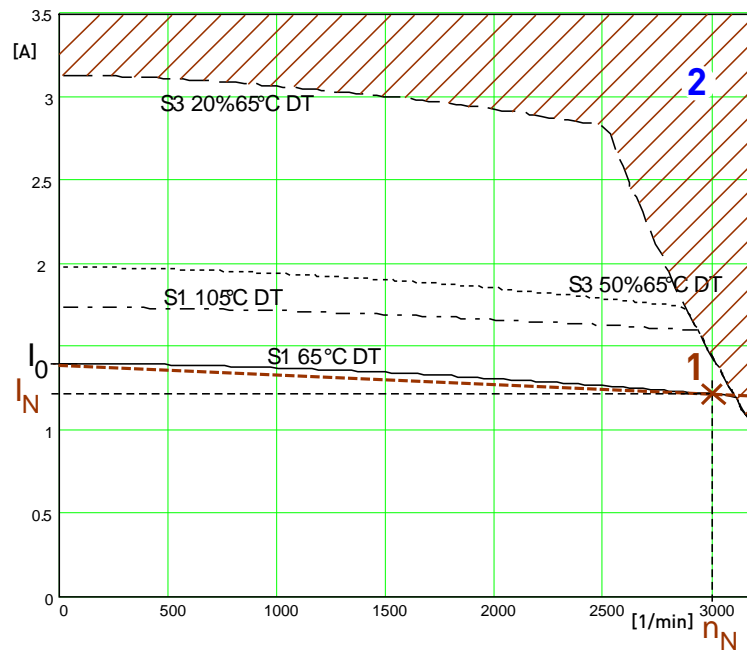
Motor continuous usage

In this chapter you can read about:

Linearized motor characteristic lien for different operating points 167
 This kind of monitoring watches over the continually deliverable torque (continuous current). This continuous current depends on the velocity and is acquired online from the linearization of the motor characteristic line.

Linearized motor characteristic lien for different operating points

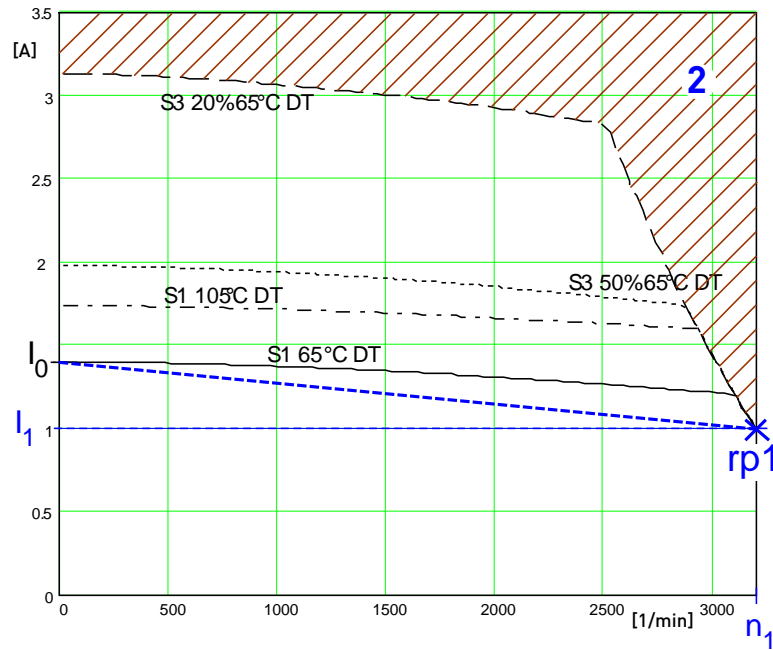
Nominal point



- I_0 Continual stall current
- 1: Nominal point
- I_N : Nominal current (defined in the MotorManager)
- n_N : Nominal speed
- 2: Forbidden range

For monitoring the continuous usage, the linearized characteristic line between I_0 und I_N / n_N is used as a threshold.

Reference point 1: higher velocity at reduced torque



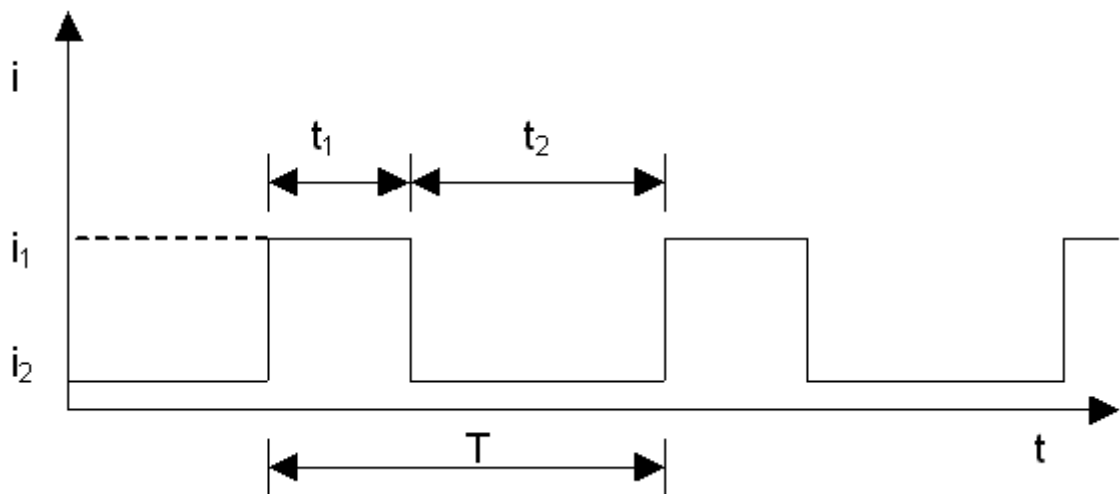
- i_0 Continual stall current
 - rp1: Reference point 1 (defined in the C3 ServoManager)
 - i_1 : Reference current to reference point 1
 - n_1 : Reference velocity to reference point 1
 - 2: Forbidden range
- For monitoring the continuous usage, the linearized characteristic line between i_0 and i_1 / n_1 is used as a threshold.

Motor pulse usage

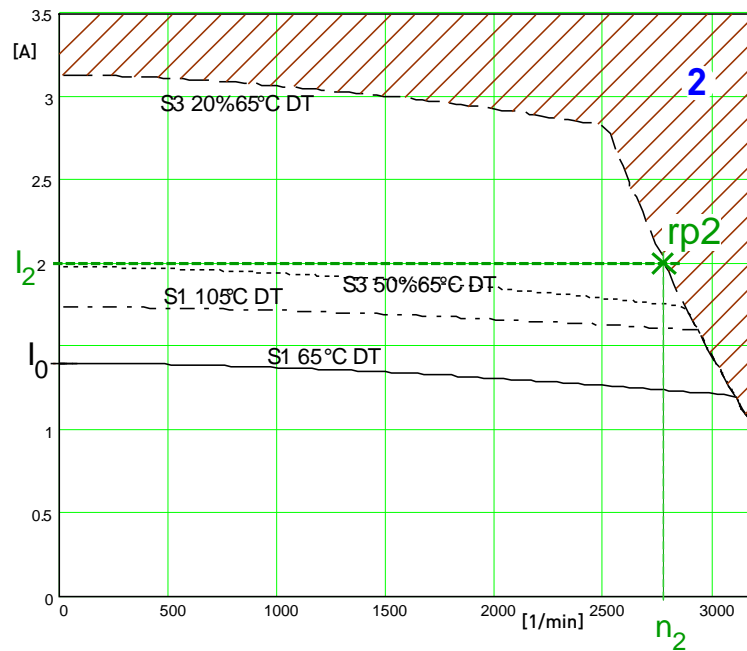
This monitoring watches over the duration of the defined pulse current. The permitted duration for the pulse current is defined by the pulse current time constant.

If the acceleration current exceeds the nominal current for a defined time t_1 , a sufficient break time t_2 is required. If the current remains in average above the nominal current, the "monitoring motor pulse usage" [0x7180] error is triggered. Upon a high pulse usage, the error will occur almost without delay.

Current cycle:



Reference point 2: Increased torque thanks to additional cooling



- I_0 Continual stall current
- 1: Nominal point
- rp2: Reference point 2 (defined in the C3 ServoManager)
- I_2 : Reference current to reference point 2
- n_2 : Reference velocity to reference point 2
- 2: Forbidden range

In order to monitor the continuous usage, the velocity-independent current limit I_2 is used.

If a r.m.s. current over the valid straight flows continually in the motor, the I_2^t monitoring will issue the "effective motor current monitoring" error message [0x5F48]. The period of time until the error occurs depends on the thermal time constant of the motor defined in the motor parameters. The electronic temperature monitoring simulates approximately the temperature behavior of the motor. By defining a reference point different from the motor nominal data, the I_2^t monitoring of the motor can be adapted to changed thermal ambient conditions (e.g. air stream caused by a ventilator fan).

Relevant application parameters

In this chapter you can read about:

Switching frequency of the motor current / motor reference point.....	169
External Moment of Inertia.....	172
Limit and Monitoring Settings	173

Application parameters relevant for the control (C3 ServoManager)

Compax3 is configured with the aid of the C3 ServoManager. Here you can make application dependant settings. Among these are also parameters, that are relevant for the control. They will be explained below.

Switching frequency of the motor current / motor reference point

In this chapter you can read about:

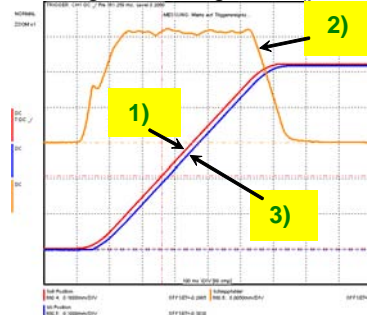
Following Error (Position Error)	170
Reduction of the current ripple.....	170
Motor parameters	171
Changing the switching frequency and the reference point.....	172

The higher the switching frequency, the better the quality of the current control. The higher switching frequency reduces the dead time of the current control path as

well as the current control noise. Furthermore, thermal losses caused by current ripple are reduced at higher switching frequencies.

Following Error (Position Error)

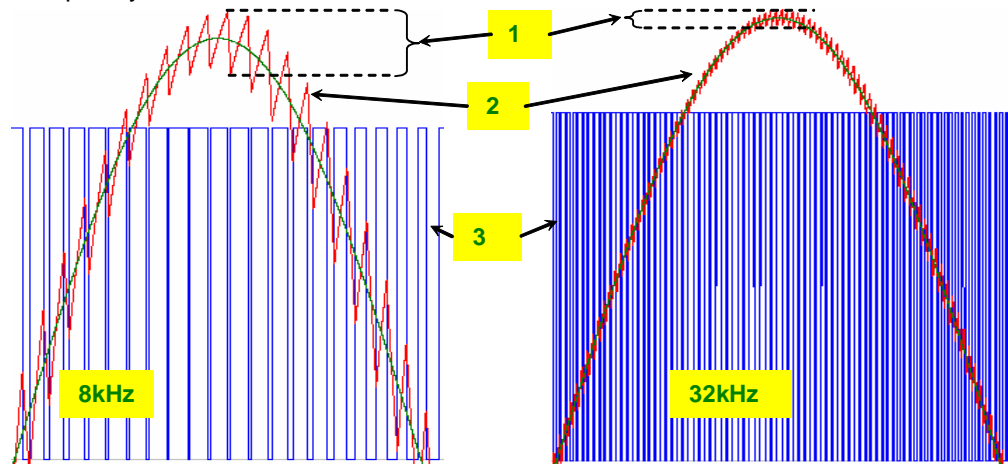
Too high following error (position error) during a movement



- 1) Setpoint Position
- 2) Position deviation = following error
- 3) Actual position

Reduction of the current ripple

Reduction of the current ripple of the phase current due to the higher switching frequency



- 1: Current ripple
- 2: Phase current
- 3: PWM control

Hint Please note that a high switching frequency means also high switching losses in the power output stage of the controller. For this reason, you must consider derated data of the servo controller for the drive design with higher switching frequencies.

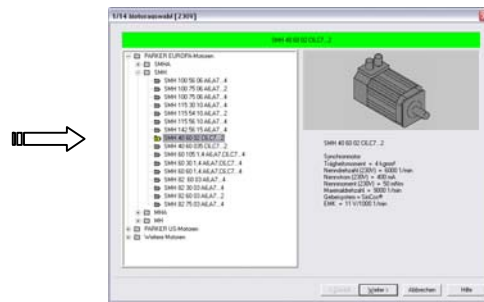
Motor parameters

In this chapter you can read about:

Parker Motor 171
 Other motor 171
 Supported motor types 171

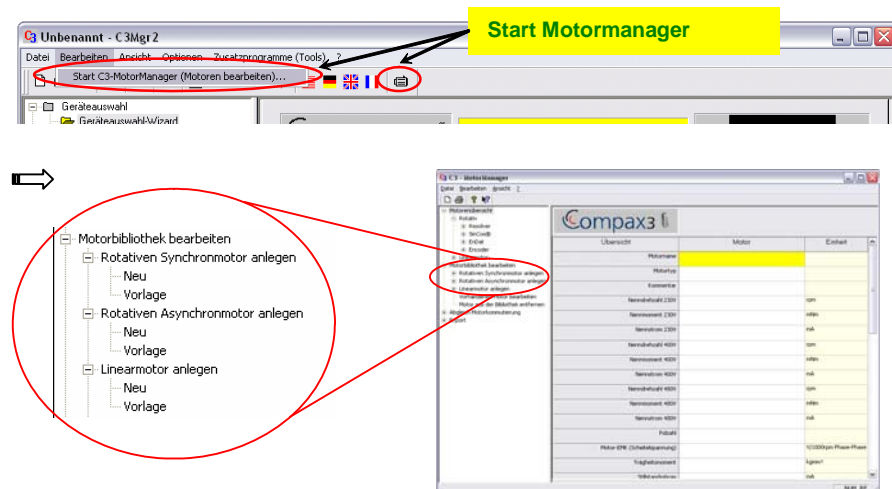
Parker Motor

If a Parker motor is used for the application, the parameters are already contained in the installed software. You can just select one of the available motors from the first configuration page.



Other motor

When using a motor from a different manufacturer, you will have to enter the relevant data. This process is supported by the MotorManager software tool, which can be called up from the ServoManager:



After doubleclicking on "new", the individual motor parameters are queried by the MotorManager.

Be careful to respect the units of the individual parameters when making your entries!

Furthermore you can use the MotorManager to edit motors already available. In addition, the import and export of motor data entities in XML format is supported.

Supported motor types

Compax3 supports the following motor types:

- ◆ Permanently excited synchronous rotaty motors
- ◆ Permanently excited synchronous linear motors
- ◆ Asynchronous rotaty motors

In general, rotary and linear motors do have the same signal flow chart. The difference consists solely in the basic physical values, which refer to circular

movement resp. the linear motion laws of physics. For this, the following analogies can be established:

Rotary drive [unit]		Linear drive [unit]	
		Rotary drive [unit]	Linear drive [unit]
[rev]	Path x	[m]	Mass moment of inertia J
[kgm ²]	Mass m	[kg]	Velocity n Angular velocity ω
[rps] [1/s]	Velocity v	[m/s]	Torque constant Kt
[Nm/Arms]	Force constant KF	[N/Arms]	Torque M
[Nm]	Force F	[N]	<p>For reasons of clarity, we will in the following refer to the rotary motor, which will represent both drive types.</p> <p>An asynchronous motor is set up in the same way as a synchronous motor. The only differences are varying motor parameters.</p>

Changing the switching frequency and the reference point

The switching frequency and the reference point are activated in the ServoManager: "Motor reference point" wizard

A reference point differing from the nominal data may also be entered on the wizard page displayed above.

Please activate "activate changing the reference point", then you may enter the new reference velocity as well as the new reference current.

Motor reference point

A reference point differing from the nominal data may also be entered on the wizard page displayed above.

Please activate "activate changing the reference point", then you may enter the new reference velocity as well as the new reference current.

External Moment of Inertia

The external mass moment of inertia is set against the moment of inertia of the rotor to form the total moment of inertia. The total moment of inertia is used for the controller design.

If you do not know or have only a vague knowledge of the external mass moment of inertia, the mass inertia can be determined via the load identification.

Configuration of an unknown external mass inertia:

The load identification is activated in the ServoManager:

Wizard "External moment of inertia" "unknown: using default values".

The correct values can be determined later via the load identification!

Limit and Monitoring Settings

On the "limit and monitoring settings" wizard page, you can set among others the current and velocity limits in % of the nominal values. The nominal values are motor parameters resulting from the motor library or from shifting the reference point on the "motor reference point" wizard page.

Limit and Monitoring Settings wizard page:

Funktion	Wert	Einheit
Strom-Begrenzung	200	% In (= 5400 mA)
Positionsfenster	0.1	mm (10 % Umd)
Positionsfensterzeit	0	ms
Fehlerreaktion Schleppfehler (0x7320)	Abrampen, Stromlos schalten	
Schleppfehler (+/-)	1	mm (100 % Umd)
Schleppfehlerzeit	0	ms
Max. Betriebsdrehzahl	100	% von nN = 3000.0 (1/min)

1: Current (Torque) Limit

2: Velocity limit

4.3.3.3 Automatic controller design

In this chapter you can read about:

Dynamics of a control	174
Cascade control	181
Stiffness	182
Automated controller design	184
Controller coefficients	185

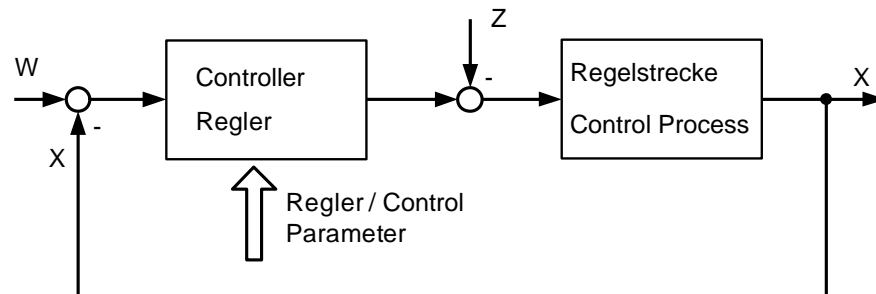
Dynamics of a control

In this chapter you can read about:

Structure of a control	174
Oscillating plant	174
stability, attenuation	175
Velocity, bandwidth	176
Setpoint and disturbance behavior of a control loop	178
response	180
Limitation behavior	181

A change in the input value of a dynamic transmission element causes a change of its output value. The change of the output value is however not immediately effective, but takes a certain time, the transient response. The course of the transient response is characteristic for certain kinds of transmission behavior. For this reason, a complete description of the transmission properties of a control comprises the stationary behavior (all setpoint, actual and disturbance values in settled state), as well as the dynamic behavior.

Structure of a control



The basic task of a control is the generation and maintaining of a desired state or sequence in spite of interfering disturbances. It is essential that the effects of the disturbances are balanced with the correct force and at the correct time. In the above figure, the setpoint value W represents the desired state and the disturbance value Z represents the interfering disturbance. The actual value X represents the generated and maintained state.

Oscillating plant

Oscillating control paths are control paths that respond with attenuated or unattenuated oscillation to an abrupt change in the setpoint value. Part of this class are for instance:

- ◆ Linear actuators with toothed belts, as a toothed belt represents an elasticity.
- ◆ A mechanic shaft with an external mass moment of inertia, as the shaft represents an elasticity due to its torsional properties.

In general this kind of elasticity is due to a high ratio between J_{Load}/J_{Motor} , as the shaft is normally not designed for this high external load and which may lead to a considerable distortion.

stability, attenuation

In this chapter you can read about:

Stability problem in the high-frequency range: 175
 Stability problem in the low-frequency range: 175

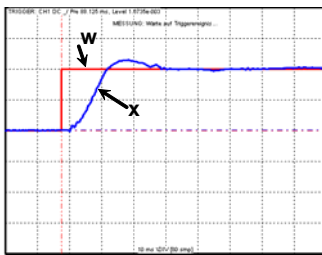
In general, two stability problems may occur in a servo drive control:

Stability problem in the high-frequency range:

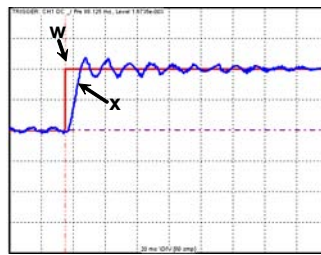
The "control structure" figure shows that the reverse effect in the control loop (negative feedback) is a prerequisite for the functioning of a control system. Due to the delay in signal transmission, the effect of the negative feedback is diminished or even compensated. The reason is that the corrective measures of the controller are also delayed in the event of delayed signal transmission. This results in a typical oscillating course of the control variable. In the worst case, the deviation of the control variable and the effect of the corrective measures get in phase, if the delays reach a defined value. The negative feedback passes into positive feedback. If the product of the gain factors of all control loop components is higher than 1, the oscillation amplitude will continually rise.

In this case the control loop is unstable. In the total gain of 1 the oscillation keeps its amplitude and the control loop is within the limits of stability. The transient response can be characterized by the attenuation and the transient time (velocity).

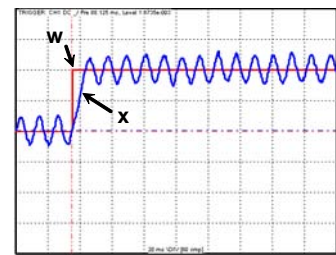
Step response of a stable controller and of a controller approaching the stability limit



Stable
Well attenuated



Stable
Poorly attenuated



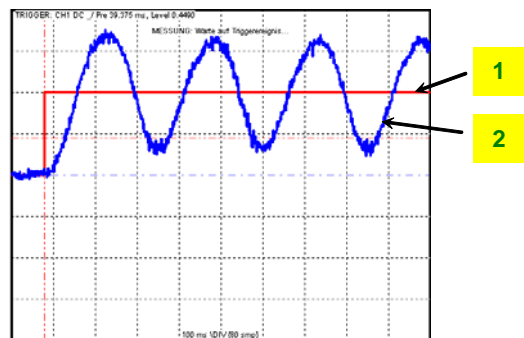
Stability limit
not attenuated

W: Setpoint value
x: Actual value

Stability problem in the low-frequency range:

In this case the controller was set for a very inert control path, while the actual control path is much more dynamic. The controller reacts to a disturbance variable with a much too strong corrective measure so that the disturbance variable is overcompensated and even an increasing oscillation may be the result. In this case the mechanic system of the control path may be destroyed.

Velocity jerk response (low-frequency stability limit)



1: Setpoint speed value
2: Actual speed value

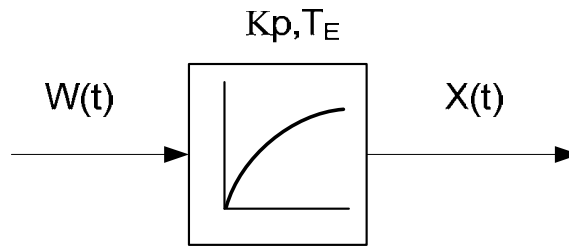
Velocity, bandwidth

In this chapter you can read about:

P-TE - Symbol 176
 Jerk response of a delay component 176
 Approximation of a well-attenuated control loop 176
 Frequency response of the P-TE component (value and phase) 178

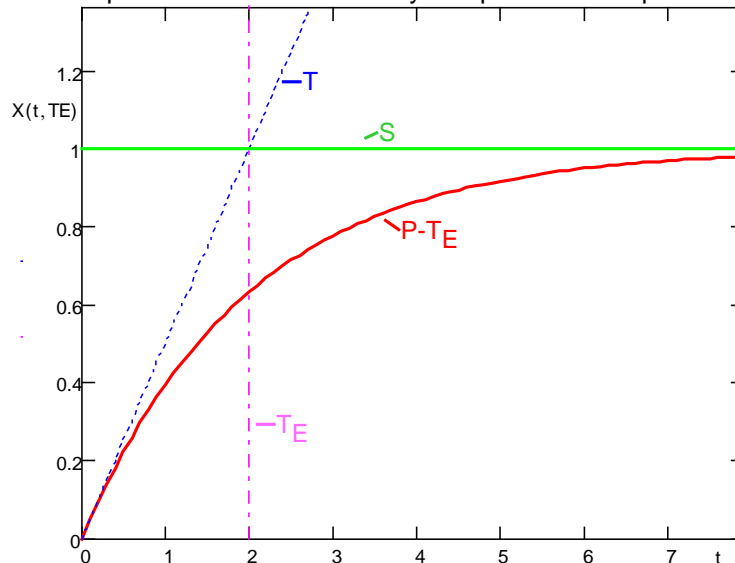
A well attenuated control loop can, under certain conditions, be approximated in order to simplify the controller design with a first order delay component (P-TE component) with the replacement time constant T_E and the total gain K_p . A P-TE component represents a first order delay component and is a simple dynamic basic component.

P-TE - Symbol



Jerk response of a delay component

Jerk response of a first order delay component with $K_p=1$ and $T_E=2.0s$



- T: Tangent
- S: Input jerk
- P-TE: Output value of the P-TE component
- TE: Time constant of the P-TE component

The definition of the delay time constant is displayed in the above figure. The time of intersection of the tangent and the jerk function itself is by definition the delay time constant (called filter time constant for filters) of a P-TE component. At this point in time the value of the jerk response is approx. 63% of the final value. In practice the jerk response corresponds, for instance, to the voltage charge curve of a capacitor.

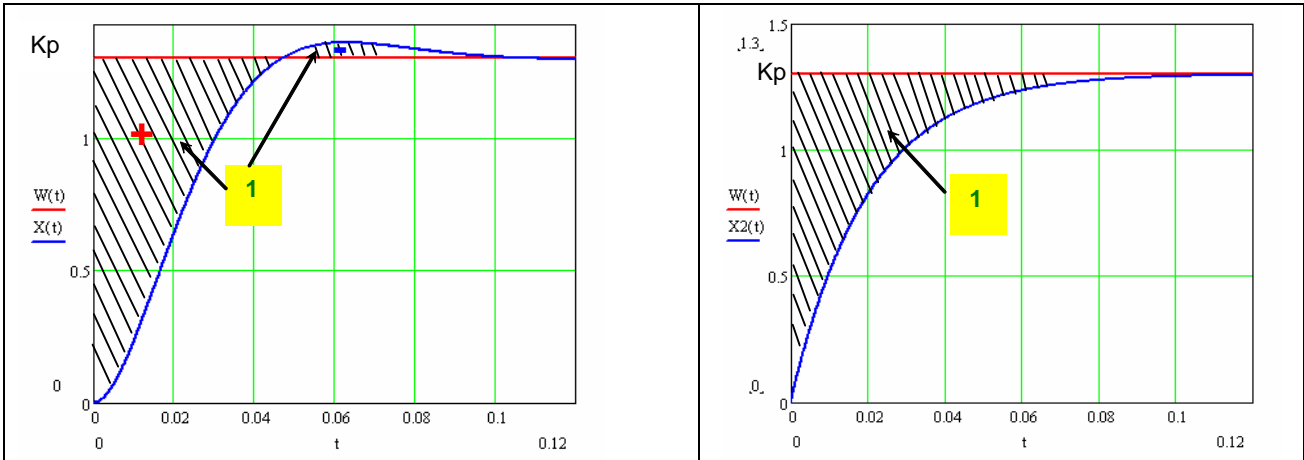
Approximation of a well-attenuated control loop

The approximation of a well-attenuated control loop is based on the sameness of the control surface of the ideal first order delay component (P-T1 component) and the approximated system (P-TE component).

The control surface is a measure for the velocity of a system and is defined in the following figure. If the surface of the approximated system corresponds to the

surface of the ideal system, the approximated system can be described, up to a certain frequency, with the transmission function of the P-T1 component.

Determination of the control surface from the transmission behavior of a P-TE component.

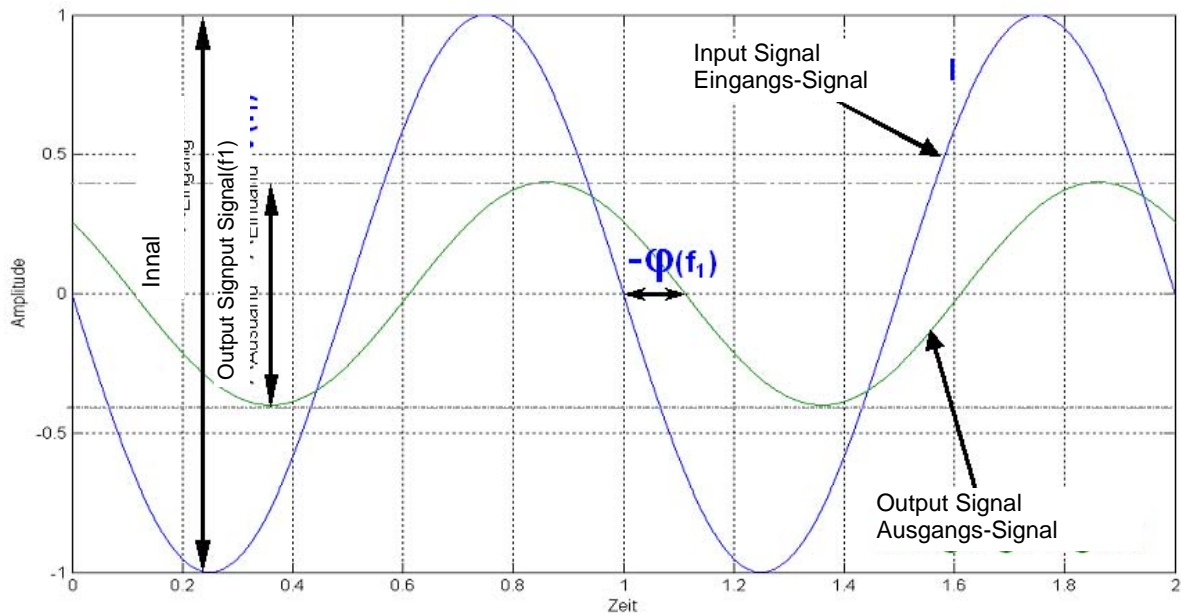


1: Control surface of the approximated system

2: Control surface of the ideal P-T1 component

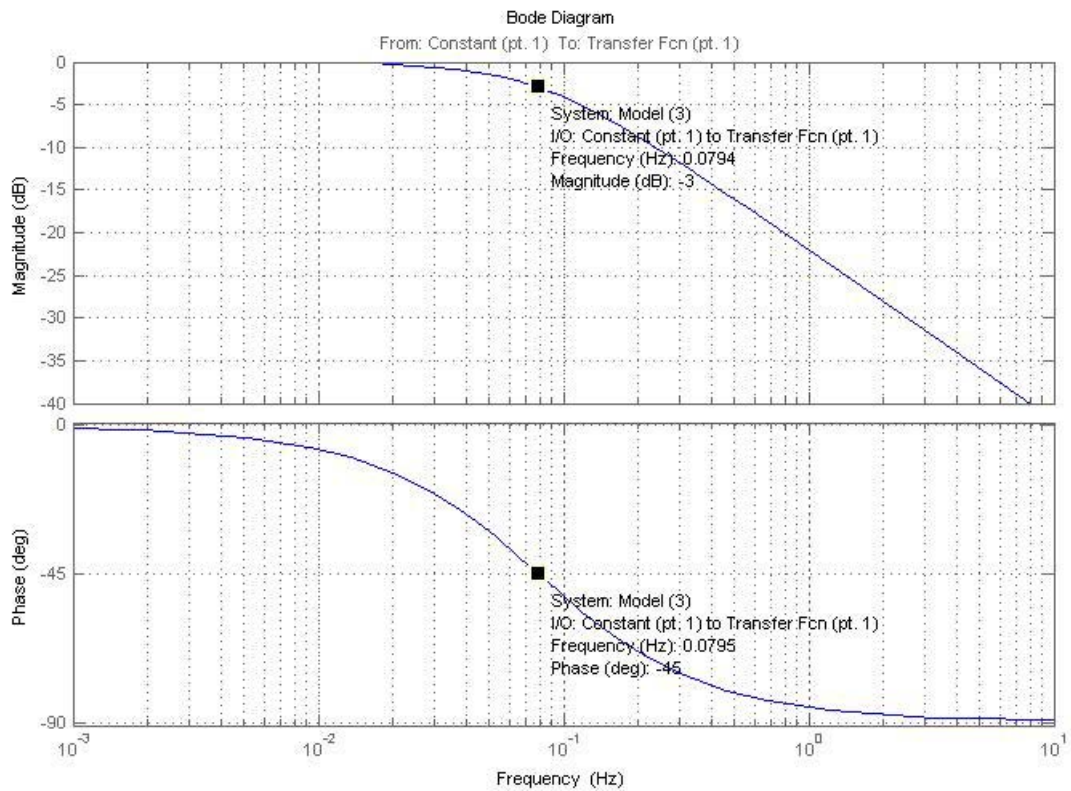
The velocity of a dynamic system can also be described in the frequency range. In the frequency range, the system behavior is analyzed to sinusoidal inputs signals of different frequencies (frequency response).

Input and output signals of a dynamic transmission component at a defined frequency $f=f_1$



The bode diagram represents the behavior of a dynamic system (in our case of the P-TE component) against the input signal frequency with respect to amplitude and phase.

Frequency response of the P-TE component (value and phase)



$$f_0 = \frac{1}{2\pi \cdot T_E} = 0,0795 Hz$$

The cutt-off frequency is the frequency where the input signal is attenuated by 3dB (-3dB attenuation). The phase shift between the output and the input is -45° at this frequency. Precisely this cut-off frequency is called the bandwidth of a control loop.

Setpoint and disturbance behavior of a control loop

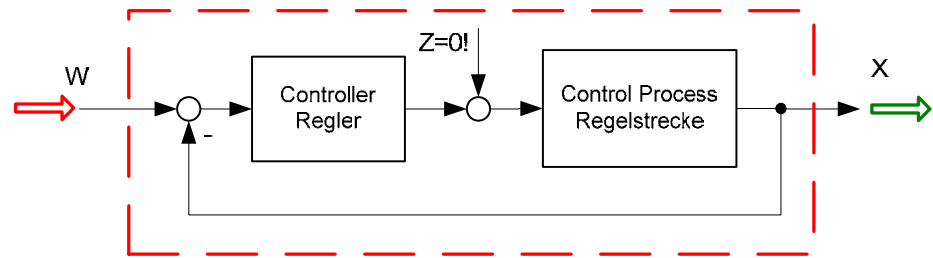
In this chapter you can read about:

Demand behavior	179
Disturbance behavior	179
Test functions	179
Characteristics of a control loop setpoint response	180

The setpoint behavior is the behavior of the control loop for the setpoint variable W. We assume that the disturbance variable Z=0.

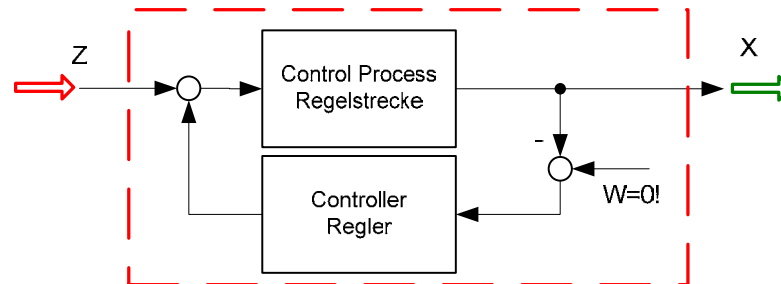
The disturbance behavior describes the behavior of the control loop for disturbance variable Z. In this case, we assume, in analogy to the setpoint behavior, that the setpoint variable W=0.

Demand behavior



W: Setpoint value
 X: Actual value
 Z: Disturbance variable

Disturbance behavior

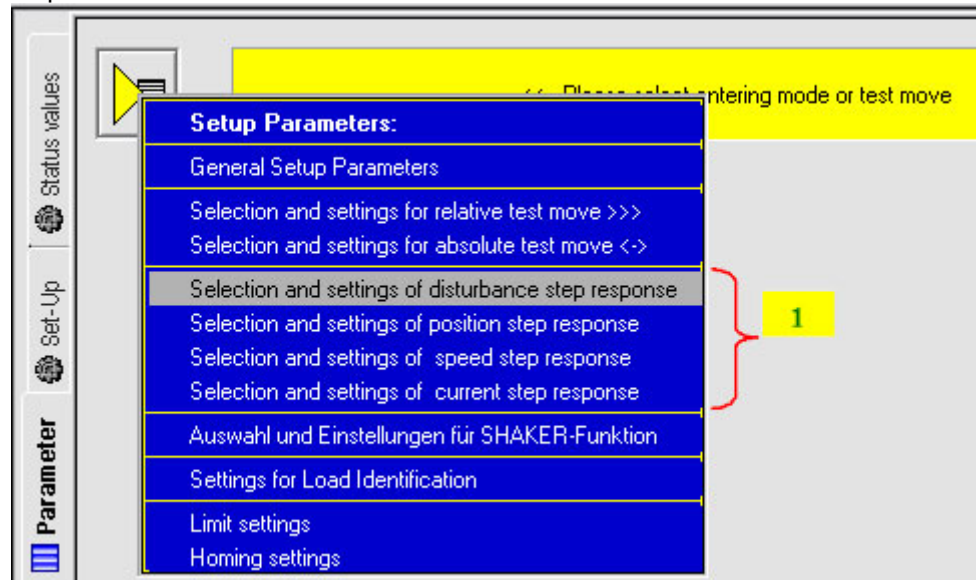


W: Setpoint value
 X: Actual value
 Z: Disturbance variable

In order to examine the disturbance and setpoint behavior, the Compax3 setup software offers 4 jerk functions.

Test functions

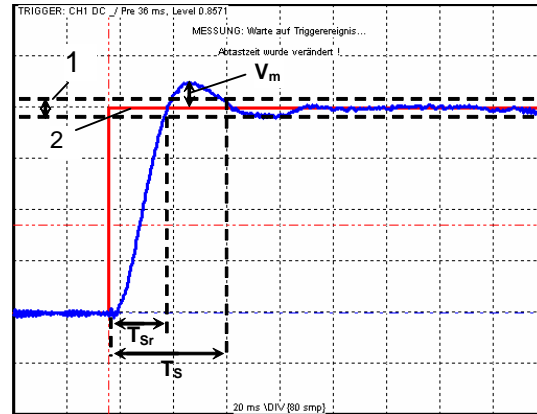
Test functions for the analysis of disturbance and setpoint behavior of the control loops



1: 4 jerk functions

The properties of the setpoint behavior of the velocity controller can be acquired from the velocity jerk response.

Characteristics of a control loop setpoint response

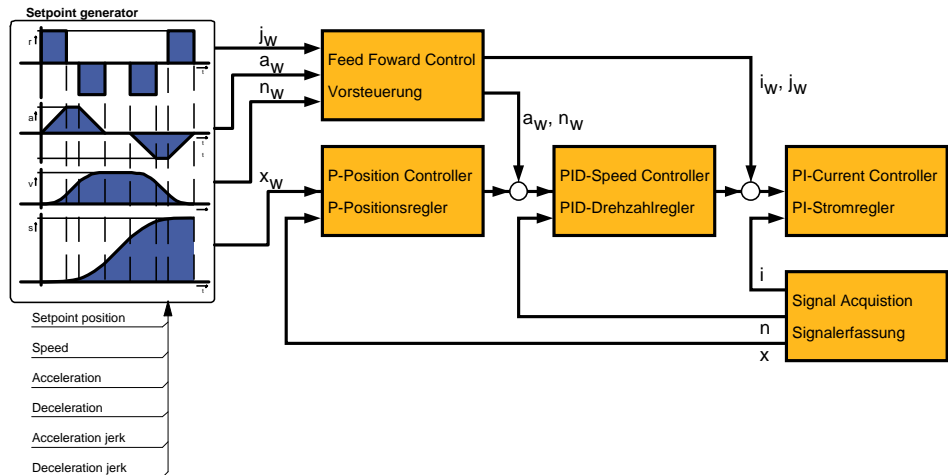


T_{sr} :	Response time. (Time elapsing until the control variable reaches one of the $\pm 5\%$ tolerance limits for the first time)
T_s :	Settling time. (Time elapsing until the control variable ultimately enters the $\pm 5\%$ range)
V_m :	maximum overshoot width
1	Tolerance range $\pm 5\%$
2	Setpoint value

response

The response of the controller is the behavior of the actual value with respect to the calculated profile of the setpoint generator. The kinematic status variables, speed, acceleration and jerk are fed into the cascade as feedforward signals. The feedforward signals work with calculated factors and contribute to an improved contour constancy due to the minimization of the following error.

Compax3 servo controller structure



- x : Position actual value
- x_w : Setpoint position value
- a_w : Acceleration setpoint value
- n : Actual (rotational) speed
- n_w : Velocity setpoint value
- i : Actual current value
- j_w : Jerk setpoint value

Limitation behavior

Each control variable is limited by the control (actuating) element. If the control variable demanded by the controller is within the linear range (without limitation), the control loop shows the behavior defined by the design. If the controller demands however a higher control variable than permitted by the limitation, the control variable is limited and the controller slows down.

Hint You should therefore make sure that the control variable (output) of the controller does not remain within the limitation or only for a very short time.

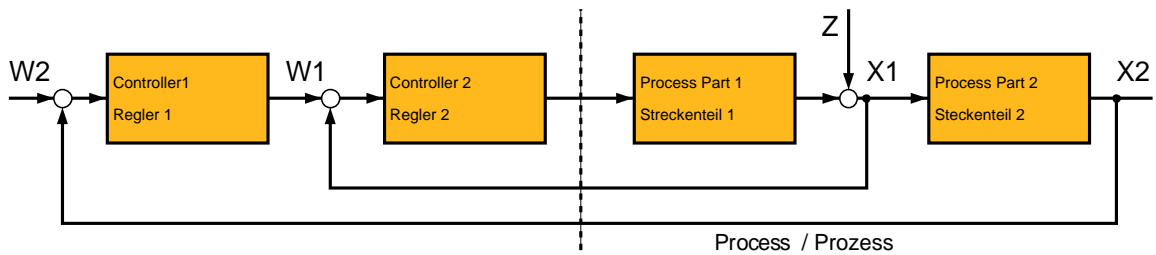
Cascade control

In this chapter you can read about:

Structure of a cascade control 181
 Cascade structure of Compax3 181

In drive technology, a cascading structure with several controllers (normally 3) is often used. This improves the control behavior. For this, additional sensors must be fixed within the control path. You will get the structure of a cascade control.

Structure of a cascade control



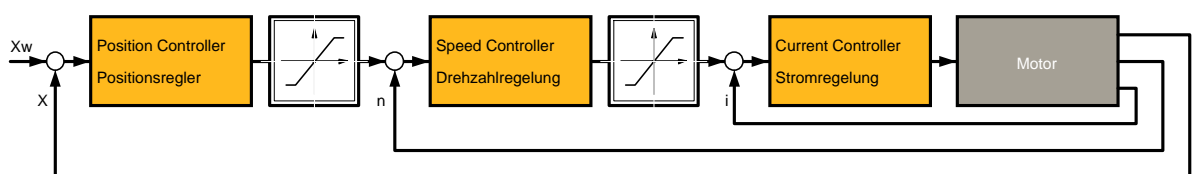
- W1 Setpoint value (setpoint) for the superposed controller 2
- W2 Setpoint value (setpoint) for the subordinate controller 1
- X2: Actual variable (actual value) for controller 2
- X1: Actual variable (actual value) for controller 1

The cascade control offers the following advantages:

- ◆ Disturbances occurring within the control path, can be compensated in the subordinate control loop. Therefore they must not pass through the entire control path and are therefore compensated earlier.
- ◆ The delay times within the path can be reduced for the superposed controller.
- ◆ The limitation of the intermediate variables can be made by the control variable limitation of the superposed controller rather easily .
- ◆ The effects of the non-linearity for the superposed controllers can be reduced by the subordinate control loops.

In the Compax3 servo controller, a triple cascade control is implemented with the following controllers - position controller, velocity controller and current controller.

Cascade structure of Compax3



Stiffness

In this chapter you can read about:

Static stiffness..... 182
 Dynamic stiffness..... 182
 Correlation between the terms introduced..... 184

The stiffness of a drive represents an important characteristic. The faster the disturbance variable can be compensated in the velocity control path and the smaller the oscillation caused, the higher the stiffness of the drive. With regard to stiffness, we distinguish static and dynamic stiffness.

Static stiffness

The static stiffness of a direct drive is comparable with the spring rate D of a mechanical spring, and indicates the excursion of the spring in the event of a constant interference force. It is the ratio between the constant force F_{Dmax} of the motor and a position difference. Due to the I term in the velocity controller, the static stiffness is therefore infinitely high in theory, as the I term is integrated until the control difference vanishes. In a digital control the static stiffness is above all limited by the finite resolution of the position signal (the error must be at least one quantization step, so that it can be detected by the reading system) and by numerical resolution. Additional effects are for instance mechanical stiffness of the mechanic components in the control path (e.g. load connection, guiding system) as well as measurement errors of the measurement system.

Dynamic stiffness

In this chapter you can read about:

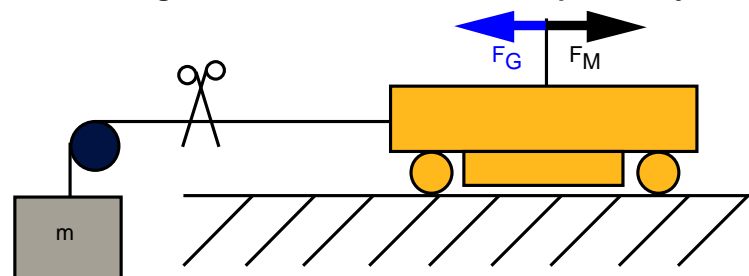
Traditional generation of a disturbance torque/force jerk 182
 Electronic simulation of a disturbance torque jerk with the disturbance current jerk 183
 Disturbance jerk response 183

The dynamic stiffness is described by the ratio between the change in load torque or in load force and the resulting position deviation (following error):

$$\frac{-\Delta M_L}{\Delta x}$$

The higher this ratio (=dynamic stiffness), the higher the necessary change is load torque in order to generate a defined following error.
 The dynamic stiffness can be acquired from the disturbance jerk response.

Traditional generation of a disturbance torque/force jerk

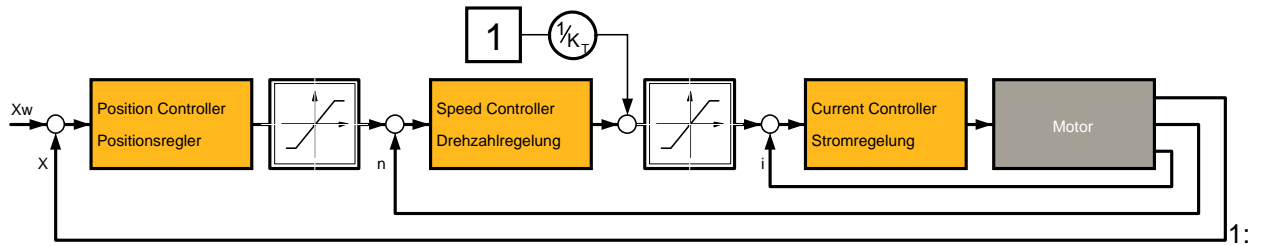


In settled state of the control, the motor force F_M corresponds exactly to the load force $F_G = m \times g$.

If the cord is cut through, the load force is eliminated abruptly and the controller must first of all settle to the new situation.

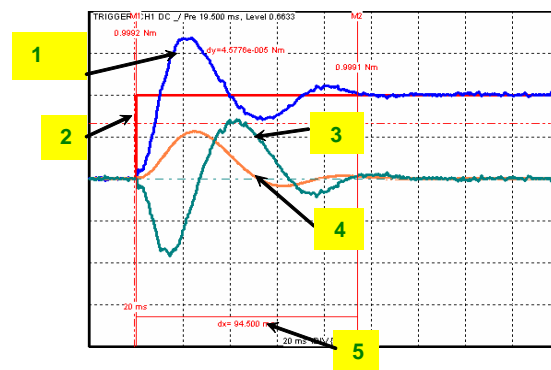
In order to simulate this load jerk electronically, a disturbance current jerk is fed to the Compax3 as a variable proportional to the disturbance torque at the velocity controller output.

Electronic simulation of a disturbance torque jerk with the disturbance current jerk



Feeding in of a disturbance current jerk, which corresponds to a disturbance torque jerk. The maximum amplitude and the settling time of the following error decline with rising dynamic stiffness. The settling behavior of the following error is furthermore a measure for the attenuation and the bandwidth of the control.

Disturbance jerk response



- 1: Compensation torque of the controller
- 2: Simulated disturbance torque
- 3: Actual speed
- 4: Following error
- 5: Settling time

Correlation between the terms introduced

The introduced terms:

- ◆ stability
- ◆ Attenuation
- ◆ velocity
- ◆ bandwidth
- ◆ setpoint and disturbance behavior
- ◆ Control variable limitation
- ◆ Replacement time constant
- ◆ Stiffness

are related as follows:

- ◆ A well-attenuated control features a stable control behavior.
- ◆ The velocity of a control loop is a measure for the reaction rate of the controller to the disturbance variable (disturbance behavior) as well as to the setpoint variable (setpoint behavior).
- ◆ The faster the control, the higher its bandwidth.
- ◆ The term replacement time constant is an approximation and is only valid in a defined scope¹. In this scope, the control is always stable and well-attenuated.
- ◆ If the controller does not work in the linear range, but the control variable of the controller is within the limitation, the control slows down and the control difference rises.
- ◆ The stiffness represents the bandwidth of the velocity control. The higher the stiffness value of the velocity control, the higher the bandwidth of the velocity controller and the stiffer the drive.

Automated controller design

In this chapter you can read about:

Jerk response of the velocity loop depending on the optimization parameter "attenuation" and "stiffness"	185
D-term	185
Position loop	185

The controller design takes place after the configuration immediately before the configuration download into the device. The controller coefficients are preassigned according to the design method of cross-ratios so that a stable control is achieved. The automatic, robust controller design calculates the P and I terms of the individual controllers (current, velocity, position) on the basis of the configured motor and application parameters.

Please observe: Faulty motor and application parameters may lead under certain circumstances to instable controllers.

The controller parameters are not directly available for the optimization. Instead, they can be changed with the aid of the following optimization parameters:

- | | |
|--|--------------------------------------|
| Optimization of the current controller dynamics: | ◆ Current loop bandwidth in % |
| | ◆ "Attenuation of current loop" in % |
| Optimization of the velocity loop dynamics: | ◆ "Stiffness" in % |
| | ◆ "Attenuation" in % |
| | ◆ Velocity loop - "D" term in % |

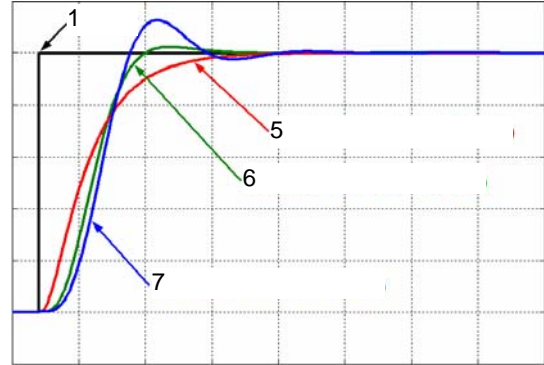
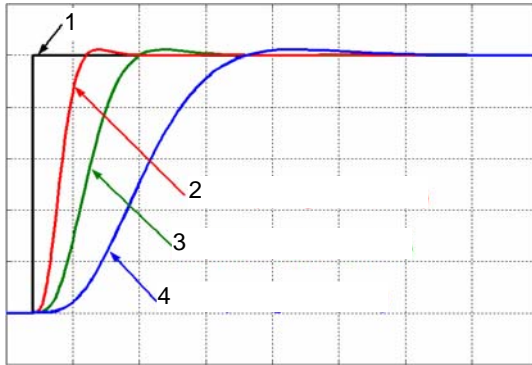
The bandwidth parameter states the actually effective % of the calculated default velocity. The default bandwidth of the controller is fixed to approx. $f_{GR}=531\text{Hz}$. In reverse this signifies that each motor delivers the same jerk response. The prerequisite is, of course, that you keep out of the control signal limitation (voltage limitation). The attenuation characterizes the controller's tendency to oscillate with respect to an excitation signal (see below). The stiffness (of the velocity loop,

corresponds to the bandwidth of the current loop) describes the velocity of the velocity loop (see below).

Jerk response of the velocity loop depending on the optimization parameter "attenuation" and "stiffness"

Attenuation = 100%

Stiffness = 100%



- 1: Setpoint value
- 2: Actual value (stiffness = 200%)
- 3: Actual value (stiffness = 100%)
- 4: Actual value (stiffness = 50%)
- 5: Actual value (attenuation = 500%)
- 6: Actual value (attenuation = 100%)
- 7: Actual value (attenuation = 50%)

D-term

The D-term parameter (of the velocity loop) activates existing control oscillations of drives with elastic coupling (e.g. toothed belt drives). The D-term is not automatically designed and must therefore be set manually.

Position loop

The position controller is automatically adapted depending on the stiffness of the velocity loop.

Controller coefficients

In this chapter you can read about:

Velocity Loop "P" Term	186
D-term of the KD velocity controller	186
P-term KV position loop	186

Dependance of the controller coefficients from the optimization objects

The controller coefficients are influenced by the optimization objects such as "stiffness" and/or "attenuation". The dependency is displayed below.

I-term KI in the velocity loop

$$K_I = \frac{St[\%]}{100 \cdot T_{EGD}}$$

$$\Rightarrow K_I \sim St$$

T_{EGD}: the replacement time constant of the closed velocity loop.

St Stiffness

Velocity Loop "P" Term

$$K_{PV} = \frac{St[\%]}{100 \cdot T_{EGD}} \cdot \frac{Tm[\%]}{100} \cdot T_N \cdot \frac{100}{EMK[\%]} \cdot \frac{30 + 0,14 \cdot Dp[\%]}{20}$$

$$\Rightarrow K_{PV} \sim St \wedge K_{PV} \sim Tm / EMK \wedge K_{PV} = f_{LIN}(Dp)$$

T_{EGD} : the replacement time constant of the closed velocity loop.

T_N : The mechanical integration time constant of the motor.

$f_{LIN}()$: Linear function (straight) between attenuation and KPV

Tm Moment of Inertia

St Stiffness

Dp Attenuation

D-term of the KD velocity controller

$$K_D = \frac{Dterm[\%]}{100} \cdot K_{D_100\%}$$

$$\Rightarrow K_D \sim Dterm$$

KD_100 The defined 100% coefficient
%:

$Dterm$ D-term

P-term KV position loop

$$K_V = \frac{St[\%]}{100 \cdot T_{EGD}} \cdot \frac{20}{30 + 0,14 \cdot Dp[\%]} \cdot T_X$$

$$\Rightarrow K_V \sim St[\%] \wedge K_V = f_{LIN}(1/Dp[\%])$$

T_{EGD} : the replacement time constant of the closed velocity loop.

T_X : The position integration time constant of the motor.

St Stiffness

Dp Attenuation

$f_{LIN}()$: Linear function (straight) between 1/attenuation and KV

4.3.3.4 Setup and optimization of the control

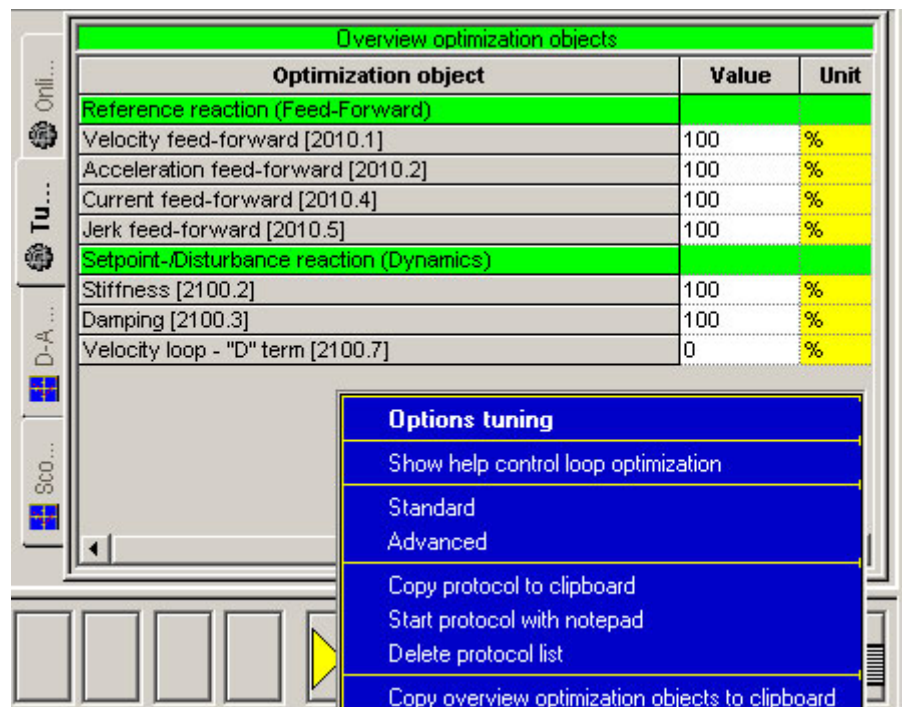
In this chapter you can read about:

Standard 187
 Advanced..... 194
 Commissioning window 210
 Proceeding during controller optimization..... 212

For the setup and optimization of the control loops, the optimization window is available.

The Compax3 control functionality is divided into 2 sections, standard and advanced; the advanced functionality does however incorporate the entire standard functionality. The switching can be made in the optimization window.

Switching between standard and advanced

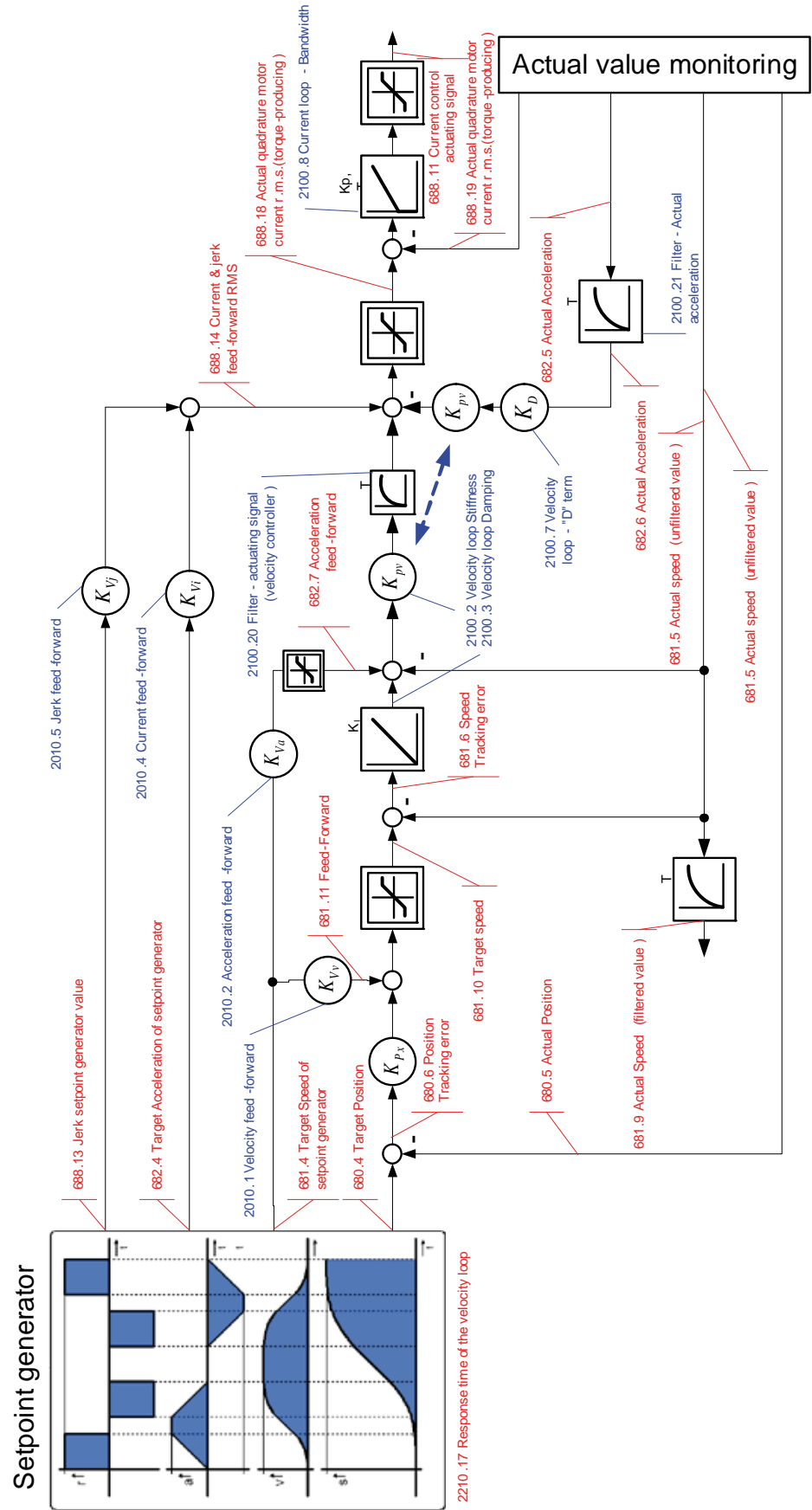









Standard

In this chapter you can read about:

standard cascade structure 188
 Standard optimization parameters 189
 Control signal limitations 189
 Feedforward channels 191
 Control signal filter / filter of actual acceleration value 193

standard cascade structure



Symbol	Description
	Proportional term signal is multiplied with K_p
	First order delay component (P-T1 component)
	Integration block (I-block)
	PI-block
	Limitation block (signal limitation)
	Notch filter (band elimination filter)
	Addition block
blue description	Optimization objects (simple pointer line)
red description	Status objects (pointer line with vertical stroke)

Standard optimization parameters

Overview optimization objects		
Optimization object	Value	Unit
Reference reaction (Feed-Forward)		
Velocity feed-forward [2010.1]	100	%
Acceleration feed-forward [2010.2]	100	%
Current feed-forward [2010.4]	100	%
Jerk feed-forward [2010.5]	100	%
Setpoint-/Disturbance reaction (Dynamics)		
Stiffness [2100.2]	100	%
Damping [2100.3]	100	%
Velocity loop - "D" term [2100.7]	0	%

The above figure shows the parameters for the standard group. With the aid of these parameters, you can optimize the standard cascade structure.

Control signal limitations

In this chapter you can read about:

Limitation of the setpoint velocity	190
Limitation of the setpoint current.....	190
Limitation of the control voltage	190

The cascade structure shows that a limitation block is available in the control signal sector of each controller. The limitations of the position and velocity loops are calculated from the set limitations in the configuration and the motor parameters of the selected motor.

Limitation of the setpoint velocity

Limitation of the setpoint velocity in the control signal sector of the position loop:
This limitation value is calculated from the maximum mechanical velocity of the motor and the set value in the configuration in % of the nominal velocity. The smaller of the two values is used for the limitation.

Example

MotorManager

maximum mechanical velocity of the motor:	$n_{max}=3100\text{rpm}$
Rated speed of the motor:	$n_N=2500\text{rpm}$

C3 ServoManager

Maximum Operating Speed:	$n_{bmax}=200\%$ of n_N $\Rightarrow 5000\text{rpm}$
--------------------------	---

Velocity limitation value = **3100rpm**
 $MIN(n_{max}, n_{bmax} * n_N / 100) =$

Limitation of the setpoint current

Limitation of the setpoint current in the control signal sector of the velocity loop:
This limitation value is calculated from the device peak current, the pulse current of the motor and the set value in the configuration in % of the nominal current. The smaller of the three values is used for the current limitation.

Example

Device

C3 S063 V2 F10 T30 M00 device peak current:	$I_{Gmax}=12.6A_{rms}$
---	------------------------

MotorManager

Rated current of the motor:	$I_N=5.5A_{rms}$
Peak Current:	$I_{imp}=300\%$ I_N $\Rightarrow 16.5A_{rms}$

C3 ServoManager

Current (Torque) Limit:	$I_{bmax}=200\%$ of I_N $\Rightarrow 11A_{rms}$
-------------------------	--

Current limitation value = **11A_{eff}**
 $MIN(I_{Gmax}, I_{imp} * I_N / 100, I_{bmax} * I_N / 100) =$

Limitation of the control voltage

Limitation of the control voltage in the control signal sector of the current loop:
This limitation is fixed and cannot be influenced by the user. The limitation value depends on the DC voltage of the device.

Please note!

In the event of highly dynamic motion cycles it is necessary to make sure not to enter the control signal limitation (or, if so only for a very short time) as the drive is then not in the position to follow the set dynamics due to the slow drive physics and the limited control signal range.

Feedforward channels

In this chapter you can read about:

Influence of the feedforward measures	191
Motion cycle without feedforward control.....	192
Motion cycle with feedforward measures.....	192

The feedforward channels are used for the specific influence of the guiding behavior of a control. The calculated and evaluated status variables are coupled into the corresponding places within the controller cascade. In practice, the feedforward control offers the following advantages:

- ◆ Minimal following error
- ◆ Improves the transient response
- ◆ Gives greater dynamic range with lower maximum current

The Compax3 servo controller disposes of four feedforward measures (see in the standard cascade structure):

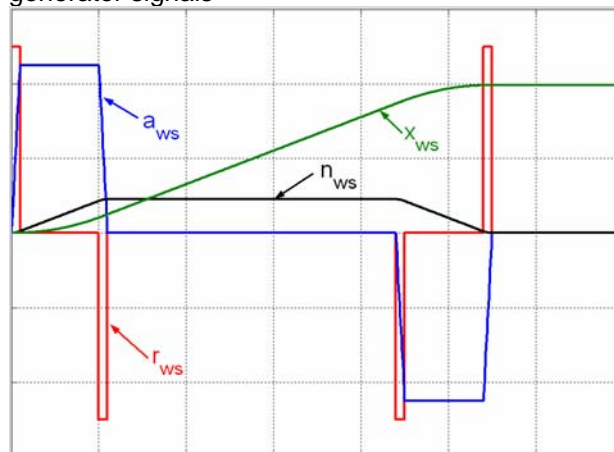
- ◆ Velocity feed-forward
- ◆ Acceleration feed-forward
- ◆ Current feed-forward
- ◆ Jerk feed-forward

The above order represents at the same time the effectiveness of the individual feedforward measures. The influence of the jerk feedforward may be, depending on the profile and the motor, negligibly small.

Please note! But the principle of feedforward control fails in limiting the motor current or the motor speed during the acceleration phase!

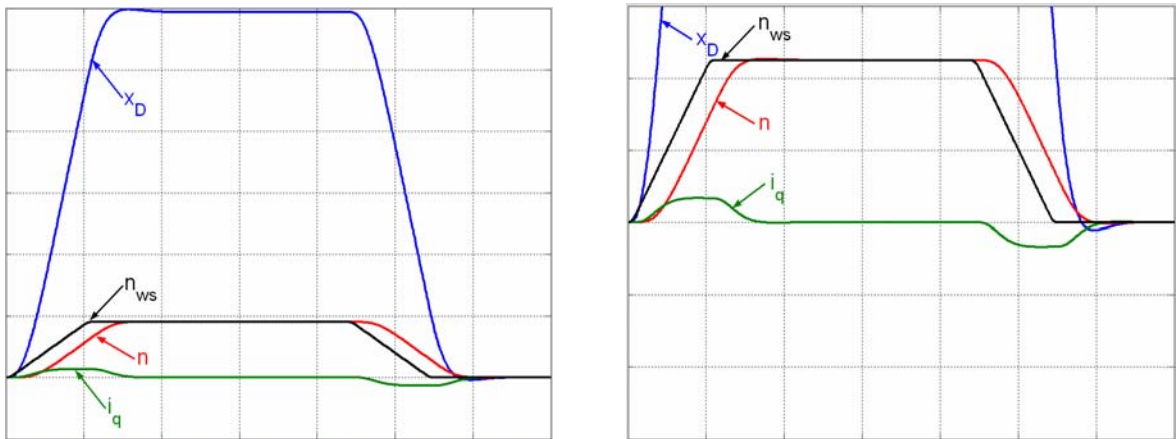
Influence of the feedforward measures

Following error minimization by feedforward control / course of the setpoint generator signals



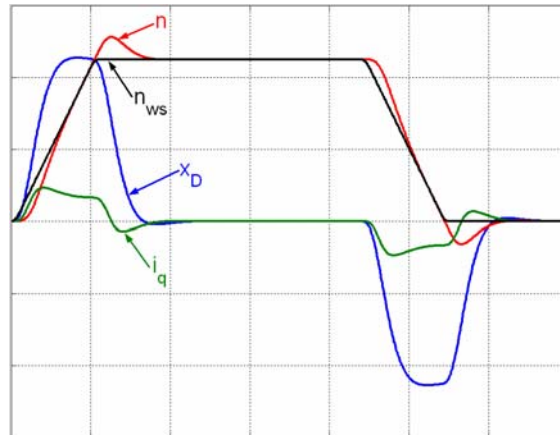
x _{ws} :	Position setpoint value of the setpoint generator
v _{ws} :	Velocity setpoint - setpoint generator
a _{ws} :	Acceleration setpoint value setpoint generator
r _{ws} :	Jerk setpoint value setpoint generator

Motion cycle without feedforward control

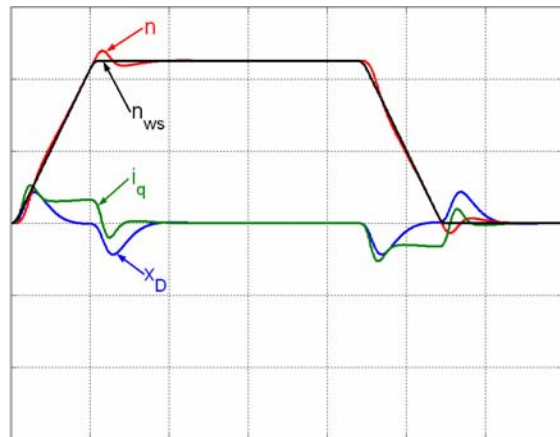


Motion cycle with feedforward measures

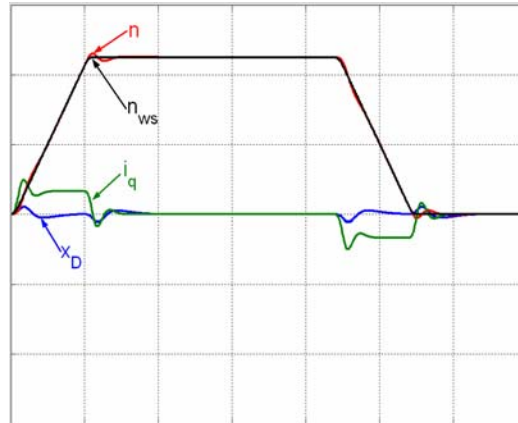
Velocity feedforward



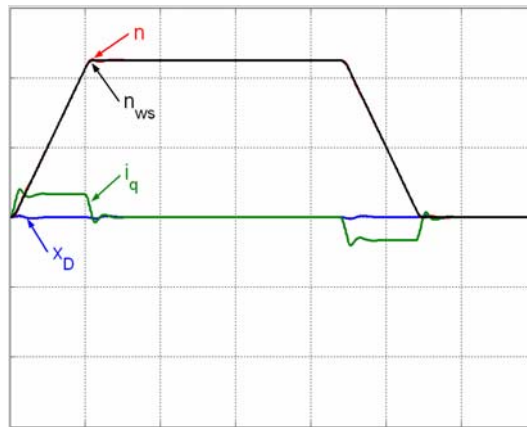
Velocity and acceleration feedforward



Velocity, acceleration and current feedforward



Velocity, acceleration, current and jerk feedforward



Control signal filter / filter of actual acceleration value

The filters in the Compax3 firmwar are implemented as P-T1 filters (first order delay component see chapter 0)

The two "control signal filter (velocity loop)" (Object 2100.20) and "acceleration value filter" (Object 2100.21) are set in μs . The value range for these filters is 63... 8 300 000 μs . Depending on the replacement time constant of the closed velocity loop, we can make recommendations for the setting.

Setting recommendation for "control signal filter (velocity loop)":

$$O2100.20 = O2210.17[\mu\text{s}] / 5 \quad \text{for } O2210.17 \geq 10\,000\mu\text{s}$$

$$O2100.20 = O2210.17[\mu\text{s}] / 3 - 1333\mu\text{s} \quad \text{for } 4000\mu\text{s} \geq O2210.17 < 10\,000$$

$$O2210.20 = 0 \quad \text{for } O2210.17 < 4000\mu\text{s}$$

O2210.17: Object replacement time constant of the velocity loop in μs .

O2100.20: Object control signal filter (velocity loop) in μs .

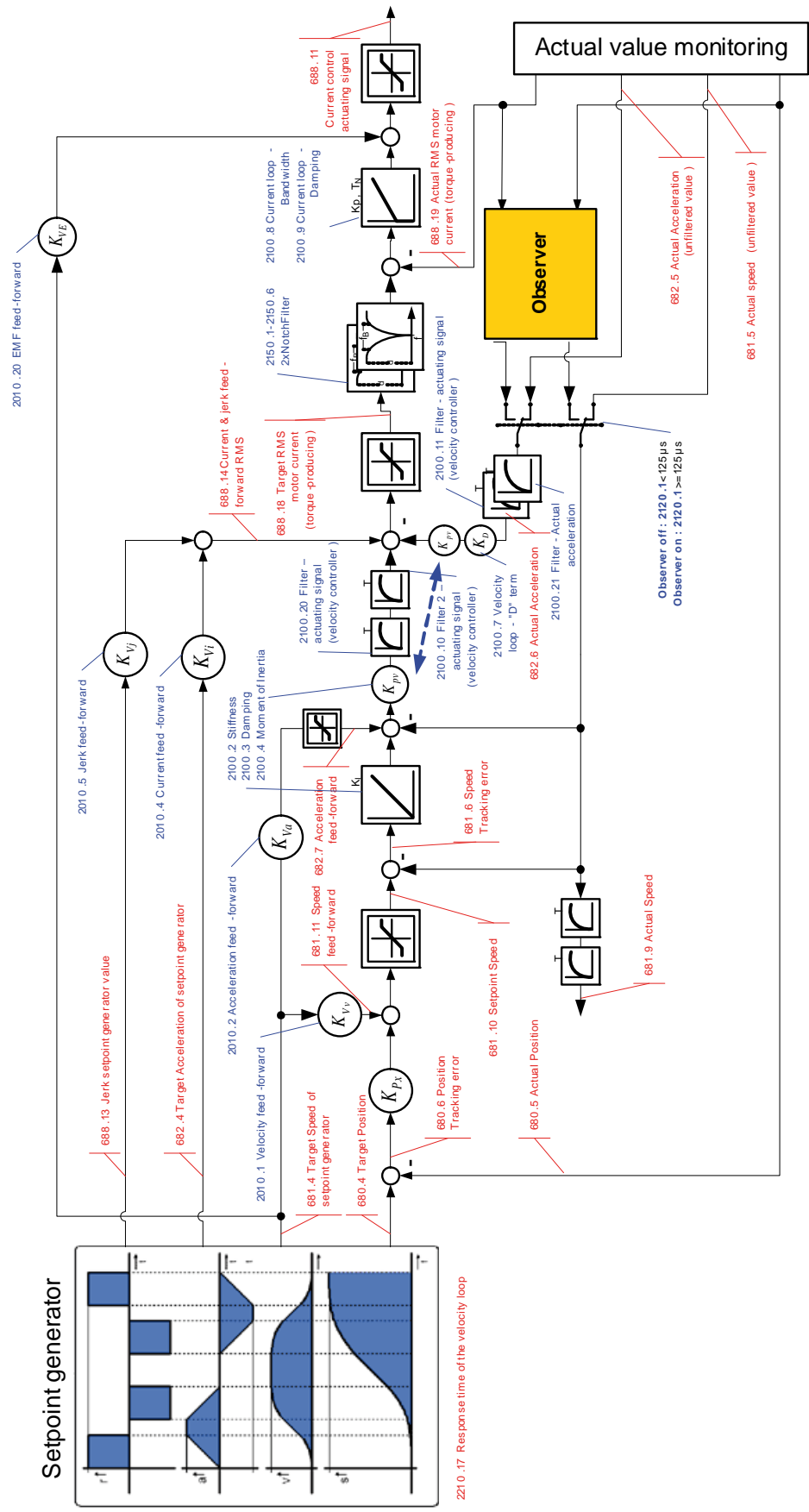
Please note!








It cannot be excluded that the filter may have a destabilizing effect even though set according to the above recommendation. In this case the filter time constant must be reduced.

Advanced**In this chapter you can read about:**

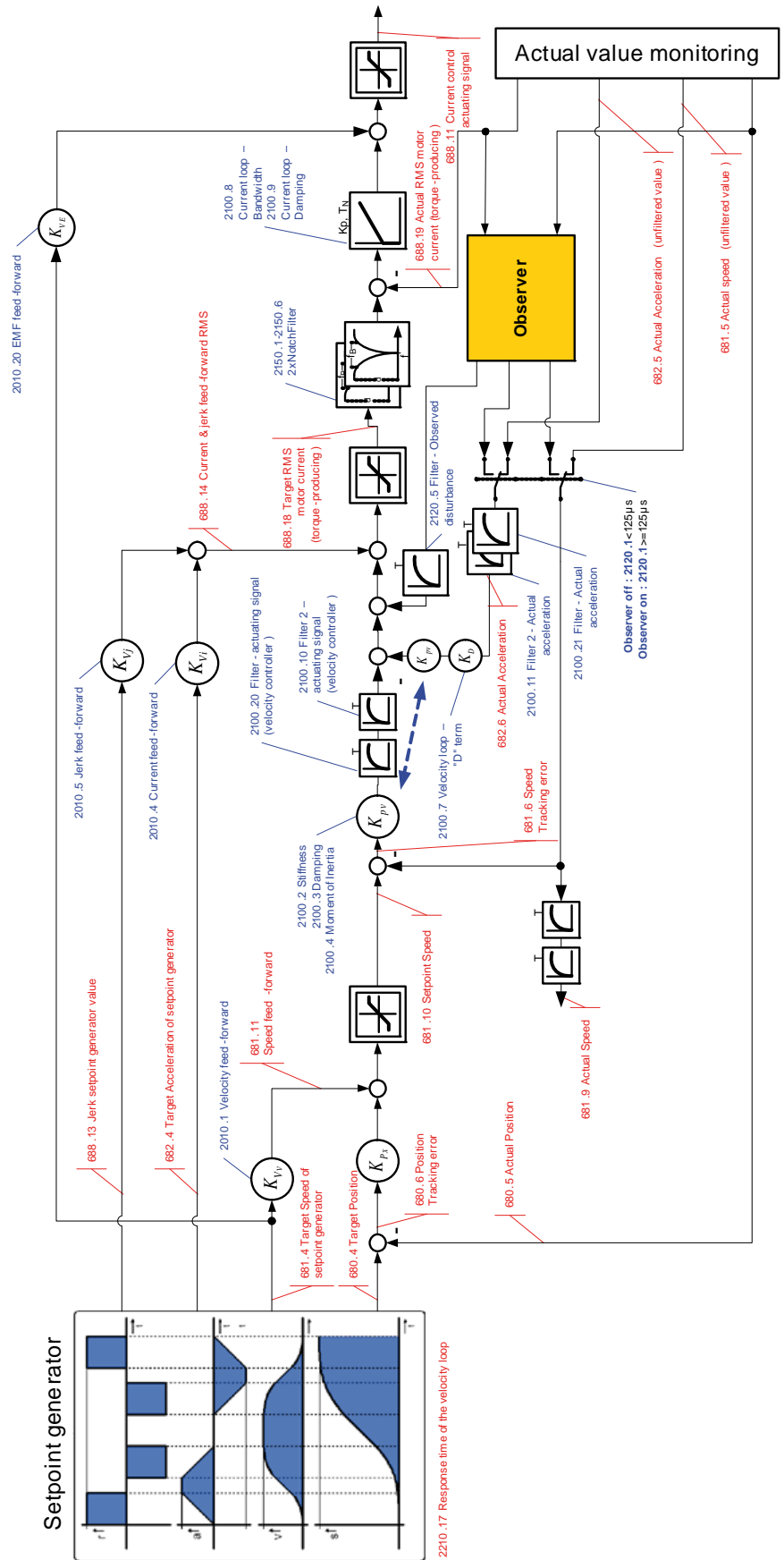
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





Extended cascade (structure variant 1)



Symbol	Description
	Proportional term signal is multiplied with K_p
	First order delay component (P-T1 component)
	Integration block (I-block)
	PI-block
	Limitation block (signal limitation)
	Notch filter (band elimination filter)
	Addition block
blue description	Optimization objects (simple pointer line)
red description	Status objects (pointer line with vertical stroke)

Extended cascade structure (structure variant 2 with disturbance variable observer)



Symbol	Description
	Proportional term signal is multiplied with K_p
	First order delay component (P-T1 component)
	Integration block (I-block)
	PI-block
	Limitation block (signal limitation)
	Notch filter (band elimination filter)
	Addition block
blue description	Optimization objects (simple pointer line)
red description	Status objects (pointer line with vertical stroke)

Optimization parameter Advanced

Overview optimization objects		
Optimization object	Value	Unit
Reference reaction (Feed-Forward)		
Velocity feed-forward [2010.1]	100	%
Acceleration feed-forward [2010.2]	100	%
Current feed-forward [2010.4]	100	%
Jerk feed-forward [2010.5]	100	%
Setpoint-/Disturbance reaction (Dynamics)		
Stiffness [2100.2]	100	%
Damping [2100.3]	100	%
Moment of Inertia [2100.4]	100	%
Velocity loop - "D" term [2100.7]	0	%
Filter - Actual velocity [2100.5]	100	%
Filter 2 - actuating signal (velocity controller) [2100.10]	0	us
Filter - Actual acceleration [2100.6]	0	%
Filter 2 - Actual acceleration [2100.11]	0	us
Current loop - Bandwidth [2100.8]	50	%
Current loop - Damping [2100.9]	100	%
Observer		
Time Constant [2120.1]	0	us
Filter - Observed disturbance [2120.5]	1000	us
Enable Disturbance Compensation [2120.7]	0	
Filter external signal source		
Filter - Ext. velocity feed-forward [2011.1]	500	%
Filter - Ext. accel. feed-forward [2011.2]	500	%
Trackingfilter HEDA, [2109.1]	0	500us
Filter setpoints		
Trackingfilter [2110.1]	1	500us
Filter velocity [2110.3]	0	%
Filter acceleration [2110.4]	0	%
Analog Input		
Offset [170.4]	0	
Gain [170.2]	1	

EMC feedforward

The EMC feedforward compensates the electromagnetically generated back e.m.f. of the motor U_{EMC} . This signal is proportional to velocity and is deduced from the setpoint velocity of the setpoint generator.

Motor parameters

Furthermore you can re-optimize the motor parameters inductance, resistance and EMC (or K_t) in the advanced mode. The $LdLqRatio$ parameter is the ratio of the smallest and the highest inductance value of the winding, measured during one motor revolution.

Filter "External Command Interface"

For explanations on this group of parameters please see chapter 0

Voltage decoupling

In the current control path there is a velocity and current proportional voltage disturbance variable, which must be compensated by the current loop. Due to limited controller dynamics, this disturbance variable can not always be entirely compensated by the current loop. The influence of this disturbance variable may however be minimized by activating the voltage decoupling.

Load control

If a second position feedback is available for the acquisition of the load position, the load control can be activated.

For more detailed information on the load control see device help for T30/T40 devices in the setup chapter Compax3\load control.

Luenberg observer

In this chapter you can read about:

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Introduction observer

A high signal quality of the actual signal value is of high significance in the control of the motor velocity n or the motor speed v . By means of oversampling and transmitter error compensation, a high-quality position signal can be produced for speed determination. As a rule the motor speed is determined by numeric differentiation of the motor position. In this case the quantisation noise Q_{vD} of the digital speed signal depends on the quantisation Q_x of the position signal and the sampling time T_{AR} of the digital control loop:

Quantisation – speed signal Q_{vD}

$$Q_{vD} = \frac{Q_x}{T_{AR}}$$

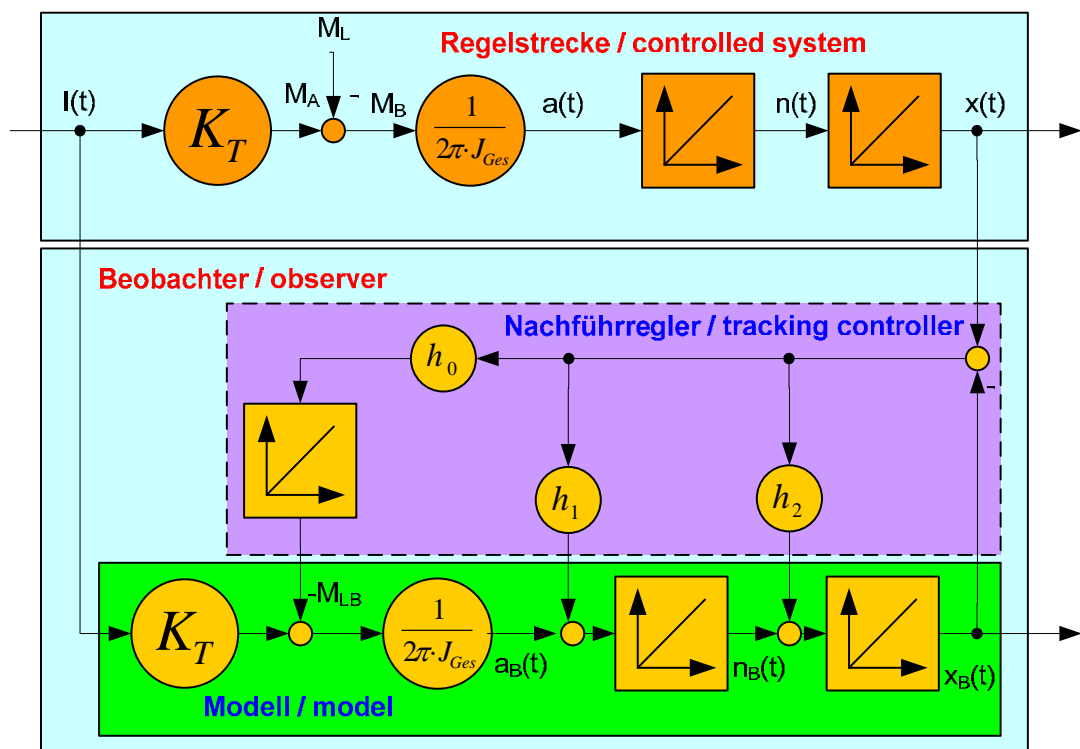
The quantisation of the speed signal is inversely proportional to the sampling time T_{AR} . Hence the demands for the lowest possible sampling time and the minimum quantisation noise oppose each other in the determination of speed by numeric differentiation. The noise superimposed by the digital speed signal may be reduced by the low-pass filter, however this is always at the cost of the stability margin of the digital control loop. An alternative method is to determine the speed by integration of the acceleration. The dependence of the quantisation noise Q_{vD} of the digital speed signal on the quantisation Q_x of the position signal and the sampling time T_{AR} of the digital control loop is shown by the following correlation.

Quantisation – speed signal Q_{vI}

$$Q_{vI} = Q_a \cdot T_{AR}$$

The observer technology offers the advantage that the velocity can be calculated with the aid of integration. The idea of the observer principle is to connect a mathematical model of the control path parallel to the section observed and with the same transfer behaviour. In this case, the controller also has the intermediate variables (state variables) of the control path available. However in the presence of model deviations (in structure or parameters), different signal values occur between the model and the control path. For this reason, the technique cannot be employed in this way in practice. However, the model contains the measurable output signal of the control section as a redundant quantity. By comparing the two variables, a tracking control can be used to adapt the model state variables to the state variables of the control path. As the model deviations have become minor in this case due to the simple mechanical drive train, the observer now has an efficient aid available to increase the signal quality. Increase in signal quality in the observer means that the noise components decrease, and the dynamics improve as the observed speed is feedforward-controlled undelayed by the current and is not just calculated delayed from the position signal using simple differentiation.

Signal flow chart Luenberg observer



$I(t)$:	Torque-forming motor current
K_T :	Torque constant
$M_L(t)$:	External disturbance torque
J_{total} :	Total mass moment of inertia (motor + load)
$a(t)$:	Acceleration
$n(t)$:	Velocity
$x(t)$:	Position
Index b:	Observed signal quantities
$h_0...h_2$:	Controller coefficients of the tracking controller

Here the quantisation of the speed signal is proportional to the sampling time T_{AR} , hence there is no longer any conflict between the requirements for minimum sampling time and minimum quantisation noise. For the integral velocity acquisition, the motor current variable, which is proportional to the acceleration, can be used. This approach is particularly advantageous in direct drive engineering; due to the absence of a mechanical drive train, there is a very good match between the mathematical model of the observer and the real physical control section in the fundamental frequency range of the control. This applies in

particular to direct drive systems with fixed moving masses, as otherwise the mismatch between model and the physical drive system has a destabilising influence on the transfer behaviour of the speed control. A remedy is to increase the observer dynamics, however this increases the noise of the observed signals. Therefore in the case of variable moving masses a compromise has to be found between the dynamics of the observer and the maximum stiffness of the drive.

Commutation settings of the automatic commutation

In this chapter you can read about:

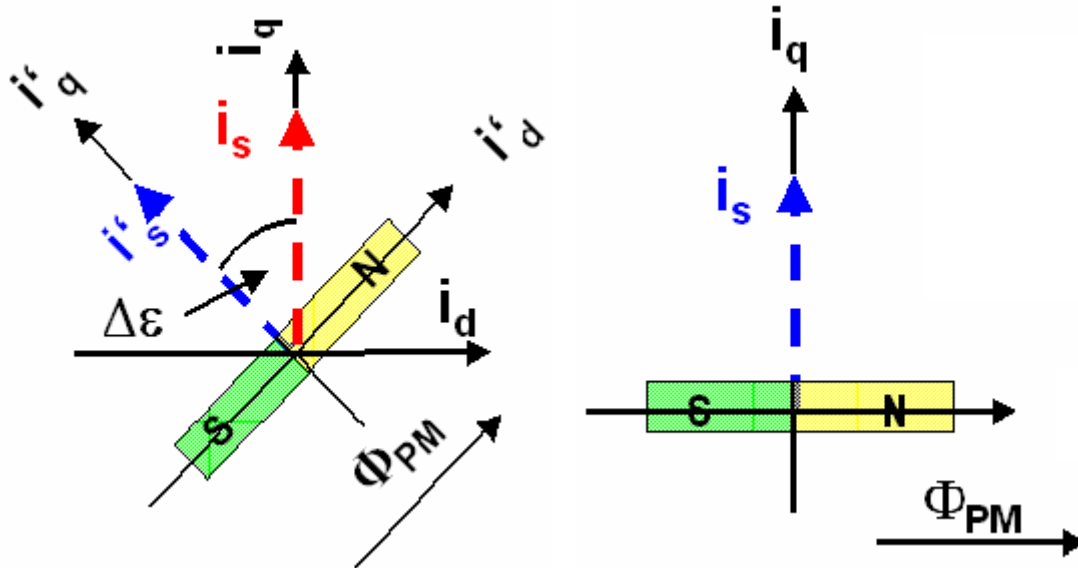
Display of the commutation error in incremental feedback systems.....	202
Prerequisites for the automatic commutation	203
Course of the automatic commutation function	203
Other	206

Permanently excited synchronous motors can only be operated with an absolute feedback system (at least for electric motor rotation). The reason is the necessary commutation information (position assignment of the magnet field generated by the motor to the motor magnets). Without the commutation information, there is inevitably the possibility of a positive feedback between position and velocity loop ("running away" of the motor) or of bad motor efficiency (reduced force constant). Digital hall sensors are the most common aid to prevent this. Due to the mechanical design it is however impossible or very hard to integrate these sensors in some motors. The Compax3 automatic commutation function (in the F12 direct drive device) described below allows however to use incremental feedback systems without hall sensors.

The functionality implemented in the servo controller establishes the necessary reference between motor stator field and permanent magnetic field without additional aids.

The incremental feedback devices are, in contrast to absolute feedback devices, able to acquire relative distances. It is true that any position can be approached from a starting point, there would be however no consistency between these position values and a fixed virtual absolute system. Other than with an absolute feedback, the correlation between rotor and stator is lost if the position acquisition is switched off ("the position acquisition zero is lost"). When switching on, the actual position is randomly taken as zero. A commutation angle error can therefore absolutely not be excluded. Even a system adjusted before, would show an angular error, for example after a current failure. Therefore the angular error occurring randomly upon each new switching on must always be compensated in an incremental system.

Display of the commutation error in incremental feedback systems

 $\Delta\varepsilon = 0$ (adjusted) $\Delta\varepsilon \neq 0$ (not adjusted)

Rotor was turned in switched-off state.

blue: ideal position
 red: unfavourable position
 PM: magnetic flux of the permanent magnets
 i_s : Current pointer
 $\Delta\varepsilon$: Commutation error
 i' : ideal position
 i_q : Quadrature current (torque forming)

The automatic commutation function (AK) in Compax3 uses the position dependent sinusoidal torque course of permanently excited AC synchronous motors. If the motor windings are energized with DC voltage for instance, the motor develops a sinusoidal torque depending on the rotor position, which can be used for example by evaluating the resulting movement in order to determine the correct motor commutation.

The automatic commutation with movement in the Compax3 has the following properties:

- ◆ The motor movement occurring during the commutation is, with correctly parameterized function, very small. It is typically in the range smaller than 10° electrical revolution (= $10^\circ/\text{motor poles physically}$ or $10^\circ/360^\circ \cdot \text{motor pitch}$ for a linear motor).
- ◆ The precision of the acquired commutation angle depends on the external conditions, however lies normally in the range better than 5° electrical revolution.
- ◆ The time until the termination of the commutation acquisition is typically below 10s.

Prerequisites for the automatic commutation

- ◆ A movement of the motor must be permitted. The movement actually occurring depends greatly on the motor (friction conditions) itself, as well as on the load moved (inertia).
- ◆ Applications requiring a motor brake, i.e. applications where active load torques are applied at the motor (e.g. vertical actuator, slope) are not permitted.
- ◆ Due to the function principle, high static friction or load torques will deteriorate the result of automatic commutation.
- ◆ When performing automatic commutation, a motion of at least $\pm 180^\circ$ must be electrically possible (no mechanic limitation)! The implemented automatic commutation function with motion cannot be used for applications with limit or reversal switches.
- ◆ With the exception of missing commutation information, the controller/motor combination is configured and ready for operation (parameters correctly assigned for the drive/linear motor). Feedback direction and effective direction of the field of rotation must be identical (automatic commutation performed in the MotorManager).

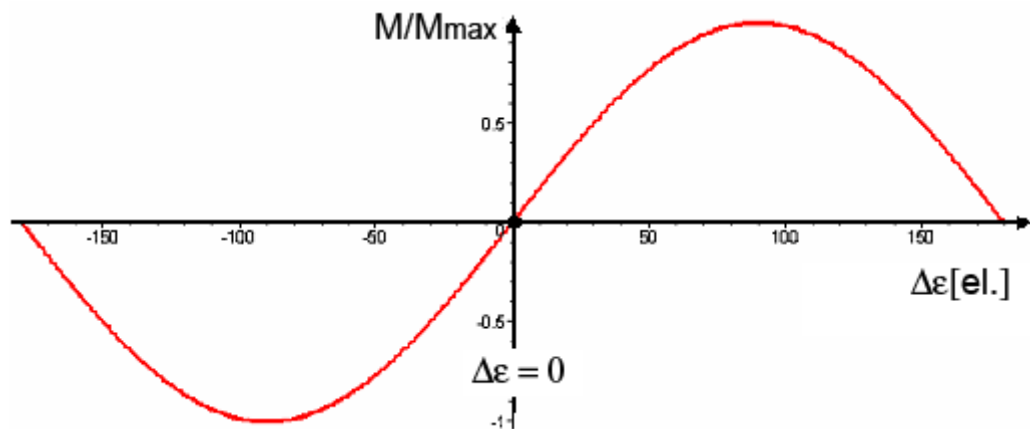
Course of the automatic commutation function

If "automatic commutation with movement" is selected as source of commutation, the automatic commutation sequence runs once if the power stage is enabled. If the power stage is enabled or disabled afterwards, the automatic commutation will be left out. If an error occurs during the execution, the automatic commutation is aborted. A new "attempt to enable" the power stage will trigger a new automatic commutation.

Function principle of the automatic commutation with movement

The implemented method with movement is based on the sinusoidal dependence of the provided motor currents and the resulting movement on the effective commutation error. The acceleration performed by the motor (-> movement) in the event of constantly maintained current is a measure for the actual change in the commutation angle in the way that it disappears upon a change of exactly 0° and is, for other angles, the acceleration and its direction in dependance of the sign and value of the angular error ($-180^\circ \dots 180^\circ$).

Acceleration torque depending on the commutation error.

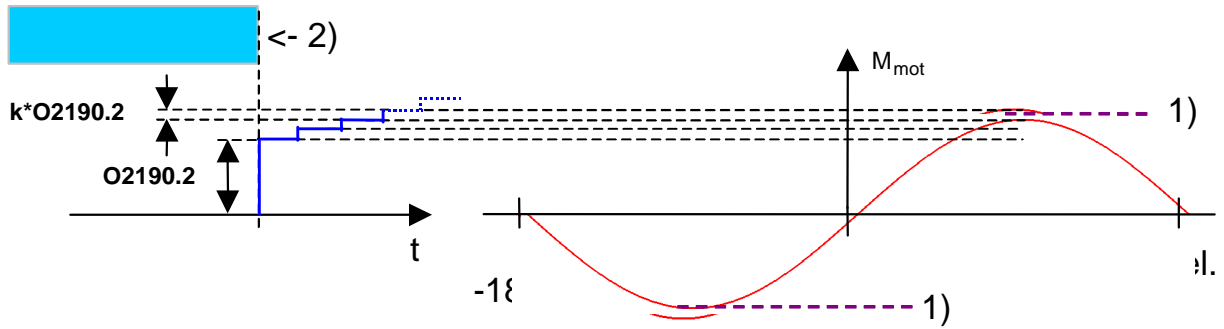


$\Delta\varepsilon:$	Commutation error
$M/M_{\mu\alpha\xi}$	normalized acceleration torque

Searching for the torque maxima (phase 1)

If the sum of the actual and the estimated error angle is $\pm 90^\circ$ electrically, the motor torque is maximal for the provided current. If you gradually increase the provided motor current, the motor will, from a defined value on, surpass its friction torque and exceed a motion threshold defined by O2190.3:

Illustration of the first phase

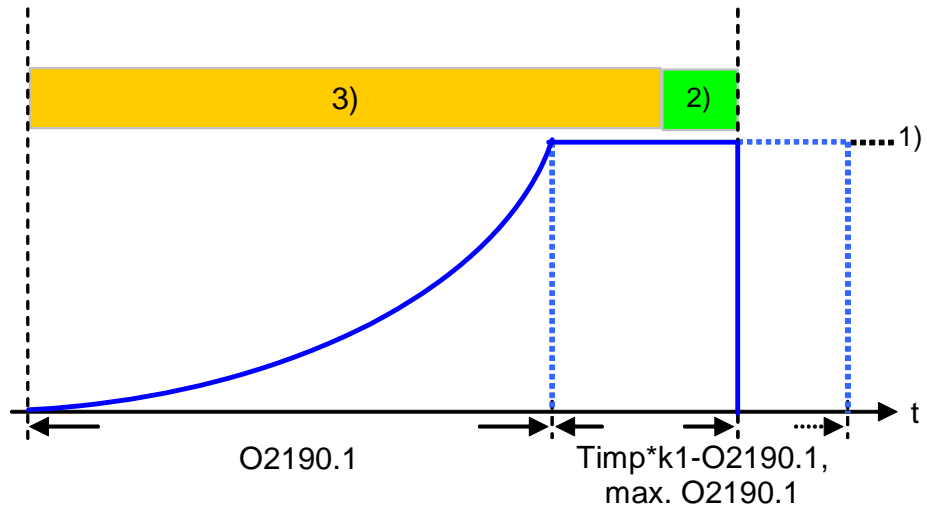


- 1): Motion threshold O2190.3
- 2): Waiting for standstill
- O2190.2: Starting current

Latching of the motor (phase 2)

Here, the drive is brought to the position with the provided motor torque=0, where the angular error is either $\pm 180^\circ$ or 0° .

Current rise in the second phase.



- O2190.1: Rising time of latching current
- 1) Maximum current from controller or motor
- 2) Monitoring on 5° electrical movement
- 3) Monitoring on 60° electrical movement

Motion reduction:

It is possible, to considerably reduce the motor movement occurring during the fine angle search with the aid of the "motion reduction" parameter (O2190.4). Please respect also that the acquired commutation result may be slightly worse than without this measure.

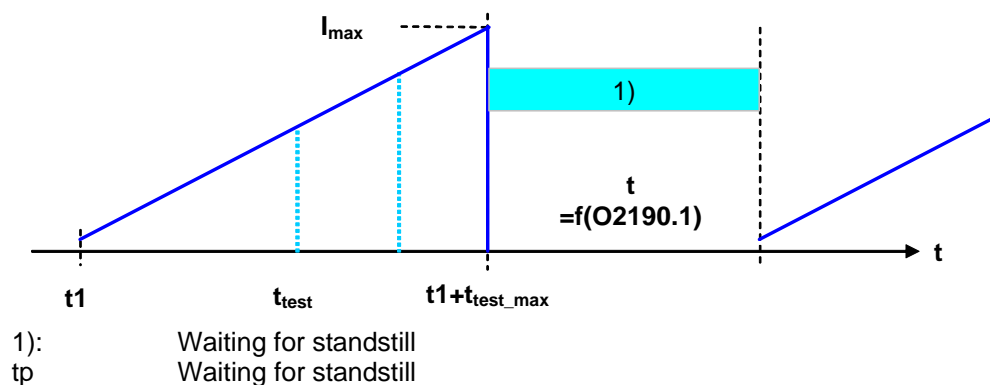
Hint As a current well above the nominal motor current is provided here, there may be saturation effects on ironcore motors, which might lead to an instable current loop (-> highly frequent "creaking noises" during the automatic commutation). This can be avoided by activating the saturation characteristic line in the motor data.

Test for positive feedback (phase 3)

Here it is verified, if the motor performs a motion in the expected positive direction in the event of positive current in the torque maximum. The same motion threshold (defined via O2190.3) as in phase 1 is valid. The test is repeated several times.

A current course in ramp form is specified (target: minimum movement). The break between the tests varies with the current rise time O2191.1.

Illustration of the third phase



- 1): Waiting for standstill
- tp: Waiting for standstill

Other

- ◆ During the sequence (time according to parameterization >> 1s) the automatic commutation is externally visualized by a LED blinking code (green permanent and red blinking).
- ◆ Device errors will lead to an abort of the automatic commutation.
- ◆ During automatic commutation, no motion commands are accepted.
- ◆ The controller cascade entirely deactivated during automatic commutation, with the exception of the current loop.
- ◆ In multi-axis applications, the axes to be automatically commutated must be awaited (output of the MC_Power block must deliver "True")!
- ◆ The automatic commutation is only started if the drive is at standstill.
- ◆ After the occurring and acknowledgement of a feedback error or a configuration change of the feedback system, the automatic commutation must be performed again, as it might be that the position entrainment in the servo controller is interrupted (commutation information is lost).

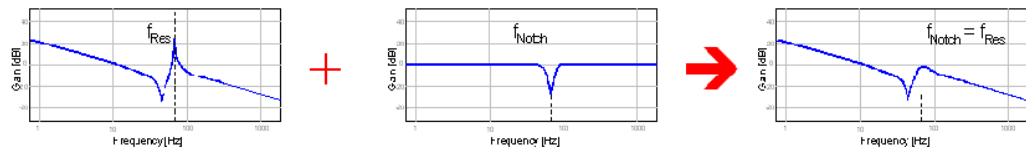
Notch filter

In this chapter you can read about:

Effect of the notch filter206
 Wrongly set notch filter206
 Frequency response of the notch filter.207
 Parameterization by 3 objects.207

Notch filters are small-band band elimination filters which slope in a wedge form towards the center frequency. The attenuation of this center frequency is extremely high in most cases. With the aid of the notch filters it is possible to purposefully eliminate the effects of mechanical resonance frequencies. With this, the mechanical resonance point is not activated itself, but the excitation of this point of resonance is avoided by the control.

Effect of the notch filter



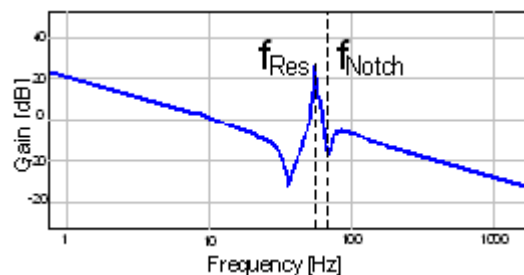
Resonance

Notch filter

Result

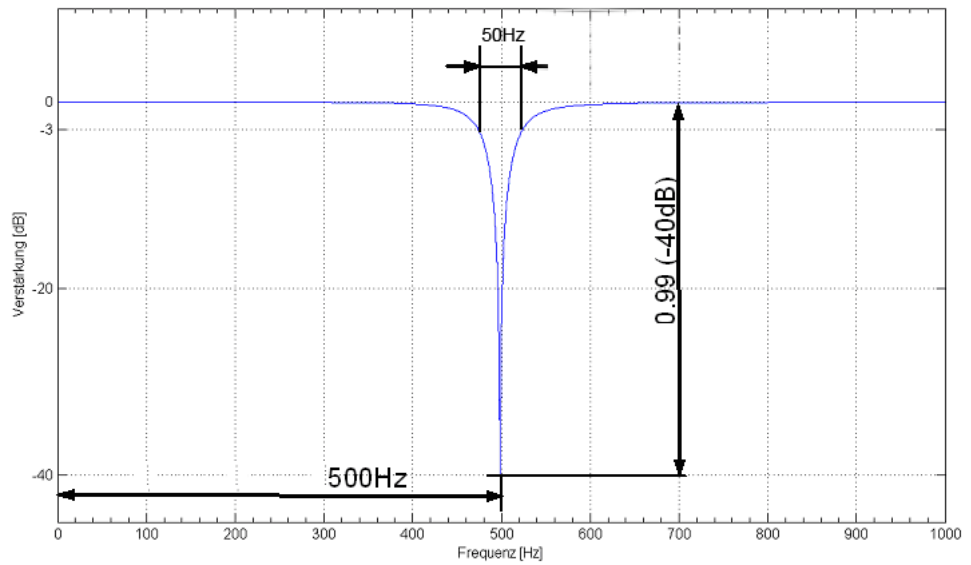
As can be seen in the figure, the notch filter is only useful in cases where the set frequency of the notch filter is exactly the same as the disturbing frequency. The notch filter as well as the resonance point are very narrowband. If the resonance point does only minimally change (e.g. by changing the masses involved), it is not sufficiently activated by the notch filter.

Wrongly set notch filter



In the Compax3, two notch filters which are independent of each other are implemented.

Frequency response of the notch filter.



Center frequency = 500Hz
 Bandwidth = 50Hz
 Depth = 0.99 (-40dB)

Parameterization by 3 objects.

In this chapter you can read about:

Frequency filter 1 (O2150.1) / frequency filter 2 (O2150.4)	207
Bandwidth filter 1 (O2150.2) / bandwidth filter 2 (O2150.5)	207
Depth filter 1 (O2150.3) / depth filter 2 (O2150.6)	208

Frequency filter 1 (O2150.1) / frequency filter 2 (O2150.4)

This defines the frequency at which the notch filter attenuation is highest. In practice it shows that notch filters can only sensibly be used if the distance between the controller bandwidth (velocity loop) and the center frequency is long enough (at least factor 5). This permits to deduce the following recommendation:

$$O2150.x \geq \frac{5000000}{2\pi \cdot O2210.17[\mu s]}$$

x = 1 or x = 4

Obj2210.17: Replacement time constant of the velocity loop in μs .

Note: If this distance is too small, the stability of the control can be very negatively influenced!

Bandwidth filter 1 (O2150.2) / bandwidth filter 2 (O2150.5)

This defines the width of the notch filter.

The value refers to the entire frequency band, where the attenuation of the filter is higher than (-)3dB.

In practice it shows that even if there is enough distance towards the control, it can be negatively influenced by too high bandwidths (higher than 1/4 of the center frequency).

$$O2150.x \leq \frac{O2150.1/4}{4}$$

x = 2 or x = 5

Depth filter 1 (O2150.3) / depth filter 2 (O2150.6)

With this the size of the attenuation of the filter must be at the position of the center frequency. One stands here for complete attenuation ($-\infty$ dB) and zero for no attenuation.

$$O2150.x = 1 - 10^{-\left(\frac{D[dB]}{20}\right)}$$

$x = 3$ or $x = 6$

D [dB]: The desired attenuation at the center frequency in dB

Saturation behavior

In this chapter you can read about:

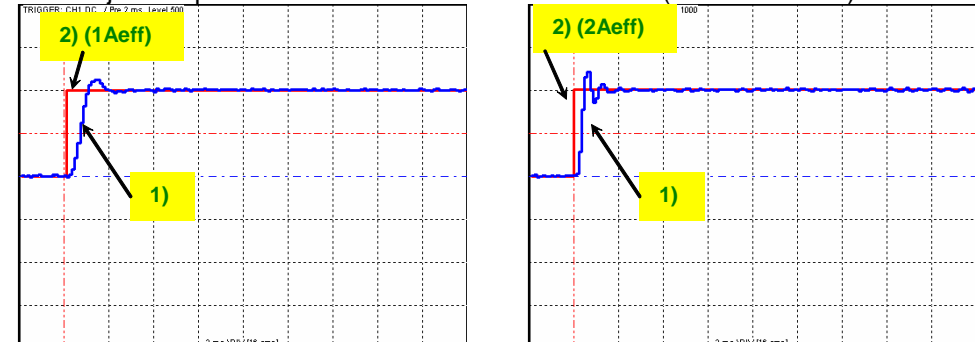
Current jerk response208

Current jerk response with the activated saturation characteristic line208

Saturation can be stated with the aid of current jerk responses at different current height.

Current jerk response

Current jerk response of a motor to 2 different currents (1Arms / 2Arms)

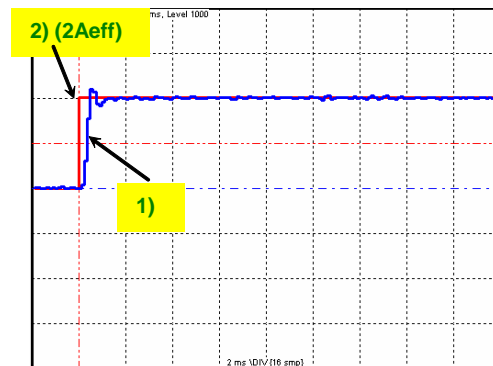


- 1) Actual current
- 2) Setpoint current

In the above figure we can see from the settling response that the drive shows a distinctive tendency to oscillate at doubled current. The saturation characteristic line, which is used to linearly reduce the P-term of the current loop depending on the current, helps against such a saturation behavior.

If you respect the saturation for the above example with the aid of the saturation characteristic line, the tendency to oscillate of the current loop can again be activated.

Current jerk response with the activated saturation characteristic line



The parameterization of the characteristic line is made in the MotorManager.

- Note:**
- ◆ In order to accept the changes in the MotorManager in the project, the entire configuration must be confirmed.
 - ◆ In order to make the changes from the MotorManager effective in the device, the configuration download must be executed.

Control measures for drives involving friction

In this chapter you can read about:

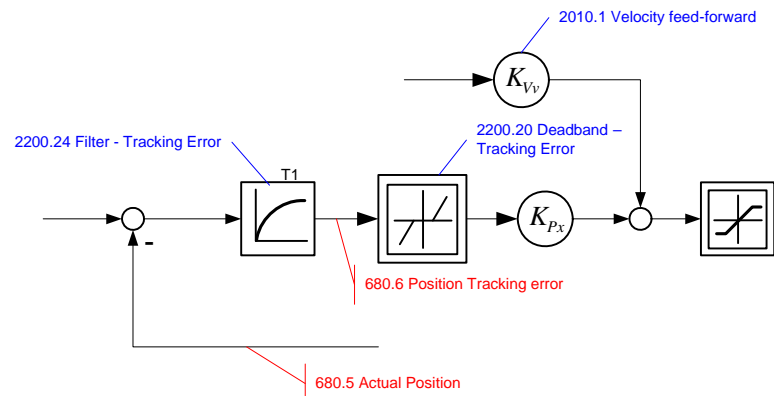
Deadband following error.....209
 Friction compensation.....210

Some drives, which involve much friction due to their guiding system, may show permanent oscillation at standstill. The transition between static friction (standstill) and kinetic friction (very low speed) is very steep. The controller can not longer follow the friction characteristic line at this position. The I-term integrates until the control variable pulls free the drive and the drive moves too far. This procedure is repeated in the opposite direction and a control oscillation occurs (so-called limit cycle). In order to eliminate this control oscillation, the following control functions were implemented:

- ◆ Deadband following error (Obj. 2200.20)
- ◆ Filter following error (Obj. 2200.24)
- ◆ Friction compensation (Obj. 2200.20)

Deadband following error

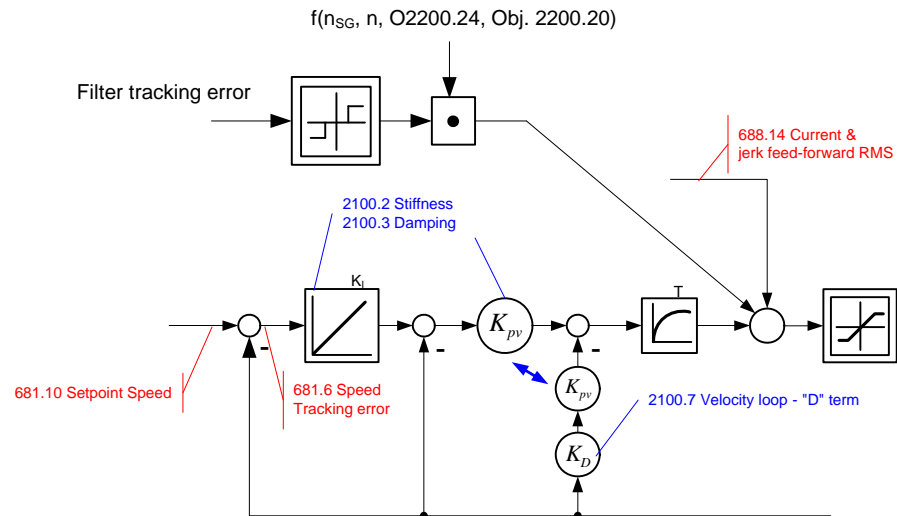
Deadband/filter following error in the position loop



The deadband does no longer supply a velocity setpoint value (zero) for the subordinate velocity loop at small following error. The integrator of the velocity loop stops integrating and the system comes to a standstill. In order to prevent that the velocity loop is excited by the noise on the following error, the following error should be filtered before the deadband, which will lead, however, to delays in the position loop. The deadband to be set depends on the friction behavior (amplitude of the limit cycle) and on the noise on the following error (the noise must remain within the deadband).

Friction compensation

The activation of the friction compensation (end of the velocity loop)



The friction compensation helps the control to surmount static friction at low setpoint speeds. The non linear characteristic line is partly compensated by this and a smaller deadband can be chosen, which will increase the position accuracy. The amplitude of the friction compensation depends on the application and must be calculated if needed. If the value is set too high, corrective movements may result and the tendency to oscillate is increased.

Commissioning window

In this chapter you can read about:

Load identification.....	210
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Commissioning window	

With the aid of the setup window, the drive can be set up in a simple way.

Load identification

If you do not know the mass moment of inertia, it can be determined. For this, you click on the corresponding button (see setup window no. 13). After the following parameter entry, the identification can be started via the same button.

- ◆ For more detailed information on the load identification, see the device help, chapter "load identification".
- ◆ This measurement requires the correct EMC or torque constant value K_t .

Setpoint generation

In this chapter you can read about:

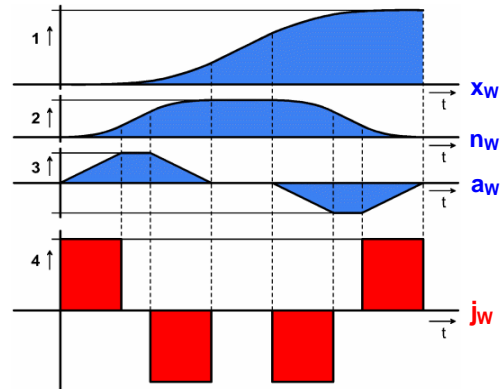
Internal setpoint generation	210
External setpoint generation	212

The setpoints for the control loops are provided in two different ways - internally or externally. The setpoint generation depends on the technology option of the device.

Internal setpoint generation

The internal setpoint generation can be used for the technology option $s > T10$. In this case, the internal setpoint generator generates the entire motion profile with position, velocity, acceleration and jerk.

Motion profile at jerk-controlled setpoint generation



x_w Position
 v_w Velocity
 a_w Acceleration
 j_w Jerk

The drive cannot move randomly through hard profiles, as certain physical limits exist for the acceleration ability due to the motor physics and the limitation of the control variable. You must therefore make sure that the set movement corresponds to the real physics of the motor and of the servo drive.

As a support you can take the following physical correlation.

The calculation of the physically possible acceleration

rotary drives

$$a [rps^2] = \frac{M_A [Nm] - M_L [Nm]}{2\pi \cdot J_{ges} [kgm^2]}$$

M_A : Drive torque of the motor
 M_L : Load torque of the motor
 J_{total} : entire mass moment of inertia
 a : possible acceleration

Linear drives

$$a [m/s^2] = \frac{F_A [N] - F_L [N]}{m_{ges} [kg]}$$

F_A : Drive force of a linear motor
 F_L : Load force of a linear motor
 m_{ges} : Total mass of a linear motor

The generation of the setpoint profile is jerk-controlled and jerk-limited by the specification of the jerk.

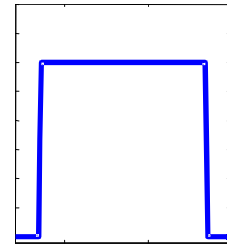
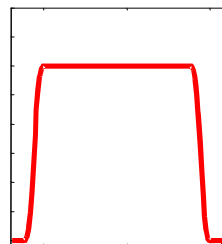
In practice, jerk-limited setpoint generation is important if the items to be moved must be handled gently. In addition, the service life of the mechanical guiding system will be extended. A separate setting of jerk and slope of the deceleration phase also permits overshoot-free positioning in the target position. For this reason, it is common practice to use higher values for acceleration and jerk in the acceleration phase than in the deceleration phase. In consequence a higher cycle rate can be achieved.

An additional important reason for the jerk limitation is the excitation of higher frequencies due to the too high jerk in the power density spectrum of the velocity function.

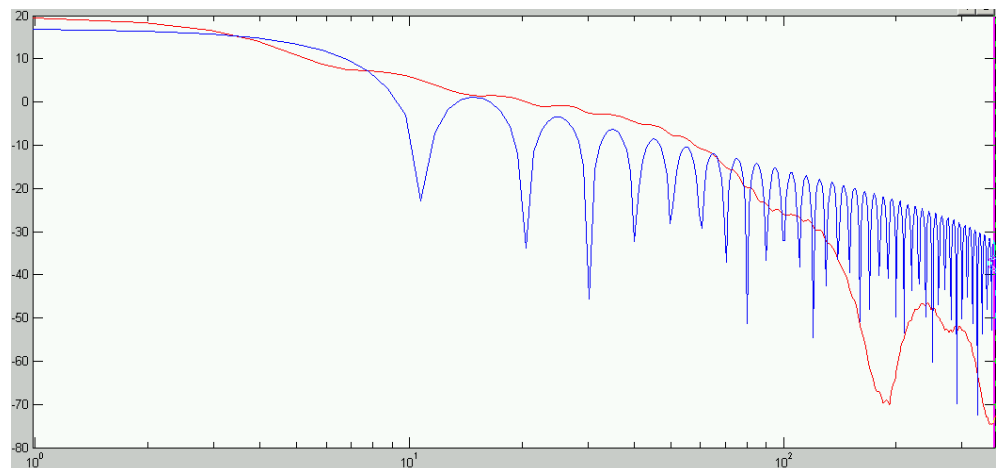
Jerk=10000°/s³

Jerk=1000000°/s³

Time function:



Time function and power density spectrum of Compax3 setpoint generator with different jerk settings



Power density over the frequency

The profile can be simply calculated and displayed for control purposes.

External setpoint generation

During external setpoint generation, the necessary feedforward signals are calculated from the external setpoint with the aid of numerical differentiation and final filtering.

Hint For more detailed information on the external setpoint generation see device help for T11/T30/T40 devices in the "setup" chapter Compax3\optimization\controller dynamics\signal filtering at external setpoint specification"

Test Move

In order to evaluate the behavior of the drive, test movements can be defined. For this you jump into the parameter entry either with the aid of the "enter setup/test movement parameters" or by selecting the parameter tab. Via the "setup settings" menu you access the settings for the desired test movement. The desired motion profile can be set via the parameters in the following window.

Proceeding during controller optimization

In this chapter you can read about:

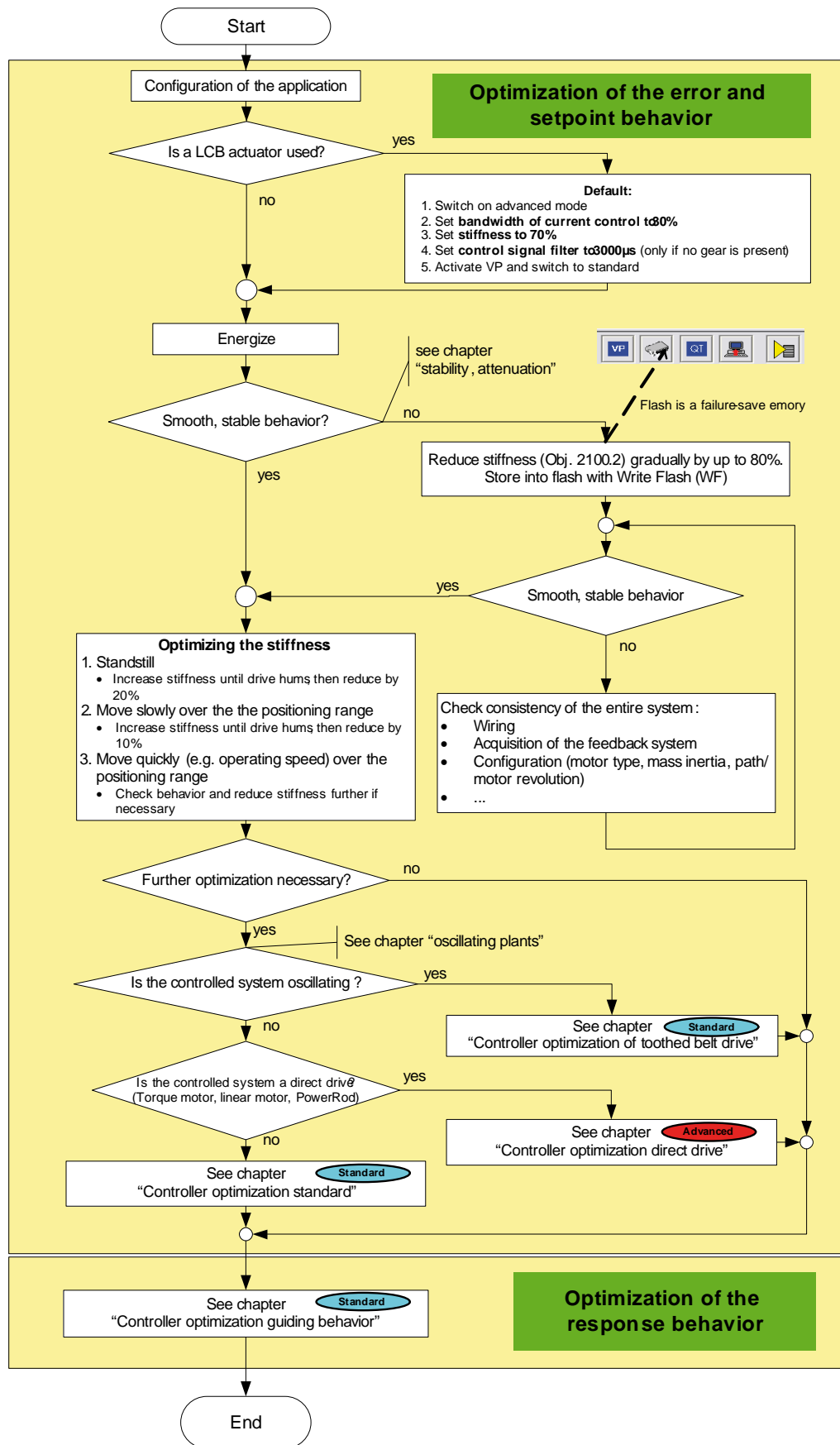
Main flow chart of the controller optimization.....	213
Controller optimization disturbance and setpoint behavior (standard).....	214
Controller optimization disturbance and setpoint behavior (advanced).....	217

If the control behavior is not sufficient for the present application, an optimization is required. We recommend the following approach:

Overview on the approach to setup a+optimization

- ◆ At first, the disturbance and setpoint behavior of the velocity loop at standstill and at different displacement velocities is optimized (stiffness, attenuation, filter).
- ◆ After that, the necessary motion profiles are set via the setup tool and the desired guiding behavior in the entire velocity range is set via the feedforward control (motion profiles, feedforward).

Main flow chart of the controller optimization

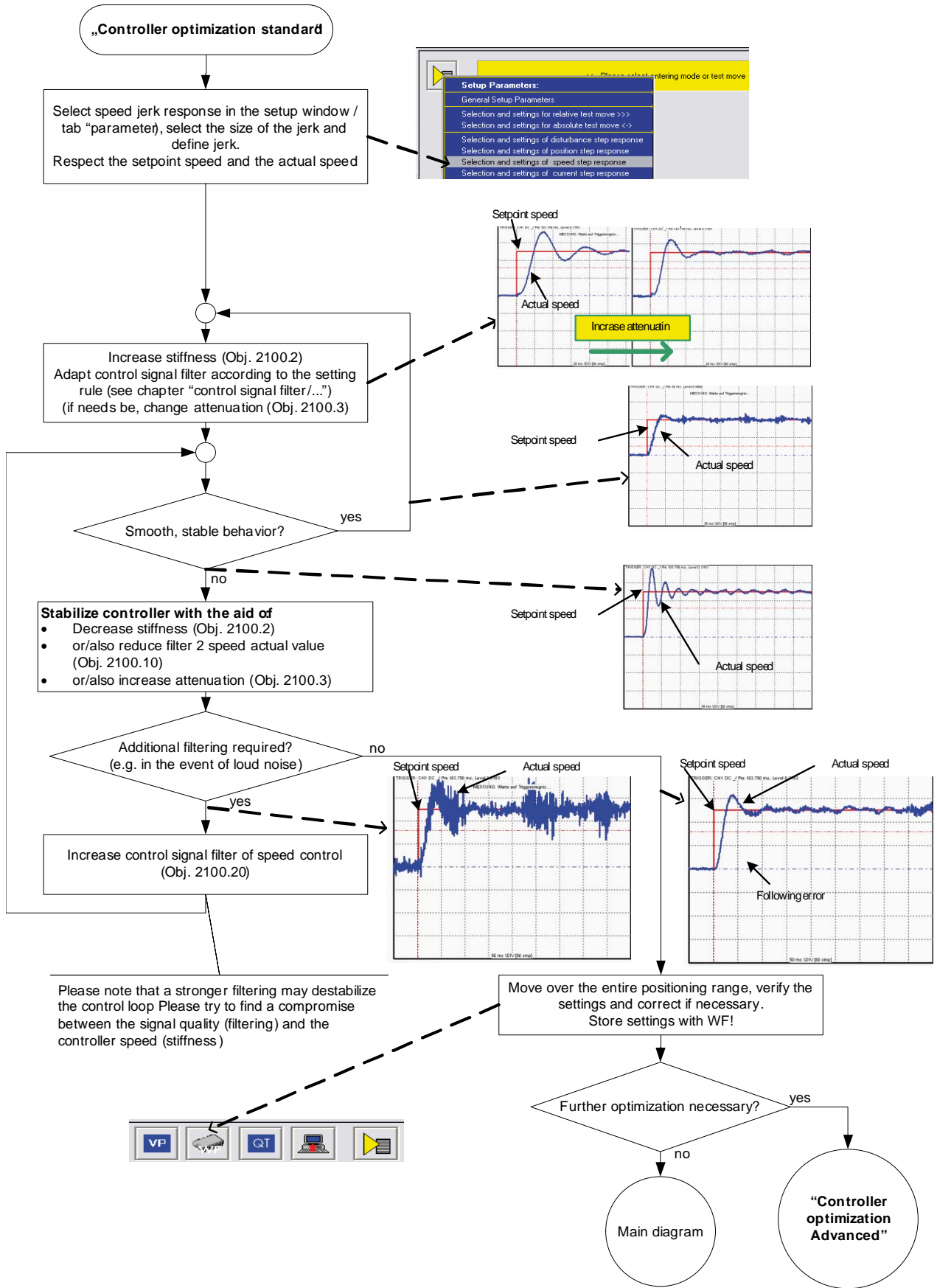


Controller optimization disturbance and setpoint behavior (standard)

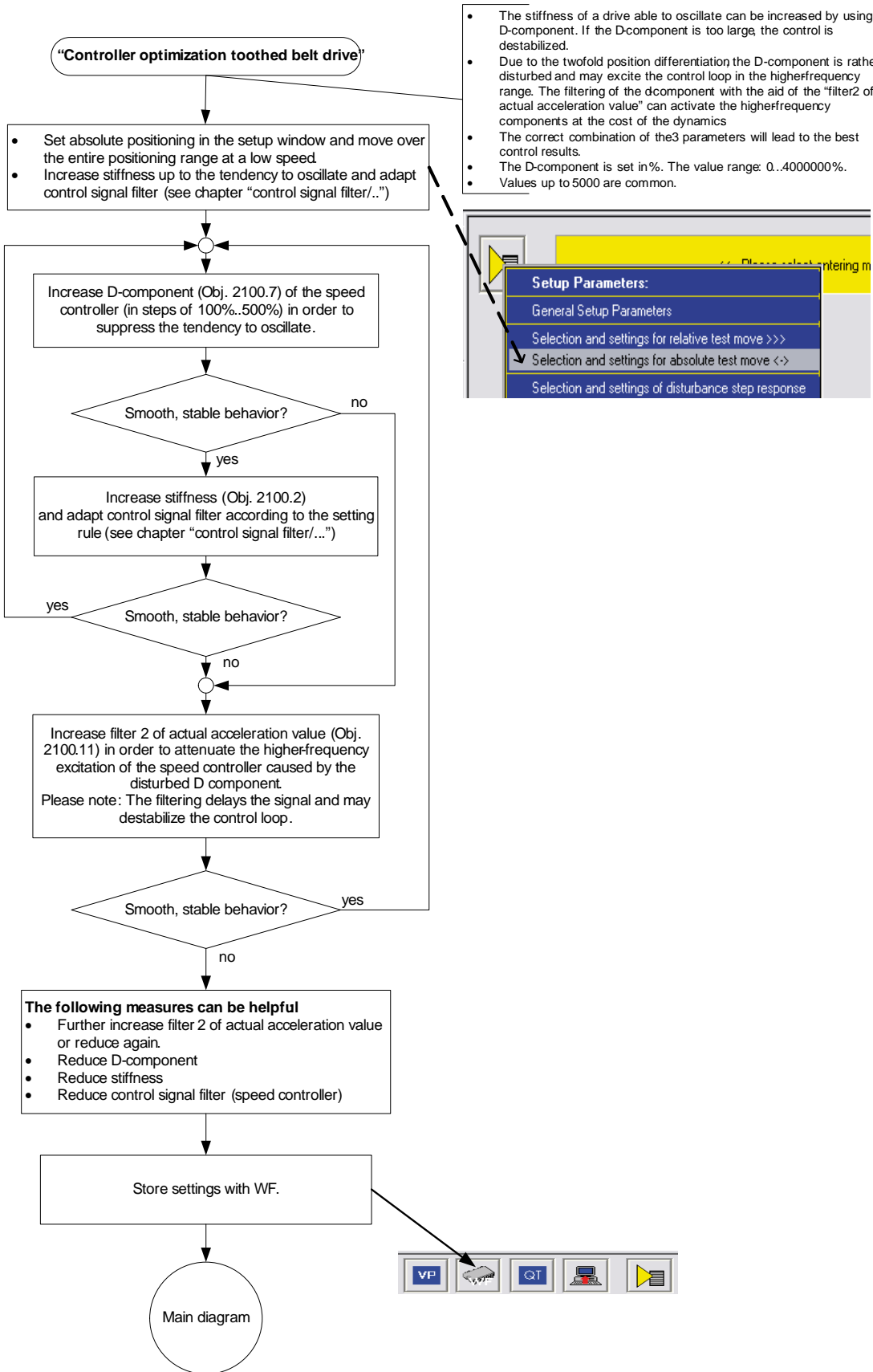
In this chapter you can read about:

Controller optimization standard	215
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Controller optimization standard



Controller optimization of toothed belt drive

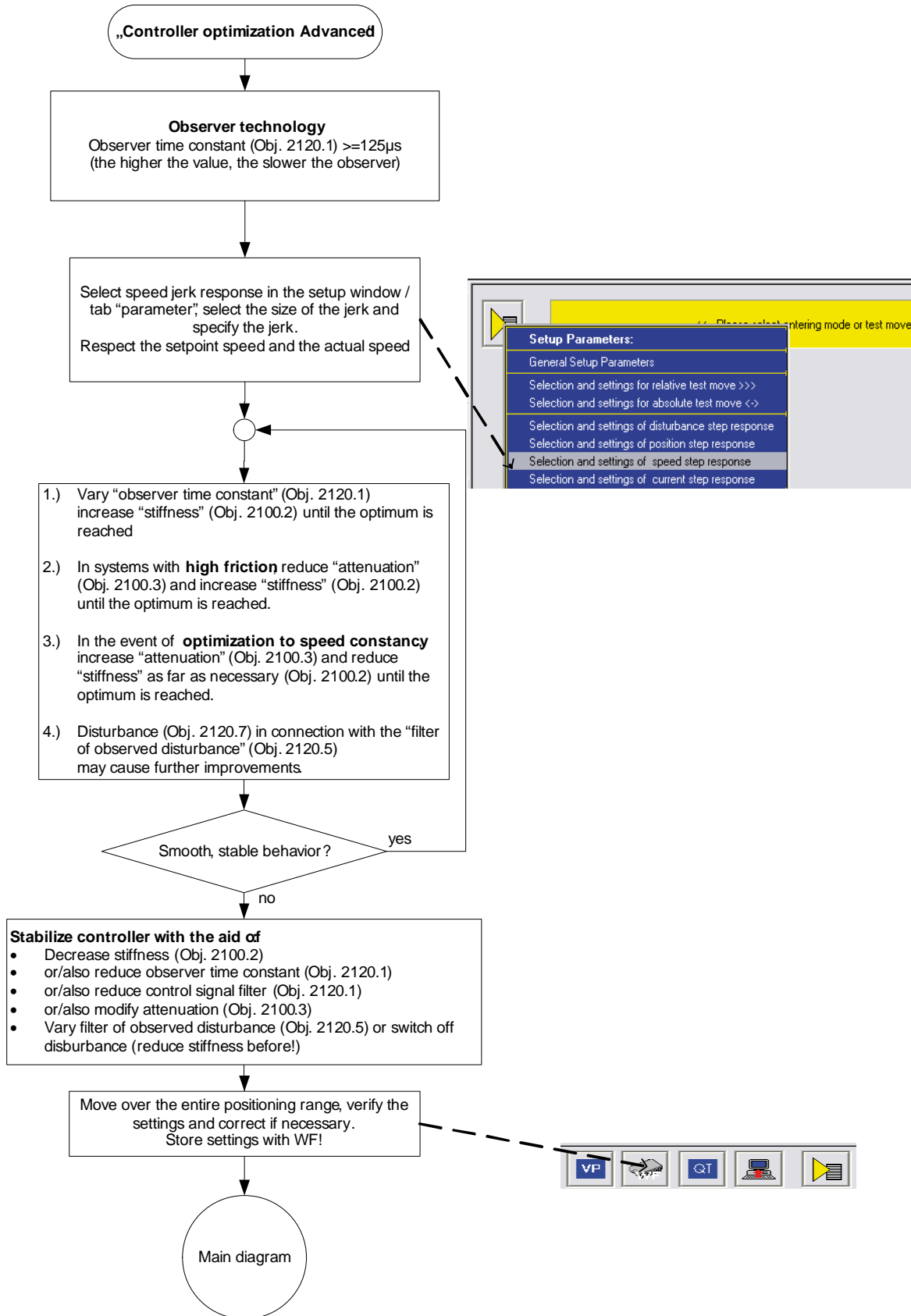


Controller optimization disturbance and setpoint behavior (advanced)

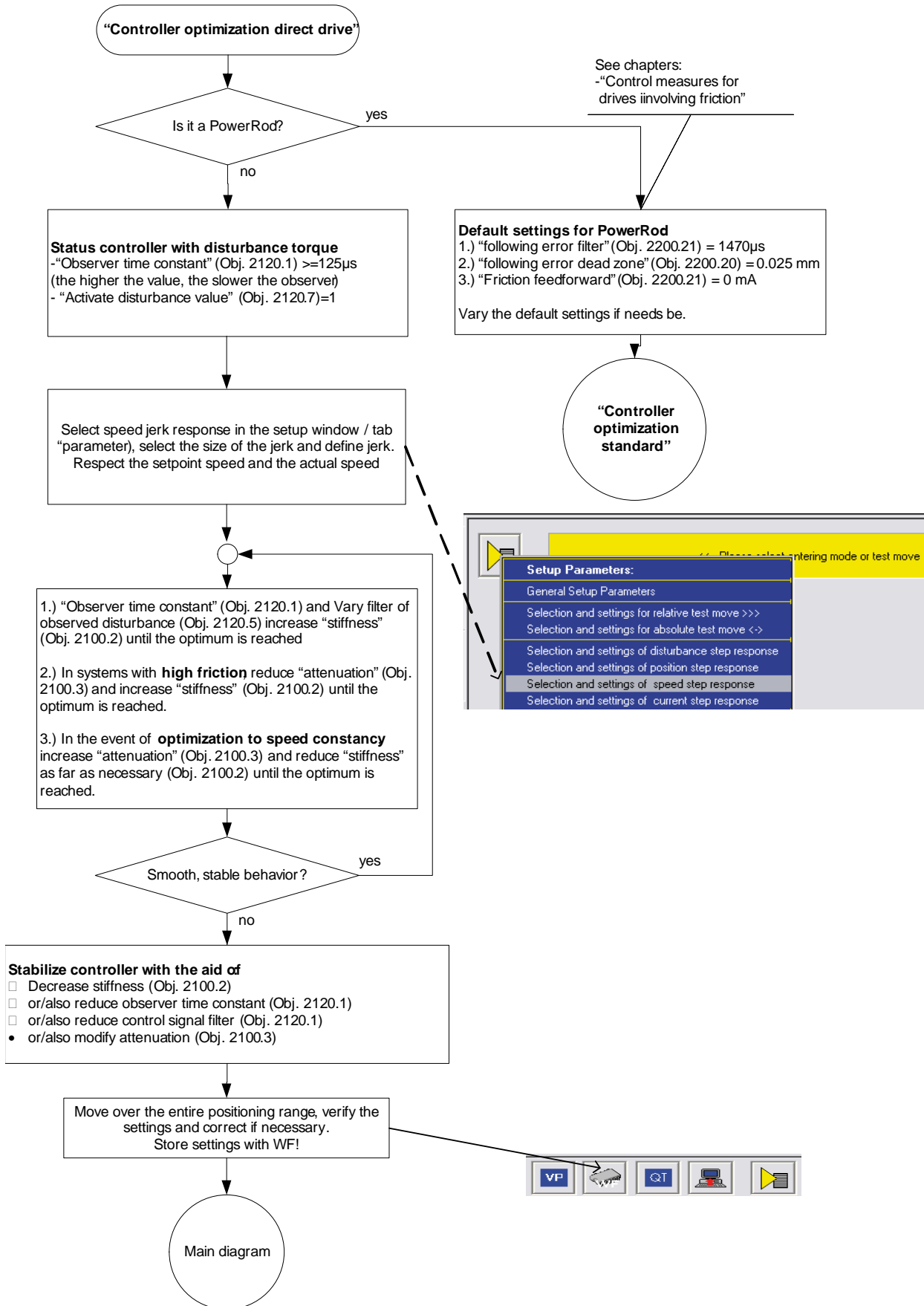
In this chapter you can read about:

Controller optimization Advanced	218
Flow chart controller optimization of a direct drive.....	219
Controller optimization guiding transmission behavior	220

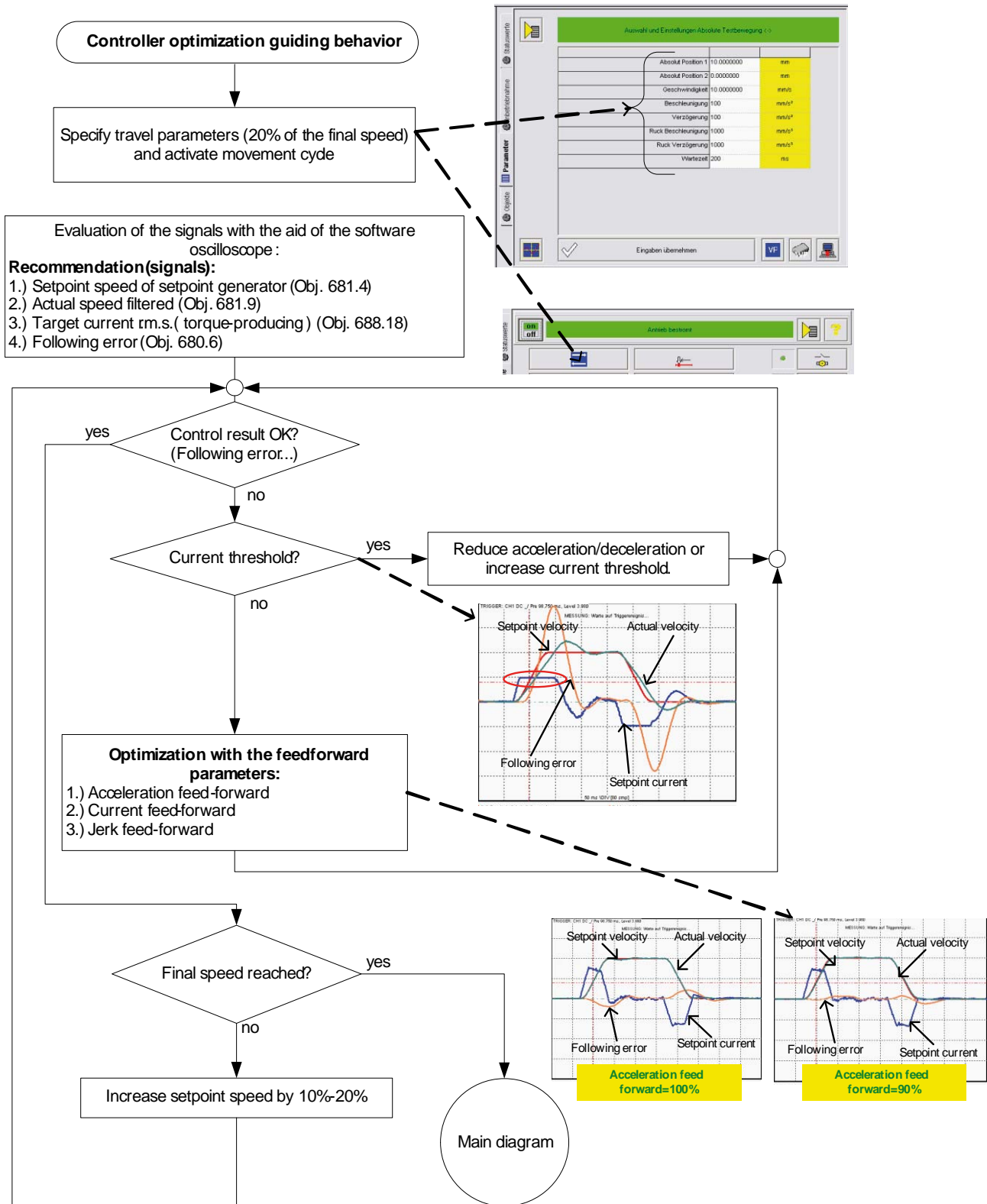
Controller optimization Advanced



Flow chart controller optimization of a direct drive

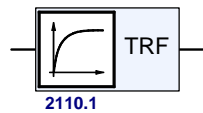
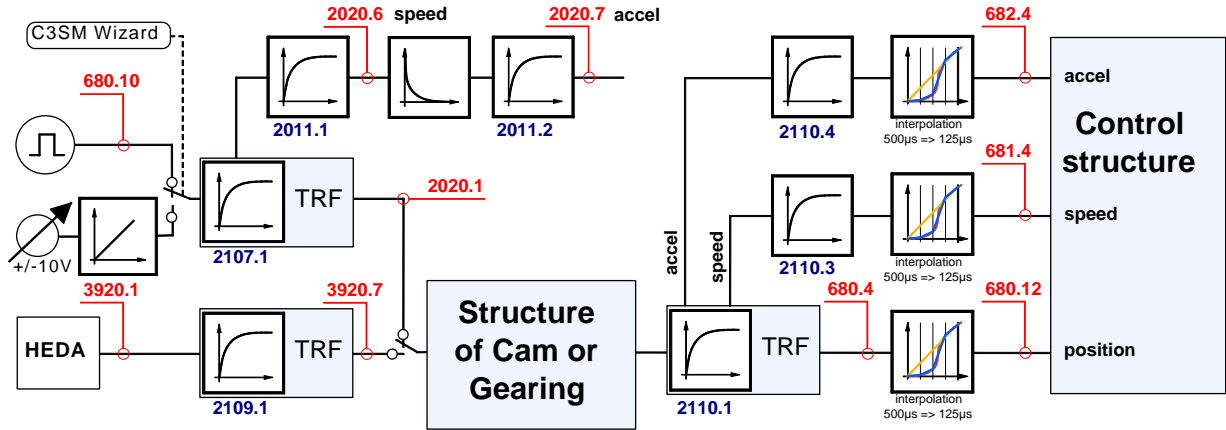


Controller optimization guiding transmission behavior



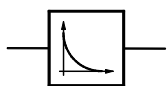
4.3.4. Signal filtering with external command value

The command signal read in from an external source (via HEDA or physical input) can be optimized via different filters. For this the following filter structure is available:



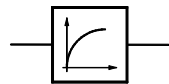
Trackingfilter

The displayed filter influences all outputs of the tracking filter.
Number: Object number of the filter characteristic



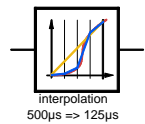
Differentiator

Output signal = $d(\text{input signal})/dt$
 The output signal is the derivation (gradient) of the input signal



Filter

Number: Object number of the filter characteristic



Interpolation

Linear Interpolation.
 Values in the 500µs grid are converted into the more exact time grid of 125µs.

Note:

- ◆ The objects 2020.6 and 2020.7 are status values, which can be used for control purposes in the IEC program.
- ◆ The objects 680.12, 681.4 and 682.4 are input characteristics which can also be found in the controller structure.
 A command jerk setpoint generator is not required for an external command value.
- ◆ The description of the objects can be found in the object list.

4.3.5. Input simulation

In this chapter you can read about:

Calling up the input simulation	222
Functionality	223

- Function** The input simulation is used for the performance of tests without the complete input/output hardware being necessary.
The digital inputs (standard and inputs of M10/M12 option) as well as the analog inputs are supported.
The following operating modes are available for digital inputs:
- ◆ The physical inputs are deactivated, the digital inputs are only influenced via the input simulation.
 - ◆ The digital inputs and the physical inputs are logically or-linked.
This necessitates very careful action, as the required function is, above all with low-active signals, no longer available.
- The pre-setting of an analog input value is always made in addition to the physical analog input.

the function of the inputs depends on the Compax3 device type; please refer to the respective online help or the manual.

The input simulation is only possible if the connection with Compax3 is active and if the commissioning mode is deactivated!

4.3.5.1 Calling up the input simulation

Open the optimization window (double click in the C3 ServoManager tree entry: Optimization).
Activate the Tab "Setup" in the right lower window.
Clicking on the following button will open a menu; please select the input simulation.



4.3.5.2 Functionality

Window Compax3 InputSimulator:

1st series: Standard inputs I7 ... I0 = "0" button not pressed; = "1" switch pressed

2nd series: Optional digital inputs (M10 / M12)

Green field: port 4 is defined as input

Red field: port 4 is defined as output

the least significant input is always on the right side

3rd series: if the button "deactivating physical inputs" is pressed, all physical, digital inputs are deactivated; only the input simulation is active.

If both sources (physical and simulated inputs) are active, they are or-linked!



Caution!

Please consider the effects of the or-linking; above all on low-active functions.

4th series: Simulation of the analog inputs 0 and 1 in 100mV – steps.

The set value is added to the value on the physical input.

After the input simulation has been called up, all simulated inputs are on "0".

When the input simulation is left, the physical inputs become valid.

4.3.6. Setup mode

The setup mode is used for moving an axis independent of the system control
The following functions are possible:

- ◆ Machine reference run
- ◆ Jog+ / Jog-
- ◆ Activation / deactivation of the motor holding brake.
- ◆ Acknowledging errors
- ◆ Defining and activating a test movement
- ◆ Activating the digital outputs.
- ◆ **Automatic determination of the load characteristic value** (see page 227)
- ◆ **Setup** (see page 226) of the **load control** (see page 139)

Activating the setup mode



By activating the setup mode, the the device function is deactivated; the system function of the device is no longer available.

Access via an interface (RS232/RS485, Profibus, CANopen,...) and via digital inputs is deactivated.

Attention! The "safe standstill according to EN954-1, category 3" is not guaranteed during setup mode!

- ◆ In the Commissioning window (left at the bottom) the commissioning mode is activated.
- ◆ Then parameterize the desired test movement in the Parameter window.
You can accept changed configuration settings into the current project.
- ◆ Now energize drive in the commissioning window and start the test movement.



Caution! Safeguard the travel range before energizing!

Deactivating the setup mode



If the setup mode is left, the drive is deactivated and the the device functionis re-activated.

- Note:**
- ◆ The parameters of the setup window are saved with the project and are loaded into Compax3 if the setup mode is activated (see below).

4.3.6.1 Motion objects in Compax3

The motion objects in Compax3 describe the active motion set.
 The motion objects can be influenced via different interfaces.
 The following table describes the correlations:

Source	active motion objects		Compax3 device
	==>	describe	
	<==	read	
Set-Up (working with the commissioning window)	==>	<ul style="list-style-type: none"> ◆ With the "accept entry" button. ◆ The current project gets a motion set. Download by activating the motion 	Active motion objects <ul style="list-style-type: none"> ◆ Position [O1111.1] ◆ Speed [O1111.2] ◆ Acceleration [O1111.3] ◆ Deceleration [O1111.4] ◆ jerk* [O1111.5] (Acceleration) ◆ Jerk* [O1111.6] (Deceleration) * for lxxT11 - devices, both jerk values are identical
	<==	<ul style="list-style-type: none"> ◆ When opening the commisioning window of a new project for the first time. ◆ Activated via the "Upload settings fromdevice" button (bottom at the left side). 	
Compax3 ServoManager project	==>	<ul style="list-style-type: none"> ◆ C3lxxT11: via an activated motion set ◆ C3l2xT11: via a configuration download 	
	<==	For Compax3 l2xT11: <ul style="list-style-type: none"> ◆ via a configuration upload ◆ in the commissioning window via "accept configuration" 	
Fieldbus (Compax3 l2xTxx)	==>	◆ Changing the motion objects directly	
	<==	◆ Reading the motion objects	
IEC61131-3 program (Compax3 lxxT30, lxxT40)	==>	◆ via positioning modules	

4.3.6.2 Commissioning the load control

If a load control was configured, the following buttons are displayed in the Commissioning window :



- 1 Status of the load control
yellow =>off
green => on
- 2 Activate / Deactivate load control
- 3 **Alignment of the position values** of motor and load
(Load position = Motor position)
Only if the load control is deactivated!

Please note the explanations for the load control (see page 139)!

4.3.7. Load identification

In this chapter you can read about:

Principle	227
Boundary conditions	227
Process of the automatic determination of the load characteristic value (load identification)	228
Tips	229

Automatic determination of the load characteristic value:

- ◆ of the mass moment of inertia with rotary systems
- ◆ of the mass with linear systems

4.3.7.1 Principle

The load characteristic value is automatically determined.

For this it is necessary to excite the system additionally with a signal (excitation signal = noise).

The excitation signal is fed into the control loop. The control loop dampens the excitation signal. Therefore, the superimposed control loop is set so slowly by reducing the stiffness, that the measurement is not influenced.

A superimposed test movement is additionally possible. This helps to eliminate possible mechanical effects such as rubbing caused by friction.

4.3.7.2 Boundary conditions

If the control is instable before the beginning of the measurement, please reduce the stiffness (in the optimization window at the left bottom)

The following factors can disturb a measurement:

- ◆ Systems with high friction (e.g. linear actuators with sliding guide)
Here, the systems where the static friction is considerably higher than the kinetic friction (slip-stick effect) are especially problematic.
- ◆ Systems with significant slack points (play)
- ◆ Systems with "too light" or susceptible to oscillation bearing of the total drive (rack).
Formation of rack resonances. (e.g. with gantries,...)
- ◆ Non constant disturbance forces which influence the speed development. (e.g. extremely strong slot moments)

The effects of the factors one to three on the measurement can be reduced by using a test movement.

caveat emptor (exclusion of warranty)

Due to multiple possibilities for disturbing influences of a real control path, we cannot accept any liability for secondary damages caused by faultily determined values. Therefore it is essential to verify all values automatically determined before loading them into the control loop.

4.3.7.3 Process of the automatic determination of the load characteristic value (load identification)

- ◆ Please click on "unknown: default values are used" in the configuration wizard in the "External moment of inertia" window.
- ◆ After the configuration download, you can enter directly, that the optimization window is to be opened.
- ◆ In the Commissioning window (left at the bottom) change to commissioning mode.
- ◆ Finally enter the values of the excitation signal and of the test movement in the parameter window.
Parameters of the excitation signal:
 - ◆ Amplitude of the excitation signal in % of the motor reference current
Only an amplitude value causing a distinct disturbance can give a usable result.
 - ◆ Permissible following error
In order to avoid a following error caused by the excitation signal, the permissible following error must be increased for the measurement if necessary.
 - ◆ Selection of the test movement: inactive, reverse, continuous
 - ◆ Parameterizing of the test movement if necessary
- ◆ Now energize drive in the commissioning window and open load identification window.



Caution! Safeguard the travel range before energizing!

- ◆ Starting the load identification.



Caution! The drive will perform a jerky movement during load identification!

- ◆ After the measurement, the values can be accepted. Depending on the application, 2 measurements for minimum external load and maximum external load are recommended.

4.3.7.4 Tips

Tip	Problem	Measures
1	Speed too low (with reverse operation)	Increase maximum speed and adapt travel range*
2	Speed too low (with continuous operation)	Increase maximum speed
3	Test movement missing	A test movement is important for drives with high friction or with mechanical slack points (play).
4	No error detected	Please note the boundary conditions . (see page 227)
5	Speed too low and amplitude of the excitation signal too small (with reverse operation)	Increase amplitude of the excitation signal; increase maximum speed and adapt travel range*
6	◆ Speed too low and ◆ amplitude of the excitation signal too small (with continuous operation)	Increase amplitude of the excitation signal; increase maximum speed.
7	◆ Test movement missing ◆ amplitude of the excitation signal too small	◆ Increase amplitude of the excitation signal or / and ◆ activate an appropriate test movement
8	amplitude of the excitation signal too small	Increase the amplitude of the excitation signal.
9	Following error occurred	Increase the parameter "permissible following error" or decrease the amplitude of the excitation signal.

*if the travel range is too short, the speed is not increased, as the drive does not reach the maximum speed.

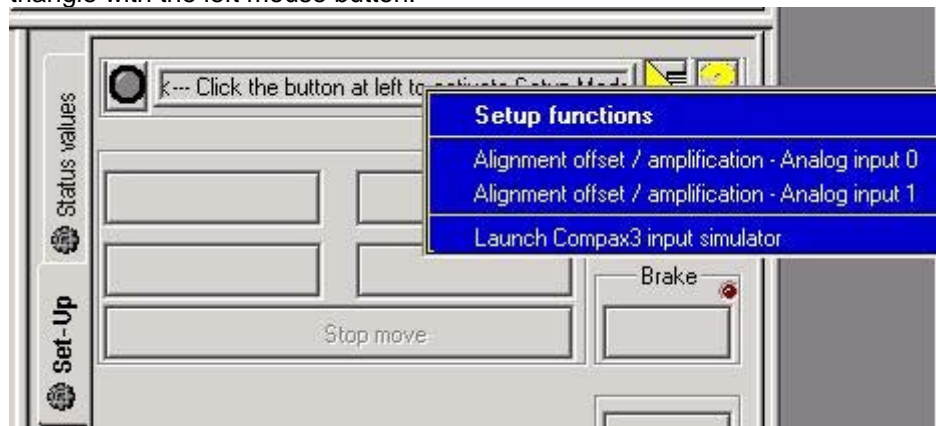
4.3.8. Alignment of the analog inputs

In this chapter you can read about:

Offset alignment.....230
Gain alignment.....230

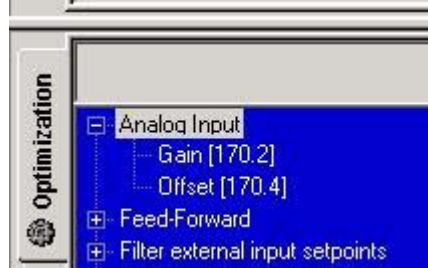
There are two possibilities to align the analog inputs in the optimization window:

- ◆ wizard-guided under commissioning: commissioning functions (click on the yellow triangle with the left mouse button:



or

◆ by directly entering under optimization: Analog Input



4.3.8.1 Offset alignment

Performing an offset alignment when working with the $\pm 10V$ analog interface in the optimization window under optimization: Analog input Offset [170.4].

Enter the offset value for 0V input voltage.

The currently entered value is shown in the status value "analog input" (optimizing window at the top right) (unit: 1 = 10V). Enter this value directly with the same sign as offset value.

The status value "analogue input" shows the corrected value.

4.3.8.2 Gain alignment

Performing an offset alignment when working with the $\pm 10V$ analog interface in the optimization window under optimization: Analog Input: Gain [170.4].

A gain factor of 1 has been entered as default value.

The currently entered value is shown in the status value "analogue input" (optimising window at the top right).

The status value "analogue input" shows the corrected value.

4.3.9. C3 ServoSignalAnalyzer

In this chapter you can read about:

ServoSignalAnalyzer – function range.....	231
Signal analysis overview.....	232
Installation enable of the ServoSignalAnalyzer	233
Analyses in the time range	235
Measurement of frequency spectra	238
Measurement of frequency responses	241
Overview of the user interface	248
Basics of frequency response measurement.....	260
Examples are available as a movie in the help file	265

4.3.9.1 ServoSignalAnalyzer – function range

The function range of the ServoSignalAnalyzer is divided into 2 units:

Analysis in the time range

This part of the function is freely available within the Compax3 ServoManager. The Compax3 ServoManager is part of the Compax3 servo drive delivery range.

Analysis in the frequency range

This part of the function requires a licence key which you **can buy** (see page 233)

The licence is a company licence and must only be bought once per company. For each PC you need however an individual key, which you can request individually.

4.3.9.2 Signal analysis overview

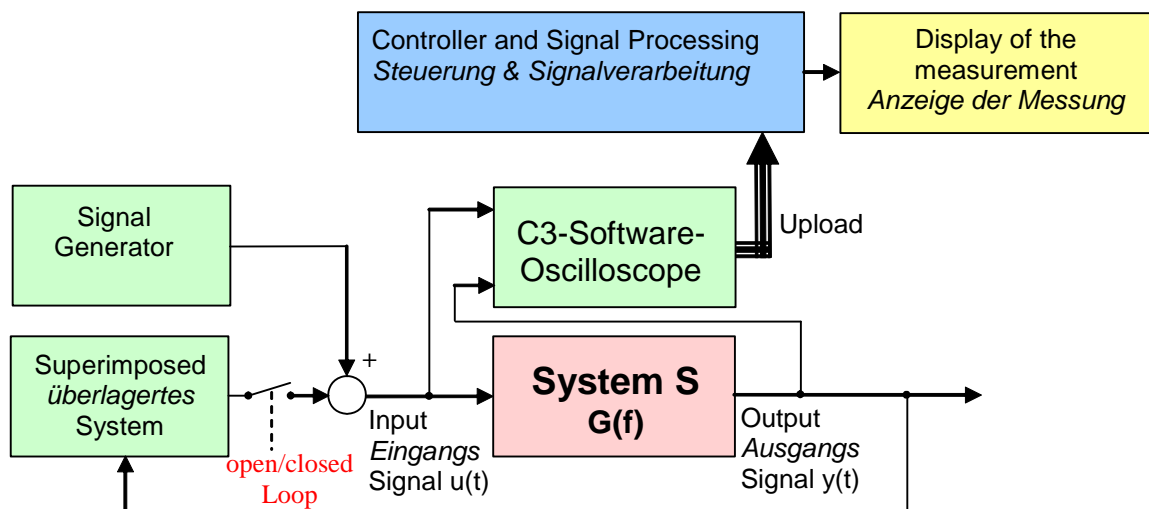
The ServoSignalAnalyzer offers three basic methods of analyzing systems:

- ◆ Analysis in the time range by measuring the step response
- ◆ Spectral analysis of individual signals
- ◆ Measurement of frequency response (Bode diagram) of the position control or of individual parts of the control as well as of the control path

These functions are available in the Compax3 ServoManager after the **activation** (see page 233) with the aid of a system-dependent key.

You do not require expensive and complex measurement equipment -> a Compax3 device and a PC will do!

Basic structure of the signal analysis



Systems / signals

Depending on the kind of measurement, the SignalAnalyzer can help analyze the most different signals and systems.

Signal generator

This allows to inject different excitation signals (step, sine and noise signals) into the control loop.

Superposed system

For different analyses, superposed systems must be manipulated in order to allow a measurement. After the measurement, the changes made for this purpose are reset

C3 software oscilloscope

With the aid of the software oscilloscope, the contents of different objects can be registered and be loaded into the PC for further analysis.

Control and signal processing

The control of the entire measurement as well as the processing of the uploaded sample data are made in the PC.

4.3.9.3 Installation enable of the ServoSignalAnalyzer

In this chapter you can read about:

Prerequisites	233
Installation	233
Activation	233

Prerequisites

- ◆ Compax3 with up-to-date controller board (CTP 17)
- ◆ Firmware version R06-0 installed

Installation

- ◆ Execution of the C3 ServoManager Setup (on CD)
- ◆ If the firmware is too old => update with the aid of the firmware from the CD

Activation

In order to being able to use the analysis functions in the frequency range (for example frequency response measurement), a software activation is required.

Please observe:

The activation is only valid for the PC on which it was performed!

Caution! : If the PC disposes of network adapters which are removed at times (e.g. PCMCIA cards or notebook docking stations), these adapters should be removed before generating the key!

In order to activate the ServoSignalAnalyzer, please follow these steps:

- ◆ Start the Compax3 ServoManager.



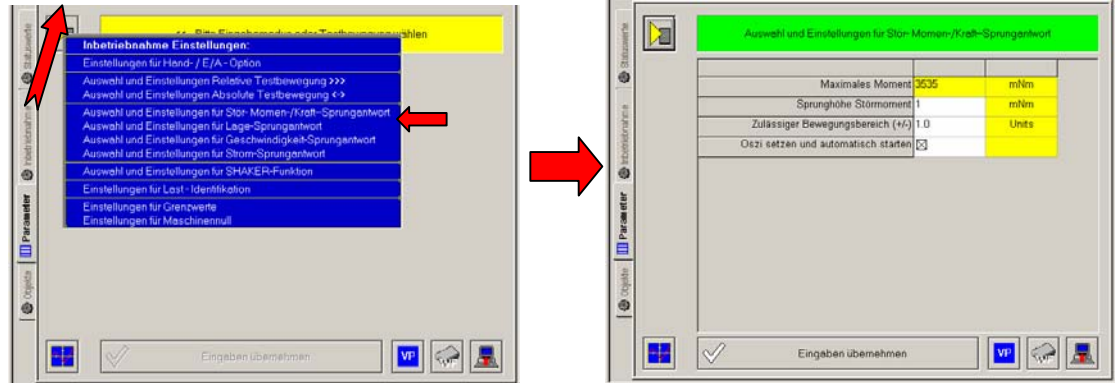
- ◆ Select the C3 ServoSignalAnalyzer in the function tree under optimization. In the right part of the window you can see the note that no key file was found.
- ◆ A double click on the preselected C3 ServoSignalAnalyzer will generate a system-dependent key.



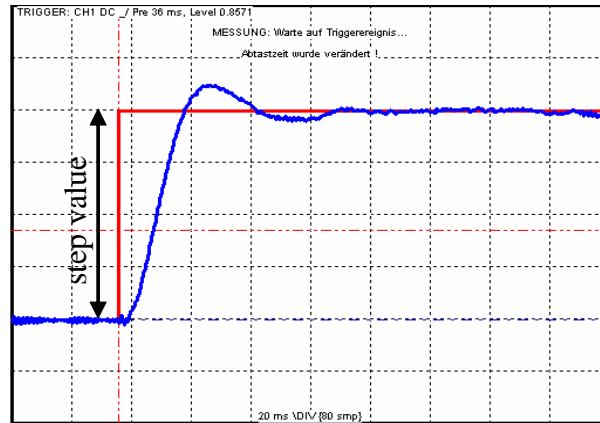
- ◆ Acknowledge with OK and enter the key, which is on your clipboard, into an e-mail, which you please send to **eme.ssalice@parker.com** (mailto:eme.ssalice@parker.com).
- ◆ After receipt of the reply, copy the attached file "C3_SSA.KEY" into the C3 ServoManager directory (C:\Programs\Parker\C3Mgr2\).
- ◆ => the software is activated.

4.3.9.4 Analyses in the time range

Selection and parameterization of the desired analysis function



Exemplary step function



The following functions are available:

Position demand value step: For analysis of the demand value behavior of the position control

Step value < (admissible motion range / 2)

=> even a 100% overshoot does not incite an error message

Speed demand value step: For analysis of the demand value behavior of the speed control

The position control is switched off during the measurement, this might lead in exceptional cases to a slow drift of the position. Furthermore you should make sure that the selected speed step value corresponds to the parameterized admissible motion range.

Step value < (admissible motion range / time of measurement)

with time of measurement > 2s

Current demand value step: For analysis of the demand value behavior of the current control

The current setpoint jerk is set at the end of the oscilloscope recording time, but is reset to 0 after max. 50mS.



Caution!

- ◆ Many systems are not stable without control!
- ◆ Position as well as speed control are switched off during measurement ==>
no measurement on z-axes!

disturbance torque- / force step response: For analysis of the disturbance value behavior of the control

The step of an external disturbance force is simulated and the reaction of the controller is registered.

Shaker function

For this, a sine signal is injected to the current which is used to excite the mechanic system. This allows to analyze the oscillation behavior - what oscillates at which frequency.

Basic settings of the analysis functions:

Maximum torque / maximum current / maximum speed (display):

This is used as a lead for the selection of a suitable step value and indicates which maximum step value is possible.

Step value:

Gives the value of a step.

permissible motion range (+/-):

- ◆ Indicaton, in which position window the axis may move during the analysis.
- ◆ This range is not left even in the event of an error.

- ◆ If the drive approaches the limits of the motion range, the controller will decelerate so that the drive will come to a standstill within the permitted motion range. The maximum permitted velocity is used to calculate the deceleration ramp, therefore the drive stops even before reaching the range limits and reports an error.
- ◆ Please make sure that a sufficiently large movement is set for the measurement and that it will be reduced by a high maximum permitted velocity.
- ◆ The motion range monitoring is especially important during current step responses, as position as well as speed control are deactivated during the measurement.

Max permitted speed

When exceeding this value, an error is triggered, the controller decelerates and reports an error.

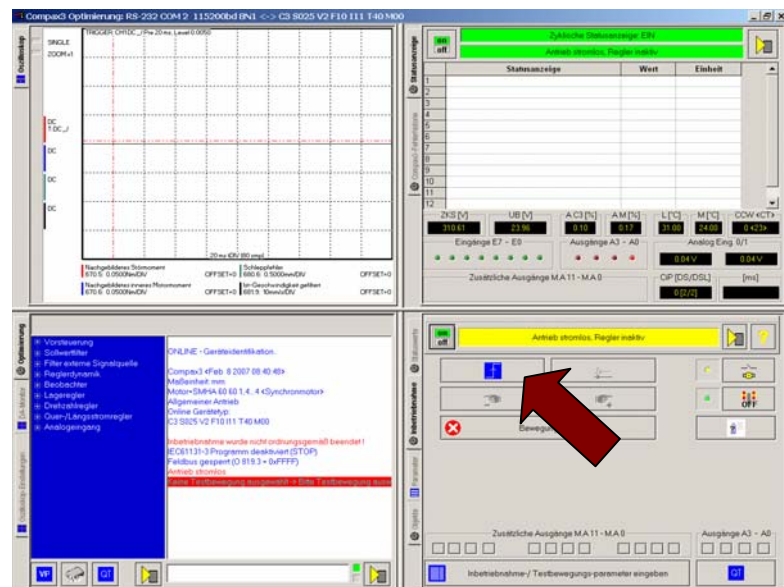
When measuring the velocity setpoint jerk, the maximum permitted velocity is set to twice the step height.

Setting and automatic start of the oscilloscope:

After pressing "accept entries", the parameters of the oscilloscope (such as scanning time and the assignment of the individual channels) are automatically set to default values according to the respective step value.

When starting the step function, the oscilloscope is automatically started.

Start of the measurement



The start of the step function is made with the aid of the highlighted button.

4.3.9.5 Measurement of frequency spectra

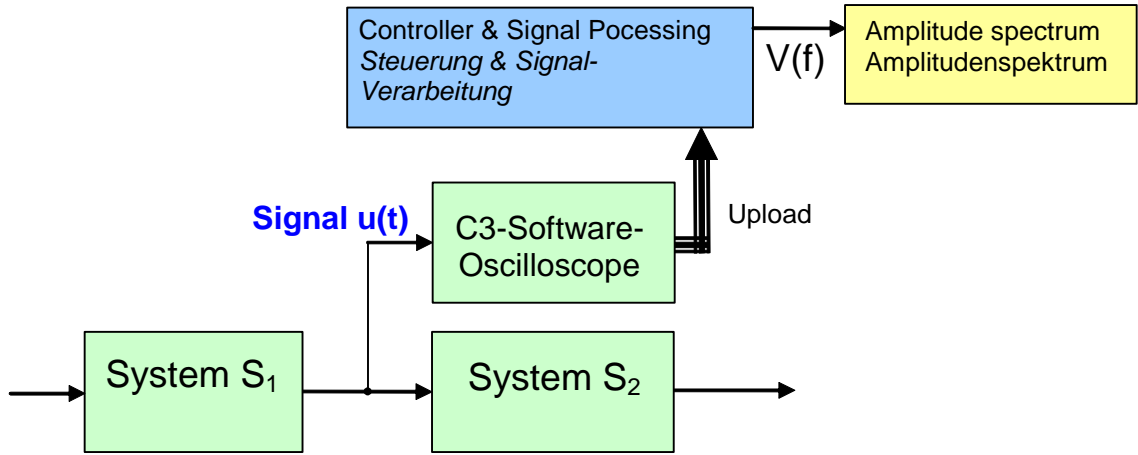
In this chapter you can read about:

Functionality of the measurement.....238
 Leak effect and windowing239

Please note that you require a licence key (see page 233, see page 231) for this application!

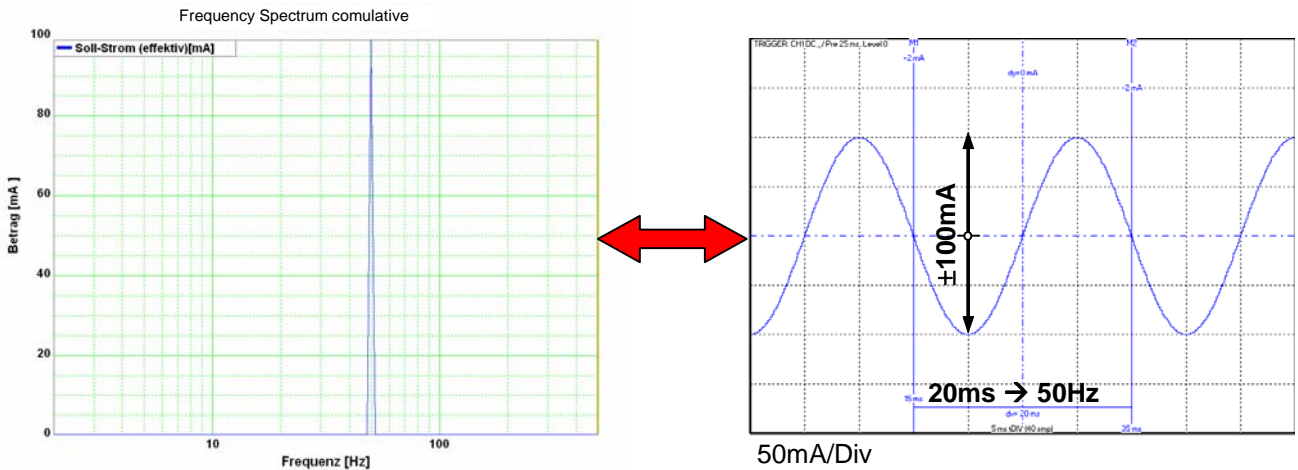
Functionality of the measurement

Measurement of the spectral analysis



During the spectral analysis of scanned signals with the aid of the discrete Fourier transformation, a so-called frequency resolution (Δf) results, Δf being $=fA/N$, independently of the scanning frequency (fA) and of the number of measurement values used (N).
 The spectra of scanned signals are only defined for frequencies, which are an integer multiple of this frequency resolution.

Interpretation of the frequency spectrum

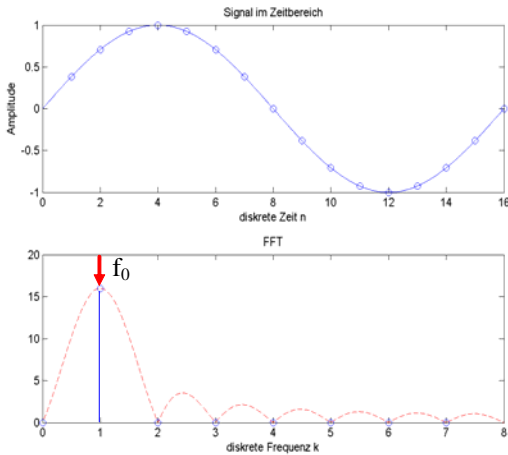


Leak effect and windowing

If frequencies not corresponding to the frequency resolution are present in the analyzed spectrum, the so-called leak effect can be caused.

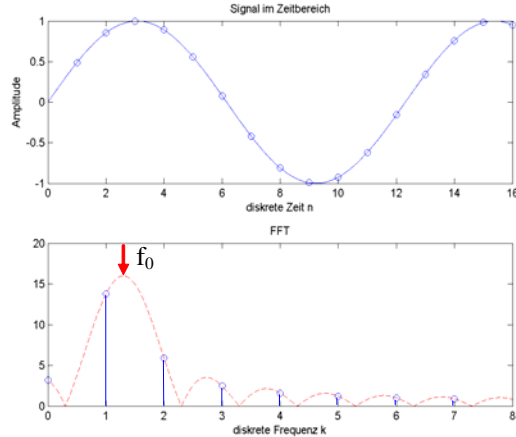
Display of the leak effect with the aid of a 16 point discrete Fourier transformation

Complete oscillation period in the scanning period



Envelope without leak effect

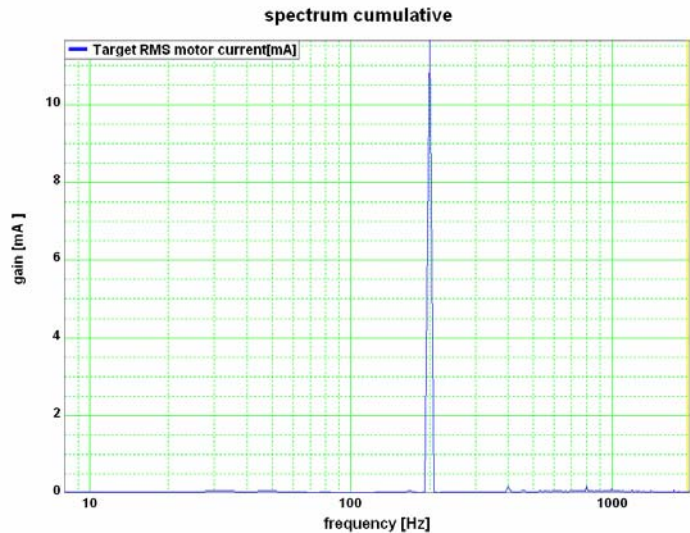
Non complete oscillation period in the scanning period



Envelope with leak effect

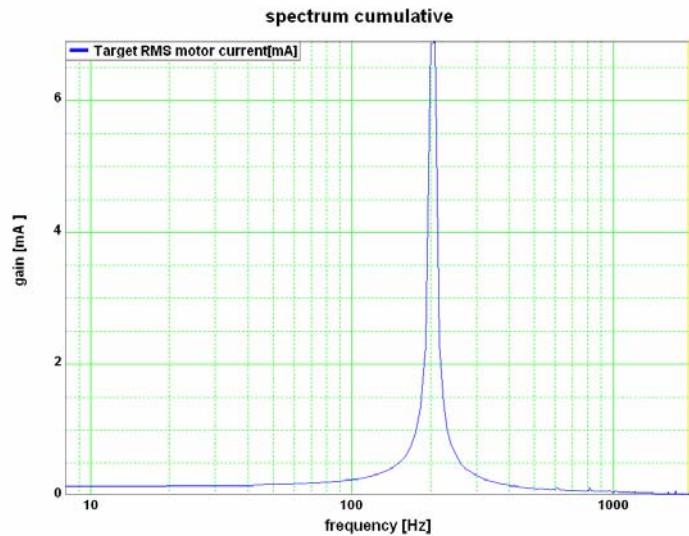
Sine at 200Hz without windowing

Consequence of the leak effect shown at the example of a sine signal.
 (f_A=4000Hz; N=500; => Δf=8Hz
 f₀=200Hz = 25*Δf frequency corresponds to the frequency-resolution



The sine frequency is exactly on a multiple of the frequency resolution (200Hz / 8Hz=25). The spectre is clearly separated and there are no leak effects visible.

Sine at 204Hz



$\Delta f=8\text{Hz} / f_0=204\text{Hz} = 25,5 \cdot \Delta f / \text{frequency}$ does not correspond to the frequency resolution!

The sine frequency has only minimally changed, due to which it does, however, no longer match the frequency resolution ($204\text{Hz}/8\text{Hz}=25,5$) => leak effect
Two consequences are visible:

The spectre is faded in the ranges at the right and at the left of the sine frequency. In this range, an amplitude is displayed, even though these frequencies are not contained in the real signal.

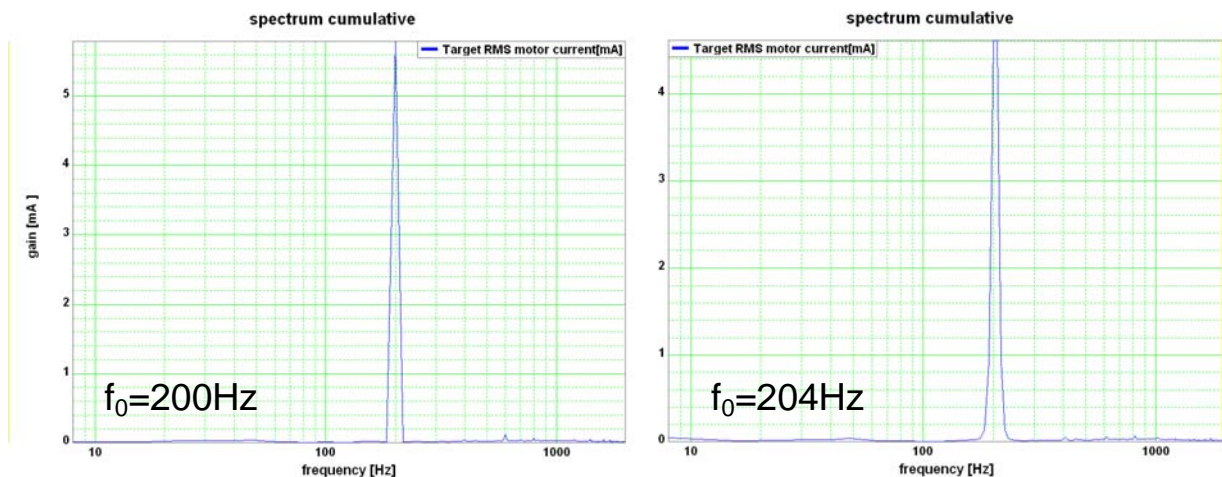
- ◆ The height of the peak of the sine frequency is reduced, => it seems as if the signal energy is leaking out and distributing over the spectre. This explains the term leak effect.

Windowing

With the aid of the windowing, leak effects can be avoided. There are many different kinds of windowing, who do all have the same restrictions.

- ◆ windowing reduces the total energy of the analyzed signal, which results in a reduced amplitude of all measured frequencies.
- ◆ Individual frequency peaks do not appear so sharp and narrow as with measurements without windowing.

Sine at 200Hz and 204Hz with Hanning windowing



4.3.9.6 Measurement of frequency responses

In this chapter you can read about:

Safety instructions concerning the frequency response measurement241
 Functionality of the measurement.....241
 Open/Closed Loop frequency response measurement243
 Excitation Signal244
 Non-linearities and their effects245

Please note that you require a licence key (see page 233, see page 231) for this application!

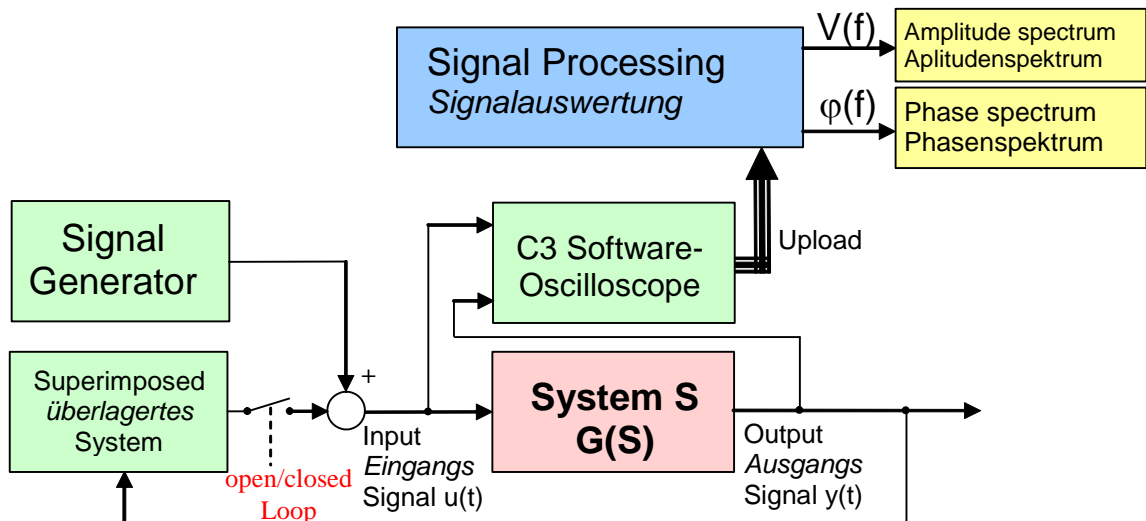
Safety instructions concerning the frequency response measurement

During the measurement of the frequency response, the control is changed and influenced in multiple ways. You should therefore respect the following notes:

- ◆ During the measurement, the entire system is excited via a broad frequency spectrum. This might damage especially sensitive components (such as lenses) The risk increases with the extent of the excitation. In addition, natural mechanical frequencies may cause an increased excitation of individual components.
- ◆ The measurement of the frequency response can only be made in the setup mode with energized controller.
- ◆ During the current measurement (between start and stop of the measurement), no write flash may be executed.
- ◆ In the event of a break in communication during the measurement, the controller must be switched off and then on again in order to reestablish the original status.
- ◆ Changes of the controller parameters during the measurement are not permitted. Those may be overwritten by standard values when the measurement is terminated.

Functionality of the measurement

Basic structure of a frequency response measurement



In general, the analysis of the dynamic behavior of a system is made by analyzing the input and output signals.

If you transform the input signal as well as the output signal of a system into the range (Fourier transformation) and then divide the output signal by the input signal, you get the complex frequency response of the system.

$$G(s) = \frac{Y(s)}{U(s)} \quad \text{with} \quad \begin{array}{l} y(t) \xrightarrow{F} Y(s) \\ u(t) \xrightarrow{F} U(s) \end{array}$$

A problem are, however, superimposed systems (the control)
Course of the measurement

- ◆ superimposed controls are switched of (open Loop) or attenuated
- ◆ The excitation signal is injected in front of the system to be measured with the aid of the signal generator. Wait, until the system settled.
- ◆ Execution of the measurement: Registration of input and output signal with the aid of the oscilloscope.
- ◆ Upload of the measurement values from the controller into the PC.
- ◆ Processing of the measurement values into a frequency response
- ◆ If a cumulated measurement is configured: Averaging over several frequency responses.

During cumulated measurement, an average is taken over all measurements in the result memory and the result is then put out.

Open/Closed Loop frequency response measurement

In order to be able to analyze the transmission behavior of subordinate systems (such as for example speed control, current control or mechanical system), the influence of the superposed controls on the measurement must be avoided.

Influence of a superposed system on the frequency response measured

In the simplest case, the superposed controls are switched off completely (Open Loop) This provides the best measurement results due to the elimination of any influence caused by the superposed controls.

This is, however, rarely possible for reasons of safety or feasibility.



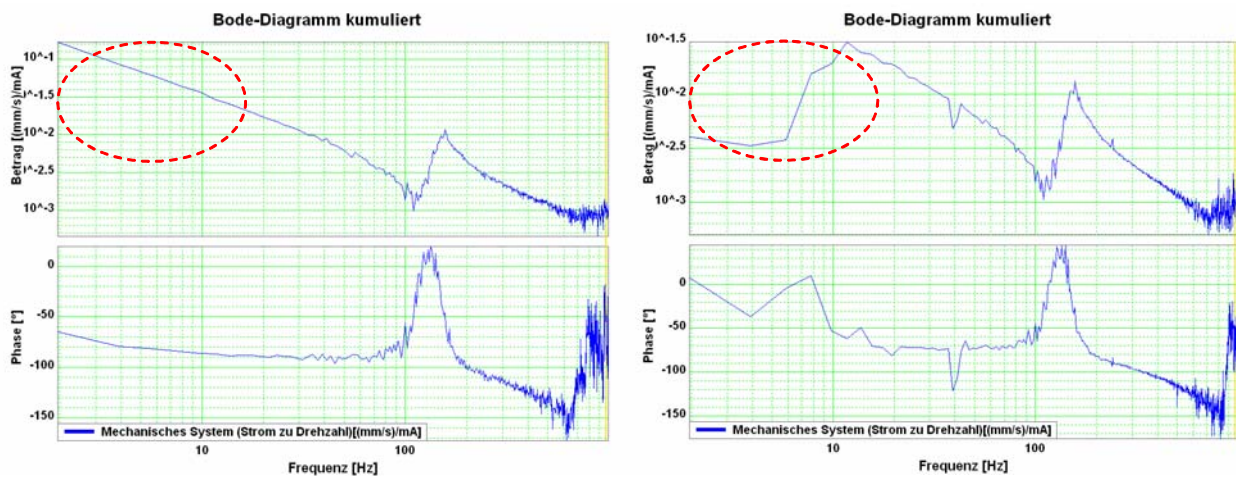
Caution!

- ◆ Many systems are not stable without control!
- ◆ Position as well as speed control are switched off during measurement ==> **no measurement on z-axes!**

If you want to analyze for example the mechanic system of a z-axis, the position control as well as the speed control must remain active.

In systems subject to friction it may be necessary in order to improve the quality of the measurement, to **move the system with a superimposed speed** (see page 246), which is however only possible with a closed loop measurement.

Influence of an active superposed control on the result of the measurement



At the left without, at the right with the influence of the superposed control

In order to attenuate the influence of the superposed controls, the controller bandwidth is reduced to such an extent, that their influence on the measurement is negligible.

Excitation Signal

In order to be able to analyze the behavior of the system at individual frequencies, it is necessary that these frequencies can be measured in the input signal as well as in the output signal. For this, a signal generator excites all frequencies to be measured. For this applies, that the signal noise distance of the measurement is the larger, the larger the excitation of the system.

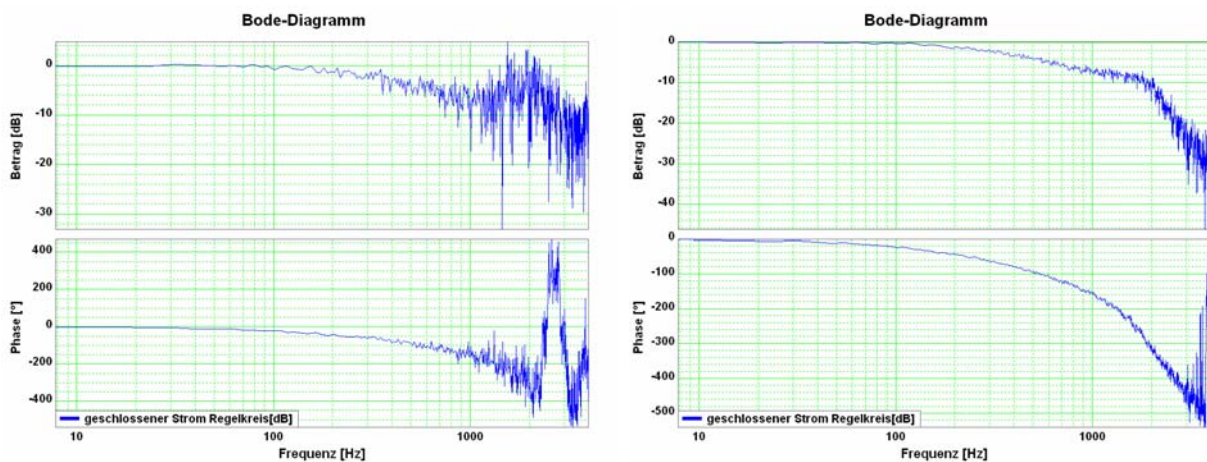
High noise distance => low influence of disturbances on the measurement.

For this, an excitation signal is injected in front of the system to be measured.

The power (amplitude) of the excitation signal can be set.

Start with a small amplitude and increase the amplitude slowly during the current measurement until the result of the measurement shows the desired quality.

Influence of the excitation amplitude on the quality of the measurement results



left: too small amplitude of the excitation signal (7.3mA)

right: suitable amplitude of the excitation signal (73mA)

In the case of non-linearities in the system, an increase in the excitation may however lead to a **decline of the quality of the measurement** (see page 245)

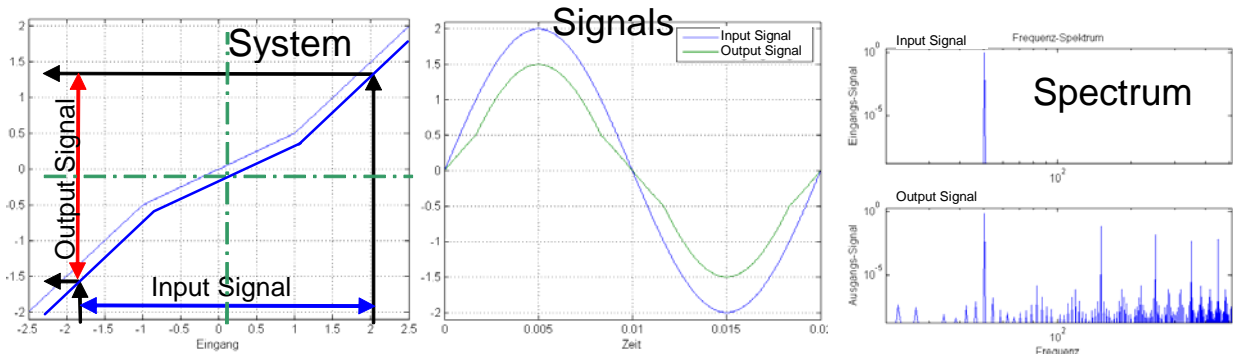
Non-linearities and their effects

In this chapter you can read about:

- Attenuation of the excitation amplitude.....245
- Shifting the working point into a linear range.....246

Non-linearities in mechanical systems are for example due to friction, backlash or position-dependent transmissions (cams and crankshaft drives). In general, the frequency response is only defined for linear systems (see **Linear Systems 7.2** (see page 261)). What happens in the frequency range in the event of a non-linear system, is shown below.

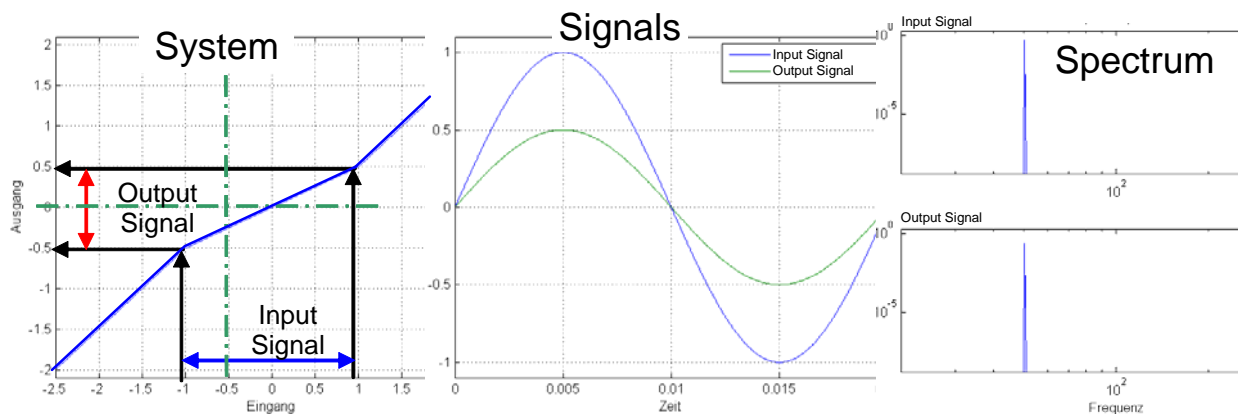
Signal amplitude too high => non-linearity in the signal range



Due to the non-linear transmission behavior of the system, many "new" frequencies were generated in the output signal. In the frequency response, only one change of the frequency present in the input signal can be displayed meaningfully.
=> The frequencies generated in the spectre of the output signal lead to a deterioration of the measured frequency response.
There are however two possibilities to make successful measurements of frequency responses in spite of non-linearities present:

Attenuation of the excitation amplitude

Signal amplitude too small => no non-linearity in the signal range



The signal range is reduced so that approximately linear conditions are valid. The results of the measurement will then display the dynamic behavior at the working point.

Example cam drive:

If the drive moves considerably (e.g. 180°) during the measurement, the behavior of the system will change greatly over this range => caused by non-linearities in the signal range.

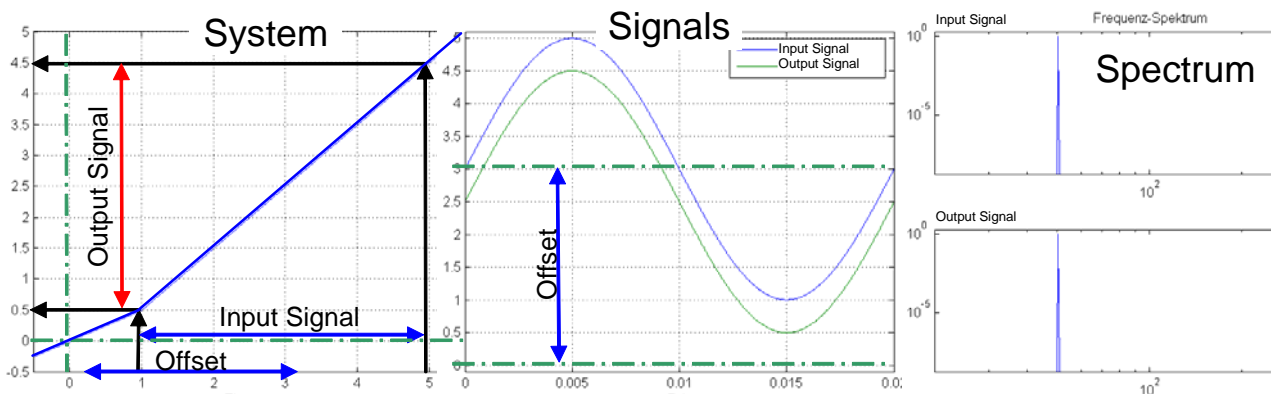
An inexact measurement is the result.

If the excitation is reduced so that the drive will move only by a few degrees, the behavior of the system at this working point will be approximately constant.

An exact measurement is the result.

Shifting the working point into a linear range

Signal amplitude large with offset => no non-linearity in the signal range



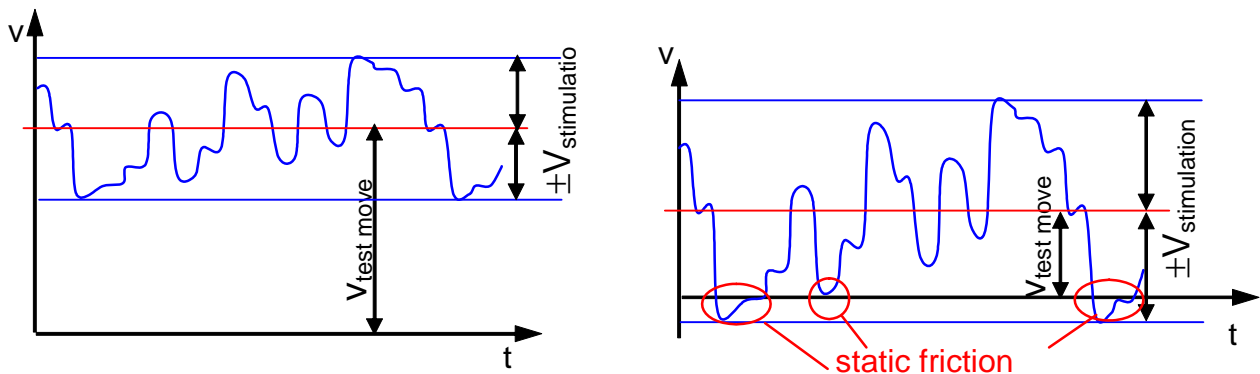
For this, the signal range is shifted so that approximately linear conditions are valid => the results of the measurement show the dynamic behavior at the working point.

Example rubbing caused by friction:

In systems subject to a distinct transition between rubbing caused by friction and sliding friction, the rubbing force will reduce abruptly as soon as the drive is moved ($v > 0$). With a motor at standstill, the excitation signal will cause a multiple passing through the range of rubbing friction during measurement. Due to the non-linearity in the signal range, the resulting measurement will be inexact.

If the drive moves, however, fast enough during the measurement, so that the speed will not become zero during the measurement, the system remains in sliding friction and a precise measurement can be obtained.

Optimal measurement with rubbing friction



$V_{test\ move}$: Speed of the test movement
 $V_{stimulation}$: Speed of the excitation signal

Example backlash: (for example in gearboxes)

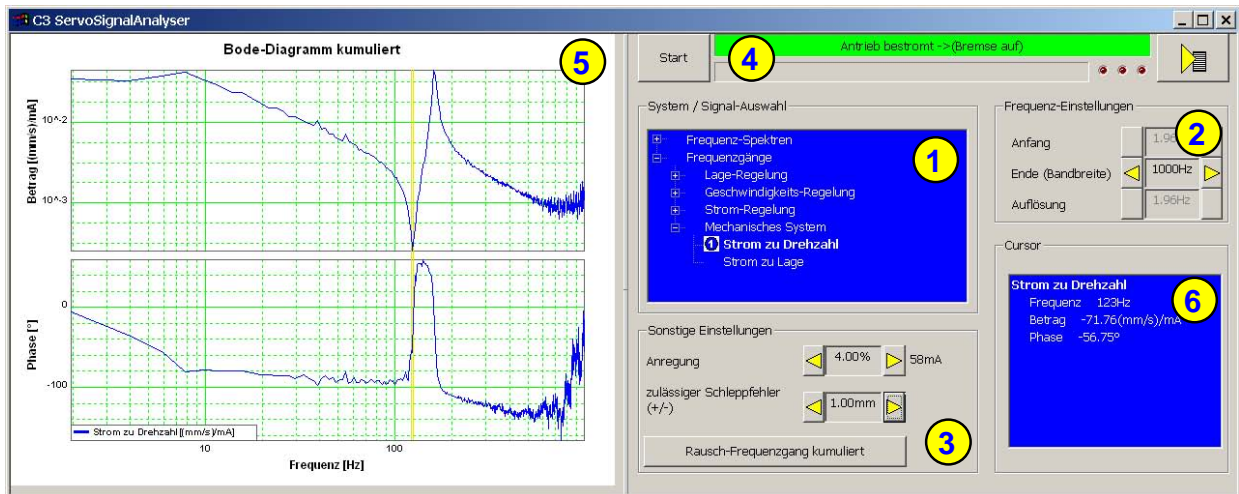
Here, non-linearities are caused, if the tooth edges will turn from one side to the other during measurement. The reason for this is a change of the sign of the force transmitted by the gearbox.

In order to avoid this, you can try to transmit a constant torque by keeping a constant speed and to avoid a change of the sign during the measurement by choosing a relatively small excitation amplitude.

4.3.9.7 Overview of the user interface

In this chapter you can read about:

Selection of the signal or system to be measured.....	248
Frequency settings	252
velocity control	252
Other settings	254
Operating and status field.....	256
Display of the measurement result	258
Display of the measurement point at the cursor position.....	259



- (1) Selection of the signal or system to be measured (see page 248)
- (2) Frequency settings (see page 252)
- (3) Other settings (see page 254)
- (4) Operating and status field (see page 256)
- (5) Display of the measurement result (see page 258)
- (6) Display of the measurement point at the cursor position (see page 259)

Selection of the signal or system to be measured.

In this chapter you can read about:

Position control	249
Current control	250
Mechanical system	251

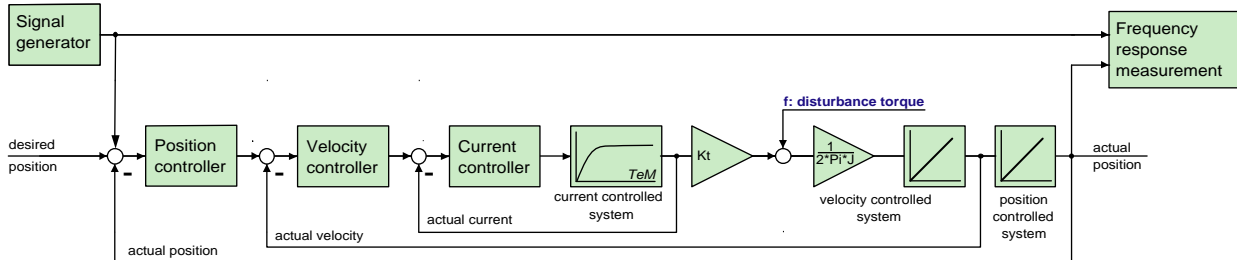
With the aid of the tree structure, you may select what you want to measure. Here, the selection is made, if a frequency spectrum or a frequency response is to be measured.

The shown structures are simplified in such as all feedbacks are displayed without special transmission behavior. This is surely not the case in reality, serves however a better overview.

Position control

Closed position control

Shows the dynamic behavior of the closed position control.
 => How a signal on the position demand value is transmitted to the position actual value.



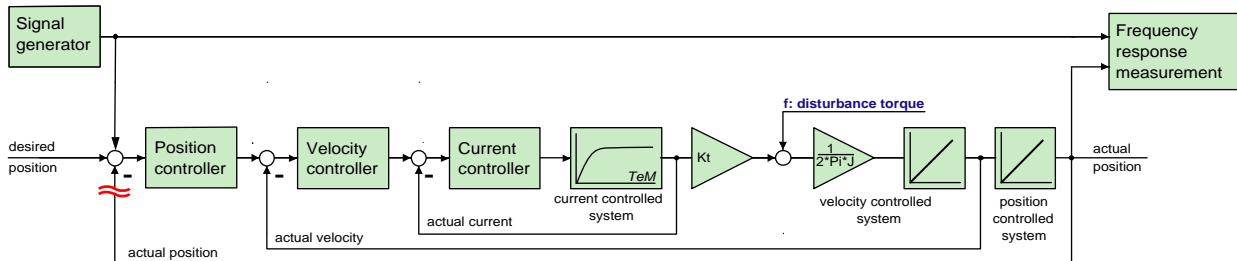
Application:

for the design of superposed controllers or systems.

- ◆ For the verification of the obtained controller speed during optimization
- ◆ for the revision of the controller design of the position control

open position control

Shows the dynamic behavior of all components in the position control loop, but without closing it.

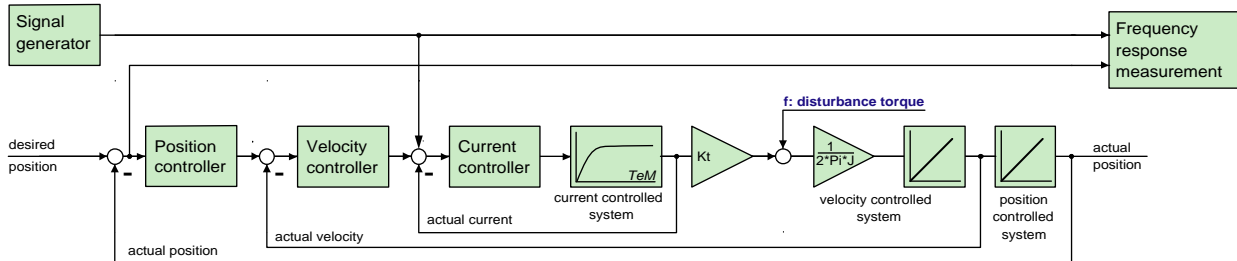


Application:

- ◆ For the graphic design of the position control.

Compliance of Position control

Shows the dynamic disturbance value behavior of the position control.
 => which dynamic influence does a disturbance torque have on the following error.
 The disturbance torque is injected as disturbance current => this corresponds to the effect of a disturbance torque f



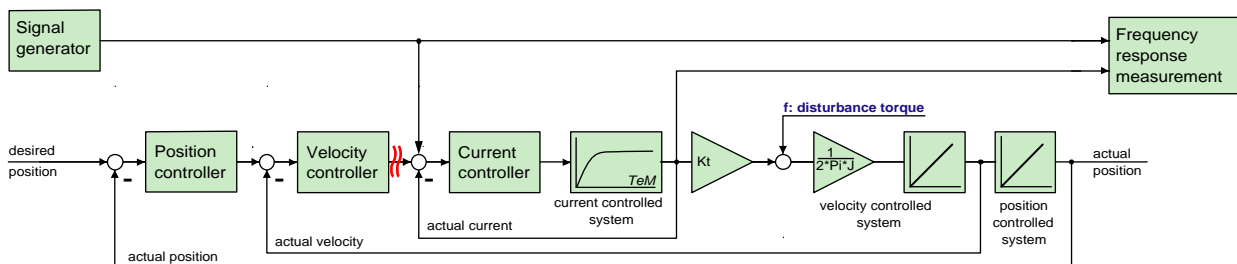
USE:

- ◆ Verification of the dynamic disturbance value behavior of the position control.
- ◆ Which following error generates a sinusoidal disturbance torque / disturbance current with the frequency f ?
- ◆ The frequency response of the compliance corresponds to the disturbance step response in the time range

Current control

Closed current control

Shows the dynamic behavior of the closed current control.
 => How a signal on the current demand value is transmitted to the current actual value.
 (response)



Application:

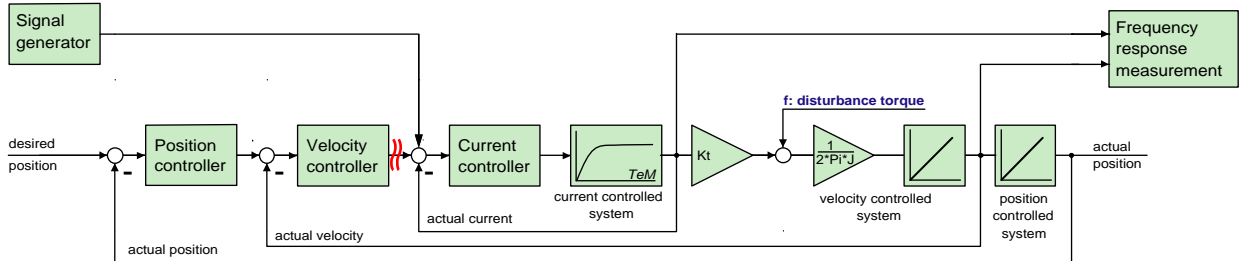
During the optimization of the current control for verification

- ◆ for the design of superposed controllers.

Mechanical system

Current to velocity

Shows the dynamic behavior between the measured current actual value and the velocity actual value



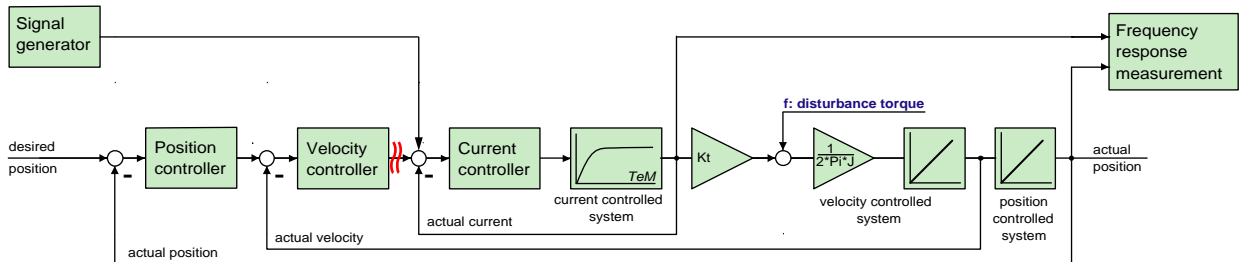
Reflects the transmission behavior between the acceleration at the motor and the acceleration at the load to be moved.

Application:

- ◆ for the analysis of the dynamic behavior of the mechanic system

Current to position

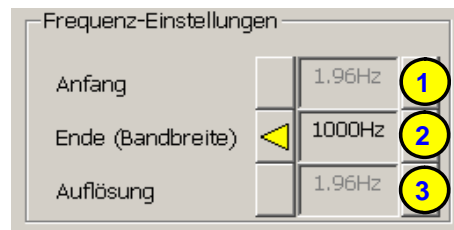
Shows the dynamic behavior between current actual value and position actual value.



use:

- ◆ for the analysis of the dynamic behavior of the mechanic system

Frequency settings



(1) start frequency

- ◆ This is the smallest frequency at which is still measured. During the measurement of frequency spectrum and noise frequency response this results automatically from the bandwidth and is only displayed as an information.

(2) End (bandwidth)

- ◆ This corresponds to the highest frequency which is measured. Start frequency as well as the frequency resolution can be varied with the aid of the bandwidth for frequency spectrum and noise frequency response.

(3) Frequency resolution (see page 238)

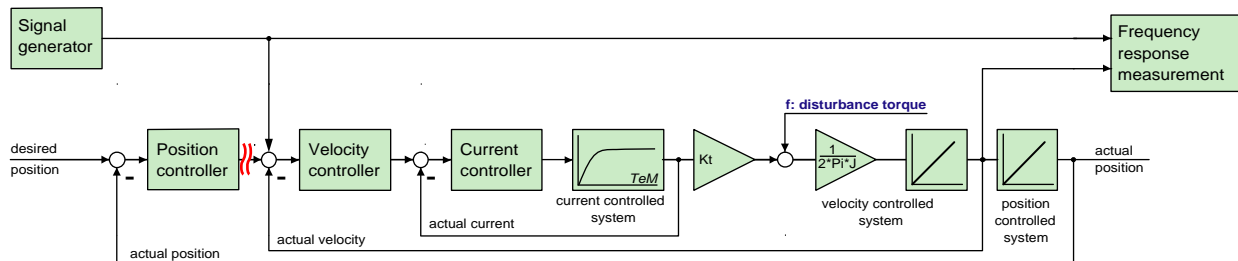
- ◆ During the measurement of frequency spectrum and noise frequency response this results automatically from the bandwidth and is only displayed as an information.

velocity control

Closed velocity control

Shows the dynamic behavior of the closed velocity control.

=> How a signal on the velocity demand value is transmitted to the velocity actual value.

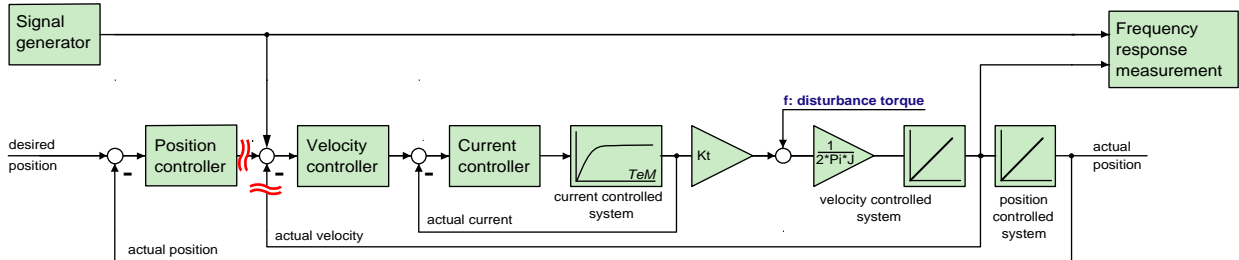


use:

- ◆ During the optimization of the velocity control for verification
- ◆ for the design of superposed controllers.

Open velocity control

Shows the dynamic behavior of all components in the velocity control loop, but without closing it.



use:

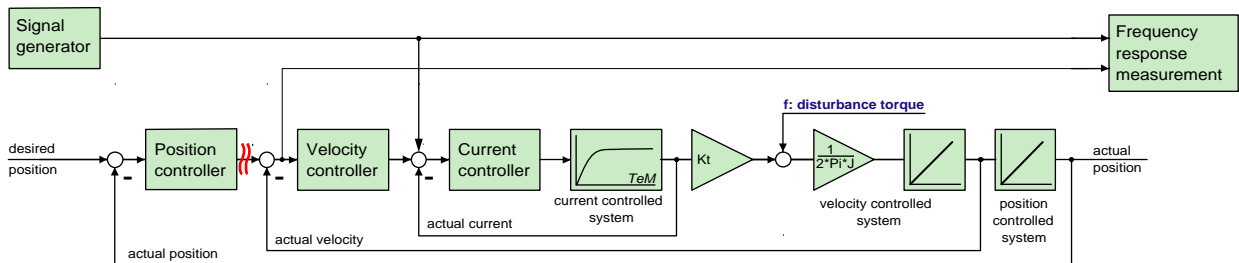
For the graphic design of the velocity control.

Compliance of velocity control

Shows the dynamic disturbance value behavior of the velocity control.

=> which dynamic influence does a disturbance torque have on the control deviation of the velocity control.

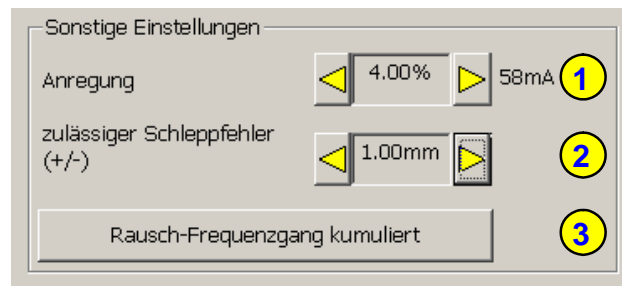
The disturbance torque is injected as disturbance current => this corresponds to the effect of a disturbance torque f



Application:

- ◆ Verification of the disturbance value behavior of the velocity control
- ◆ Which velocity deviation generates a sinusoidal disturbance torque / disturbance current with the frequency fZ ?
- ◆ The frequency response of the compliance corresponds to the disturbance step response in the time range

Other settings



(1) Excitation

Serves to set the excitation signal of the frequency response measurement.

(2) Permissible following error (only for frequency response measurement)

The resulting following error is increased by the injection of the excitation signal during the frequency response measurement. In order to allow for this, the permissible following error window can be enlarged so that the measurement can be made. After the end of the measurement, this is reset to the original value.

(3) Selection of the kind of analysis of the measurement results

Depending on the fact whether frequency spectra or frequency responses are measured, the following types of analyses are available:

For frequency spectra:

- ◆ (a) Spectrum
- ◆ (b) Spectrum cumulated
- ◆ (c) cascade diagram

For frequency responses:

- ◆ (d) noise frequency response
- ◆ (d) noise frequency response cumulated

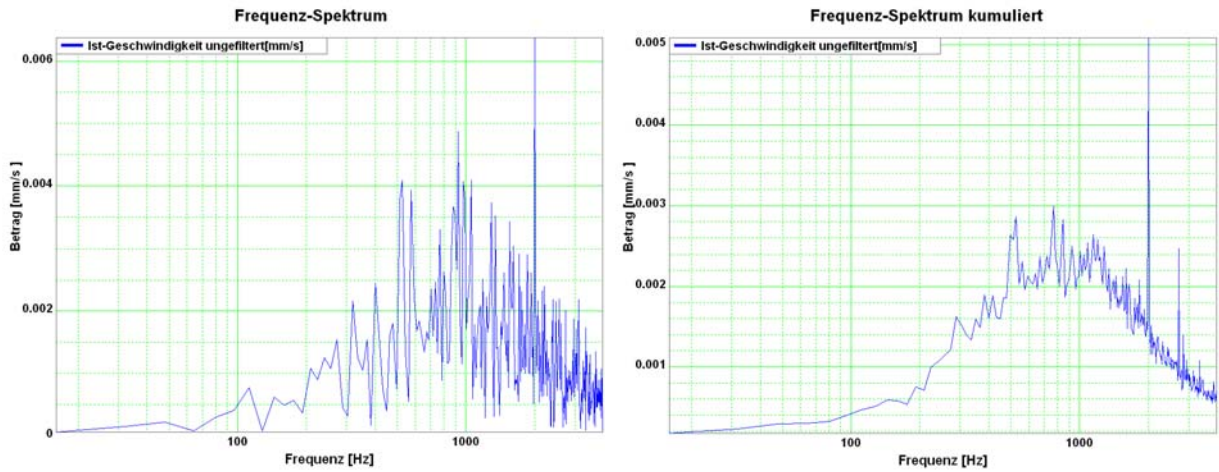
Non cumulated measurement (a & d)

The measured data are displayed directly. This is especially suitable if you wish to analyze the effects of changes on the measurement results directly and promptly. The disadvantage is however a smaller noise distance (quality) and an increased sensitiveness of the measurement towards unique disturbances.

Cumulated measurement (b & e)

An average is taken from all measurements in the result memory. This reduces the influence of random signals and disturbances extremely (improvement of the quality). The number of measurements from which the average is taken, is set with the **Size of the result memory** (see page 256).

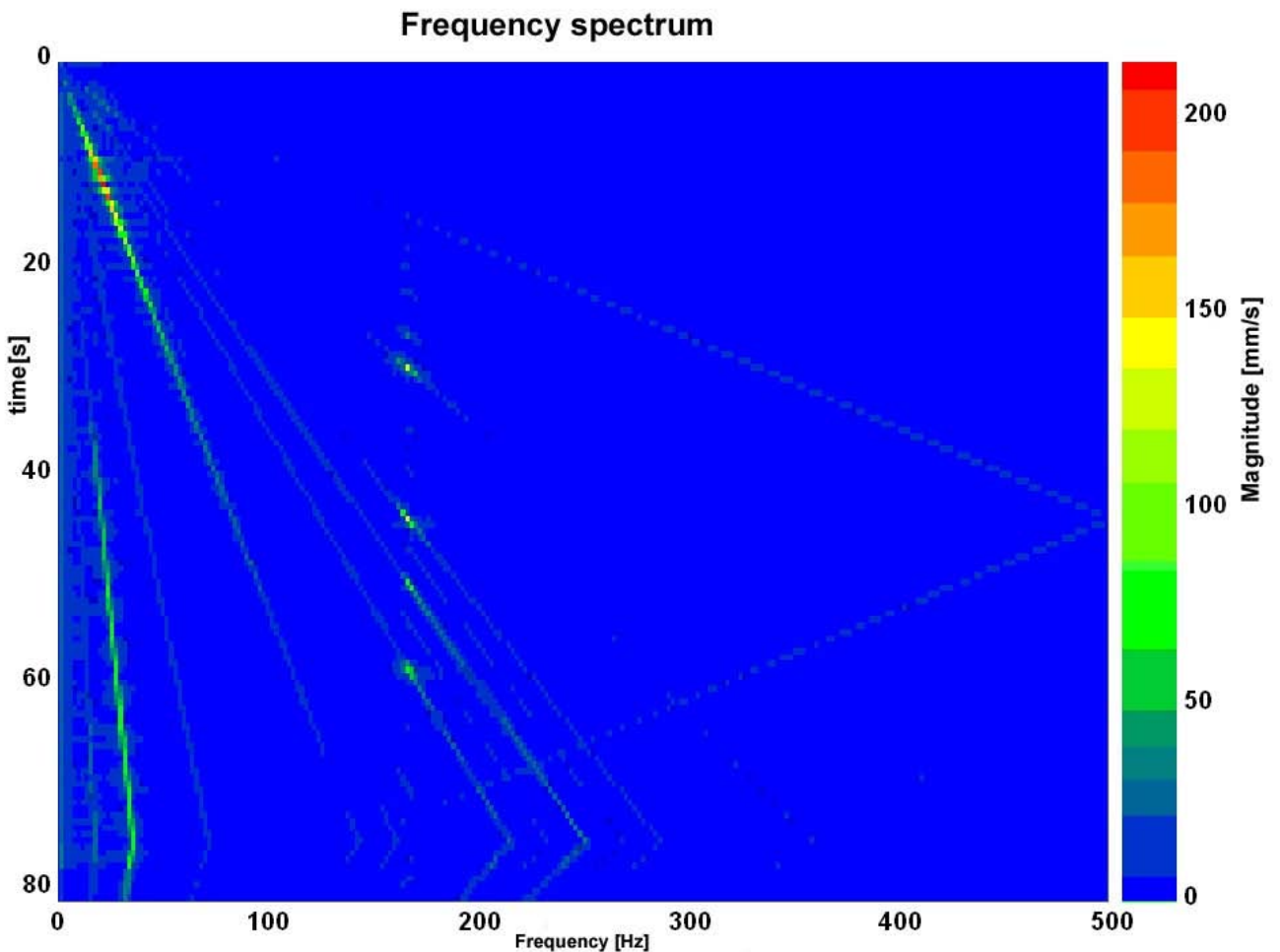
Comparison of two frequency spectra without and with cumulation



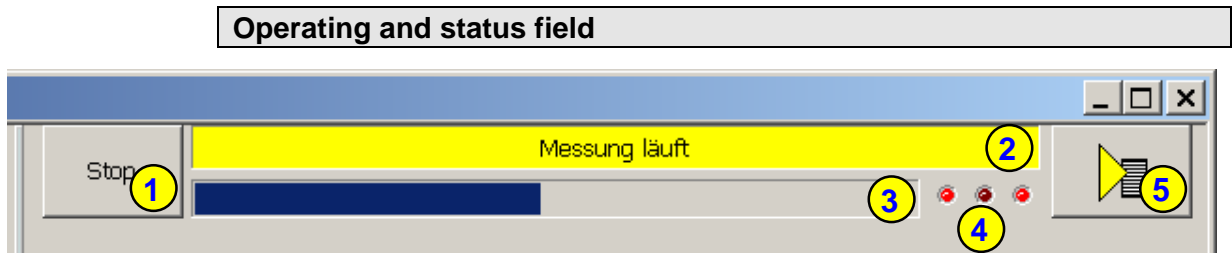
cascade diagram (c)

Frequency spectra are displayed subject to time. The information on the value of the signal is color-coded.

Cascade diagrams of the velocity signal during an acceleration process



This kind of display is suitable for the analysis of temporal changes in the measured spectrum.



(1) Start and Stop of the measurement

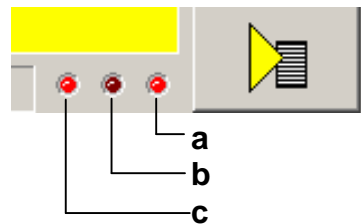
(2) Status display

Current status of the measurement or of the controller (if no measurement is taking place).

(3) Progress of the registration of the signals in the controller

The time of registration of the signals in the controller itself can, depending on the bandwidth and the kind of measurement, take up to one minute.

(4) status of the activity of the different partitions of the measurement



- a: Registration of the measurement in the controller
- b: Upload of the measurement from the controller to the PC
- c: Processing the measurement in the PC

(5) Different settings and options

Functions available in a pull-down menu:

Open superposed control loops (see page 243)

accept load force

This serves, when opening the velocity controller, to accept the load which the controller has provided at the time of switching off => a z-axis does not drop down abruptly.

Measurement synchronous to the test movement

if this option is selected, it is ensured during the measurement, that the sampling does not take place in the turning point during a movement. Unless frequencies are generated due to the deceleration/acceleration of the drive, which influence the measurement.

Result memory

In the result memory, the results of the N last measurements are kept. This is important for the display of the cumulated measurement and for the cascade diagram. The larger the memory, the "older" the results still used. When the contents is deleted, all old measurements are discarded and do no longer influence the new results.

Windowing (see page 239)

Here you can select different windowing modes for the measurement of frequency spectra. As default, no window is used.

Save measure to file

The currently displayed measurement result is stored and can be uploaded later into the ServoSignalAnalyzer. This does, however, not apply to the cascade diagram display.

Open measure from file

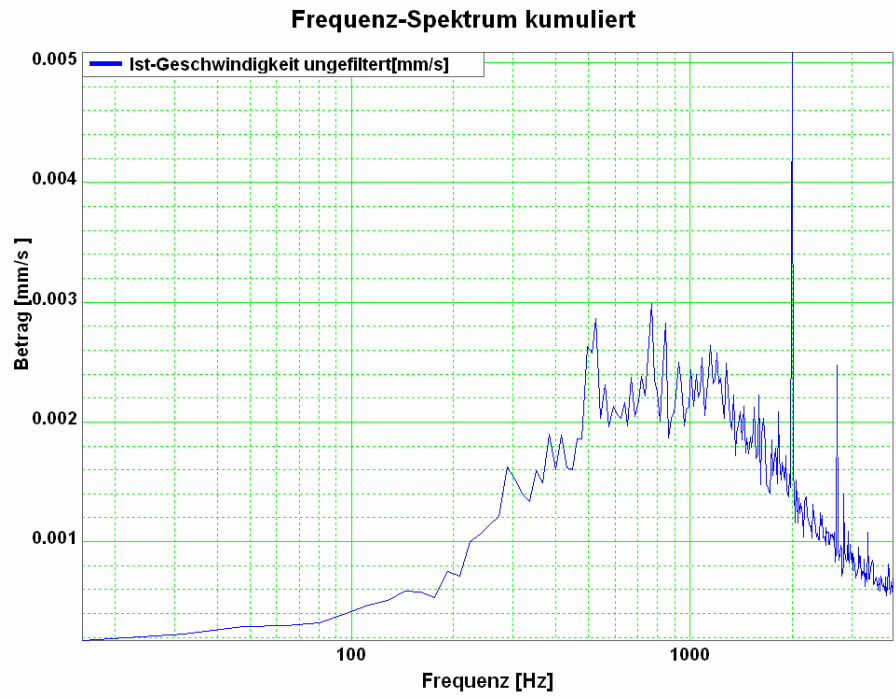
Here you can reload the measurements memorized before. You have the possibility to load up to four measurements subsequently and display them together in a graphic display.

Copy measurement to clipboard as graphic display.

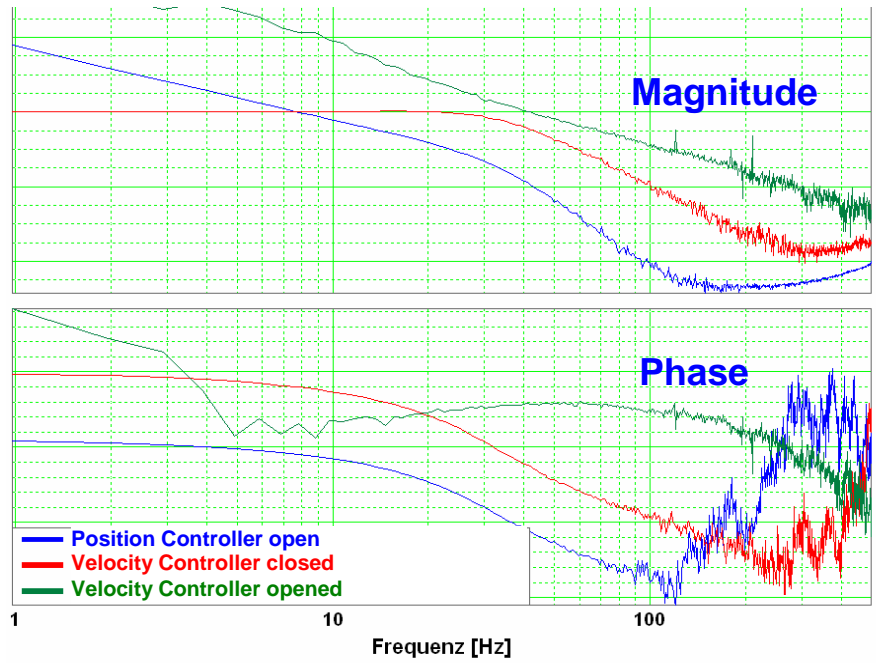
The currently displayed measurement result is copied as pixel graphic (e.g. BMP) to the clipboard.

Display of the measurement result

Frequency spectra

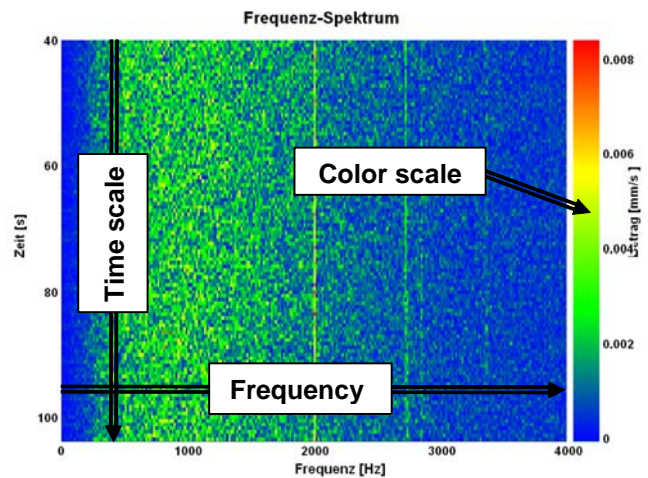


Bode diagrams: Value and phase



By clicking with the left mouse button on the legend, this can be shifted by 90°. By clicking on the color bar, the color of the respective graph can be modified.

Cascade diagrams



By clicking with the left mouse button on the color scale, you can change between autoscale mode and fixscale mode.

AutoScaleMode:

In this mode, the scaling of the color scale is adapted automatically so that all values can be displayed.

FixScaleMode:

Here, the scaling is fixed.

=> If, for instance, a considerably higher value than before is to be displayed, it is simply displayed like the former maximum (red).

Display of the measurement point at the cursor position

The cursor is set by clicking on the left mouse button. All measurement data of the selected cursor position (frequency) are displayed in the "cursor" operating field.

4.3.9.8 Basics of frequency response measurement

In this chapter you can read about:

Distinction between signals and systems	260
Linear Systems (LTI System)	261
Mechanical system	262
Resonance points and their causes.....	263

In the drive and control technology, the display of signals and systems in the frequency range is often the best possibility to solve different tasks.

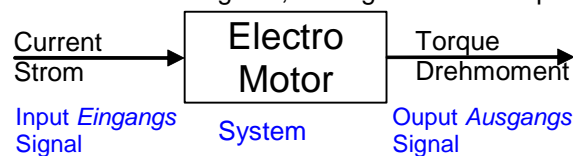
Distinction between signals and systems

Defined objects and their interactions that can be combined to a whole by a plausible distinction from their environment (i.e. the complex reality) are called a system.

Example electric motor

This consists of a multitude of different components, but the function and the behavior of a motor can be described as a whole without describing each individual component and their interactions separately.

If the motor is energized, it will generate a torque at the motor shaft.



Current is therefore a signal, which causes at the input of the system motor a change of its output signal torque.

In order to register and process such signals in the controller, they are digitized and read in with the so-called scanning frequency (f_A). Thus the physical signal was converted into a finite sequence of numbers, which can be processed in the controller.

Linear Systems (LTI System)

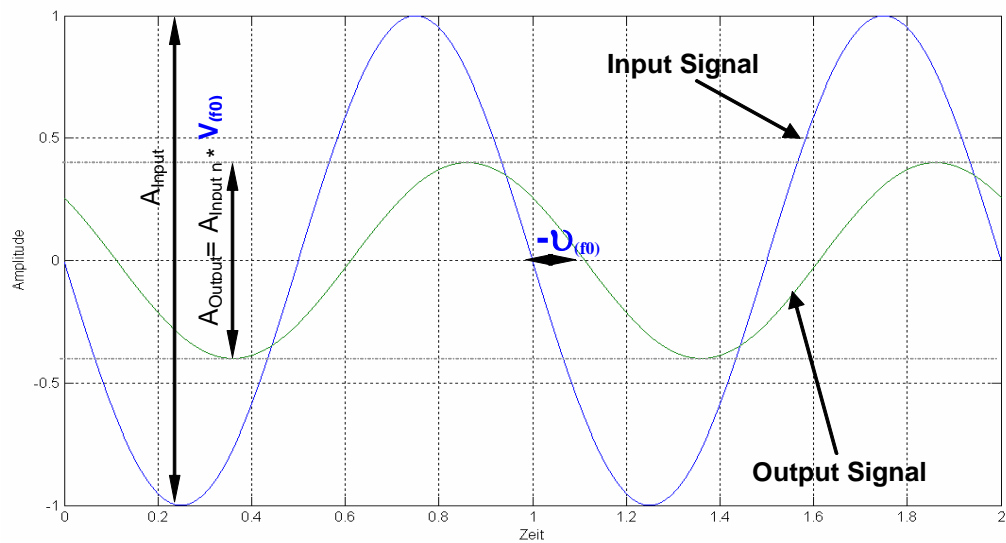
Further explanations are based on the concept of so-called linear systems. This means that doubling the input value means that the portion of the output value influenced by it is also doubled. this, for instance, is not the case in the event of influence due to limitations, friction and backlash.

=> those are called non-linear systems, which can not be analyzed with the methods described here (or only with difficulties).

One of the most important properties of linear systems is that a sine signal, which is put through a linear system, is still a sine signal at the output, which differs from the input signal only in value and phase.

When a signal passes a LTI system, no new frequencies are generated.

Input and output signals of a linear system

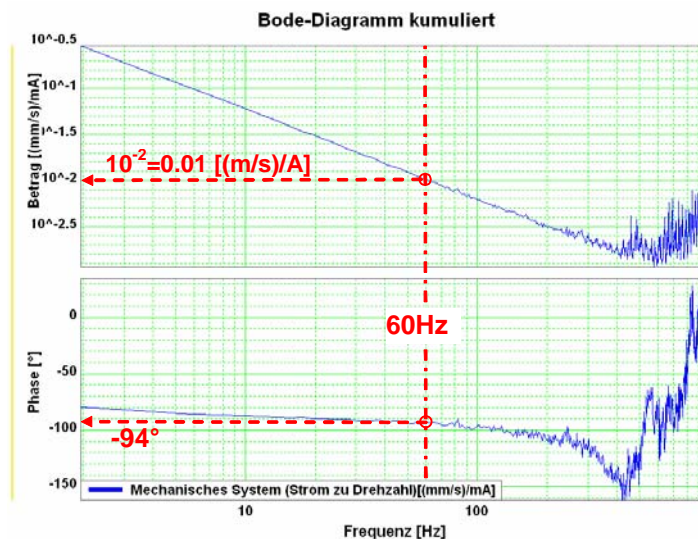


If you know the value ($V(f_0)$) as well as the phase position ($u(f_0)$) for all frequencies, the LTI system is completely defined.

Such a graph of value and phase position in dependence of the frequency, is called frequency response or bode diagram.

=> only LTI systems can be analyzed with the aid of frequency responses.

Frequency response / bode diagram

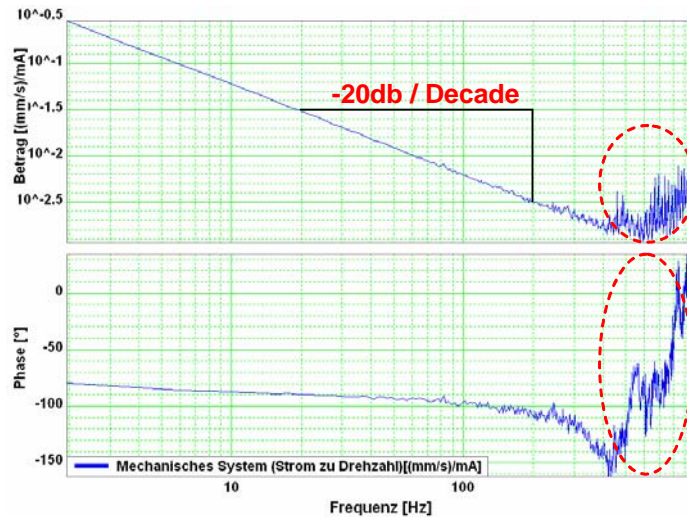


The frequency response shows the amplification (value) and the phase shift (phase), which a signal is submitted to when passing through a system.

The displayed bode diagram allows the following conclusions:
 If a sine with 60Hz and an amplitude of 1A is present at the input, a sine delayed by 94° and an amplitude of 0.01m/s will result at the output.

Mechanical system

Frequency response of a mechanic system: Current - velocity of a motor



The outlined course at the end of the measurement range does not permit statements on the system measured due to disturbances. Due to the attenuation of the signals increasing with the frequency, the sensitiveness of the measurement to disturbances (signal to noise ratio) increases with a rising frequency. The value as well as the phase response of the displayed frequency response are "disturbed" at the same intensity, this shows, that disturbances are the reason.

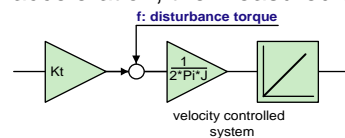
The value response consists basically of a straight, which declines with a slope of -20dB/decade (-20dB/decade => per tenfold increase of the frequency, the value decreases also by factor ten.)

the phase response remains however almost constantly at -90° over a relatively large range.

In control technology, this is called integrating behavior (I-behavior).

the I-behavior can be explained as follows.

The measured current is proportional to the motor force and thus also to the acceleration of the driven mass. As the velocity is calculated from the integrated acceleration, the measured system looks as follows:



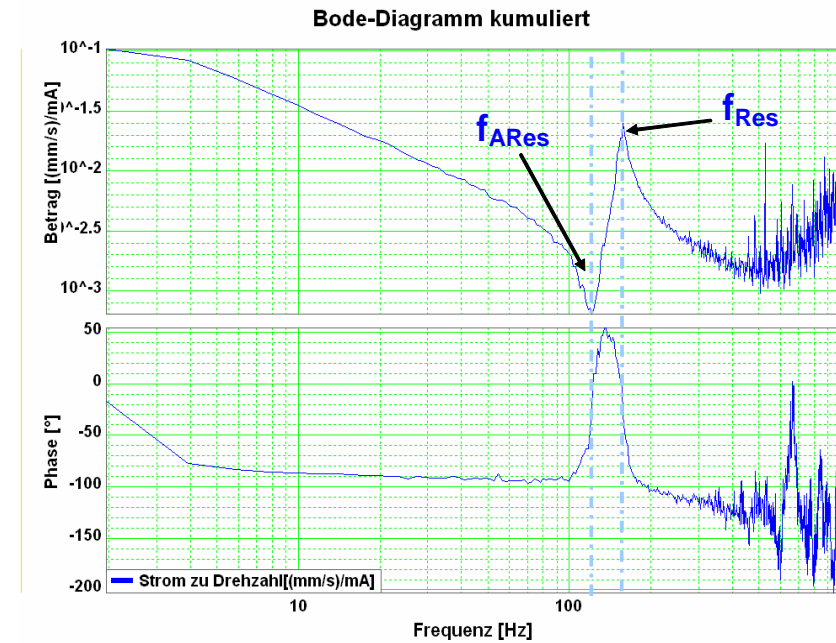
Input value is the current actual value, output value is the velocity actual value

Resonance points and their causes

In this chapter you can read about:

Rotary two mass system.....264
 Linear two mass system264
 Toothed belt drive as two mass system.....265

Mechanical system with a resonance point

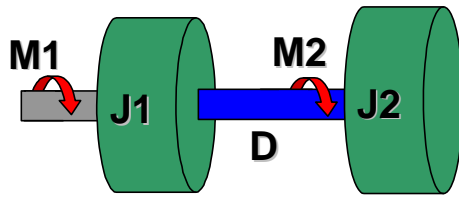


f_{ARes} : Anti resonance frequency
 f_{Res} : Resonance frequency

The displayed change of the frequency response (resonance point), has its cause in a so-called two mass system (caused by the elastic coupling of two masses).

Hint As, upon closer examination, each mechanic coupling shows a certain elasticity, it is no the question if there is a resonance point, but at which frequency it is and how well it is attenuated.

Rotary two mass system



The shown system corresponds for instance to a motor with a flywheel coupled via a shaft. Hereby J1 corresponds to the motor moment of inertia and J2 to the moment of inertia of the flywheel.

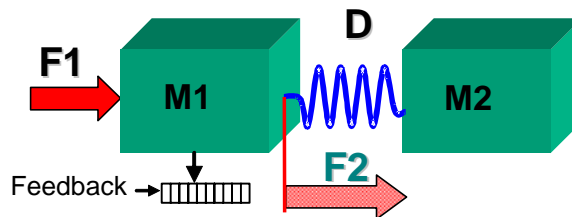
Calculation of the resonance frequencies in the rotary system with a hollow shaft as elastic coupling element

$$D = \int_{r_i}^{r_A} \frac{2 \cdot \pi \cdot G}{l} \cdot r^3 \cdot dr = \frac{G \cdot \pi \cdot (r_A^4 - r_i^4)}{2 \cdot l}$$

$$f_{ARes} = \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{D}{J_2}} \qquad f_{Res} = \frac{1}{2 \cdot \pi} \cdot \sqrt{D \cdot \left(\frac{1}{J_1} + \frac{1}{J_2} \right)}$$

G	Shear modulus of the material used [N/m ²] (e.g. approx. 80750N/mm ² for steel)
D	Torsional rigidity in [m/rad]
rA	Outer radius of the hollow shaft
ri	Inner radius of the hollow shaft
l	Length of the hollow shaft

Linear two mass system



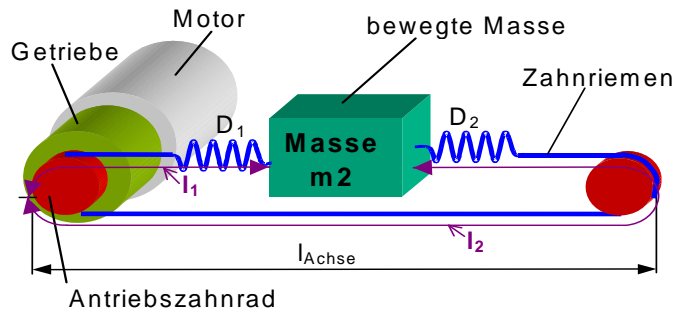
Resonance frequencies in the linear system

$$f_{ARes} = \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{D}{m_2}}$$

$$f_{Res} = \frac{1}{2 \cdot \pi} \cdot \sqrt{D \cdot \left(\frac{1}{m_1} + \frac{1}{m_2} \right)}$$

D	Rigidity in [N/m]
m1	e.g. motor mass
m2	e.g. load mass

Toothed belt drive as two mass system



In toothed belt drives, the toothed belt is the elastic coupling element. Its rigidity depends directly on the lengths l_1 and l_2 and changes in dependence of the position of the moved mass.

$$D_{spez} = \frac{F_{max}}{0,004}; \quad l_2 = 2 \cdot l_{Achse} - l_1$$

$$D_1 = \frac{D_{spez}}{l_1}; \quad D_2 = \frac{D_{spez}}{l_2}; \quad D = D_1 + D_2 = \frac{2 \cdot D_{spez}}{l_1 \cdot \left(2 - \frac{l_1}{l_{Achse}}\right)}$$

$$f_{ARes} = \frac{1}{2\pi} \cdot \sqrt{\frac{D}{m_2}} \quad f_{Res} = \frac{1}{2\pi} \cdot \sqrt{D \cdot \left(\frac{1}{m_2} + \frac{(r_{Zahnrad})^2}{J_1 \cdot (i_{Getriebe})^2}\right)}$$

D	Total spring constant of the toothed belt drive
Dspez	Specific spring constant of the toothed belt used
D1	Spring rate of the belt length l_1
D2	Spring rate of the belt length l_2
iGearbox	Transmission ratio of the gearbox
lAxis	Length of the axis
J1	Moment of inertia of motor and gearbox
m2	translatory moved mass
rToothed wheel	Radius of the drive pinion

4.3.9.9 Examples are available as a movie in the help file

Here you can find examples as a movie in the help file.

4.3.10. ProfileViewer for the optimization of the motion profile

In this chapter you can read about:

Mode 1: Time and maximum values are deduced from Compax3 input values	266
Mode 2: Compax3 input values are deduced from times and maximum values	267

You will find the ProfileViewer in the Compax3 ServoManager under the "Tools" Menu:



4.3.10.1 Mode 1: Time and maximum values are deduced from Compax3 input values

- ◆ The motion profile is calculated from Position, Speed, Acceleration, Deceleration, Acceleration Jerk and Deceleration Jerk
- ◆ As a result you will get, besides a graphical display, the following characteristic values of the profile:
 - ◆ Times for the acceleration, deceleration and constant phase
 - ◆ Maximum values for acceleration, deceleration and speed

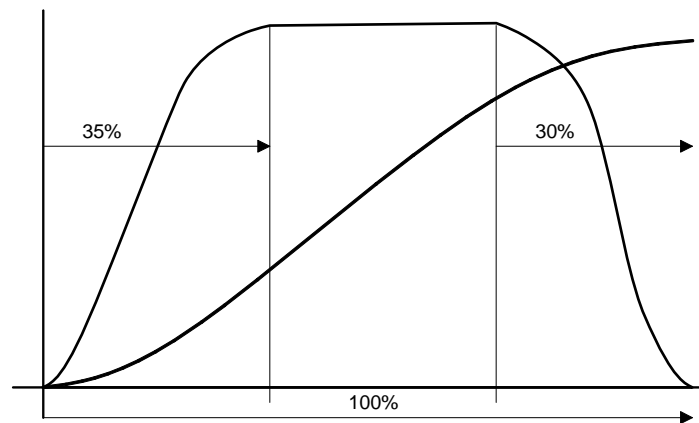
4.3.10.2 Mode 2: Compax3 input values are deduced from times and maximum values

- ◆ A jerk-limited motion profile is calculated from the positioning time and the maximum speed / acceleration
- ◆ As a result you will get, besides a graphical display, the following characteristic values of the profile:
 - ◆ the parameters Position, Speed, Acceleration, Deceleration, Acceleration Jerk and Deceleration Jerk
 - ◆ Times for the acceleration, deceleration and constant phase
 - ◆ Maximum values for acceleration, deceleration and speed

Set deceleration and acceleration phase

The profile can be defined more exactly by entering the segmentation into deceleration and acceleration phase.

When setting 50% and 50%, a symmetrical design will result, the values for triangular operation are calculated, which is limited by the maximum speed. The total of the percentage values may not exceed 100. The percentage entries refer to the total positioning time.

Example:

4.3.11. Turning the motor holding brake on and off

Compax3 controls the holding brake of the motor and the power output stage. The time behavior can be set.

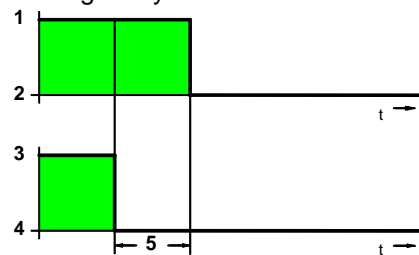
Application:

For an axis to which torque is applied in the stationary state (e.g. for a z-axis) the drive can be switched on and off in a manner such that no load movement takes place. The drive thereby remains energized during the holding brake response time. This is adjustable.

The power output stage current is de-energized by:

- ◆ Error or
- ◆ the control word
- ◆ the ServoManager

Thereafter the motor is braked to zero rotation speed on the set ramp. When zero speed is reached, the motor is de-energized with the delay "brake closing delay time".

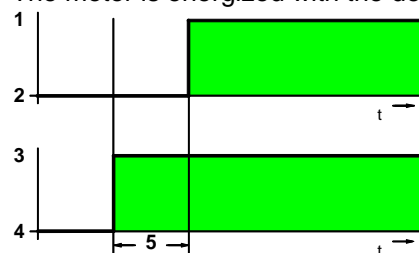


- 1: Motor powered
- 2: Motor de-energized
- 3: Brake open
- 4: Engage the brake
- 5: brake closing delay time

The power output stage is enabled by:

- ◆ Acknowledge (after error) with the control word
- ◆ the ServoManager

The motor is energized with the delay "delay time for brake release".



- 1: Motor powered
- 2: Motor de-energized
- 3: Brake open
- 4: Engage the brake
- 5: Delay time for brake release

5. Communication

In this chapter you can read about:

COM port protocol	270
Remote diagnosis via Modem	275
Ethernet Powerlink.....	279

Here you will find the description of the fieldbus interfaces, which can be configured in the Compax3 ServoManager under the tree entry "configuring the communication".

Please note: The configuration of the process data (Mapping) is made wizard-guided with the Compax3 ServoManager.
If you perform the mapping directly via the master, you must go through this fieldbus wizard once; the Compax3 ServoManager will perform the necessary initializations.

5.1 COM port protocol

In this chapter you can read about:

RS485 setting values270
 ASCII - record270
 Binary record271

You can communicate with Compax3 in order to read or write objects via plug X10 (or X3 on the mains module of Compax3M) on the front via a COM port (max. 32 nodes).

As a rule 2 records are possible:

- ◆ ASCII record simple communication with Compax3
- ◆ Binary record: fast and secure communication with Compax3 by the aid of block securing.

Switching between the ASCII and the binary record via automatic record detection.

interface settings (see page 379)

- Wiring** RS232: **SSK1** (see page 356)
 RS485: like **SSK27** (see page 357) / RS485 is activated by +5V on X10/1.
 USB: SSK33/03 (only for Compax3M)

5.1.1. RS485 setting values

If "Master=Pop" was selected, only the settings compatible with the Pops (Parker Operator Panels) made by Parker are possible.

Please note that the connected Pop has the same RS485 setting values.

You can test this with the "PopDesigner" software.

"Master=General" makes all Compax3 settings possible.

- Multicast Address** You can use this address to allow the master to access multiple devices simultaneously.
- Device Address** The device address of the connected Compax3 can be set here.
- Baud rate** Adjust the transfer speed (baud rate) to the master.
- Connection Type** Please choose between **two-wire and four-wire RS485** (see page 55).
- Protocol** Adjust the protocol settings to the settings of your master.

5.1.2. ASCII - record

The general layout of a command string for Compax3 is as follows:

[Adr] command CR

Adr	RS232: no address RS485: Compax3 address in the range 0 ... 99 Address settings can be made in the C3 ServoManager under "RS485 settings"
Command	valid Compax3 command
CR	End sign (carriage return)

Command A command consists of the representable ASCII characters (0x21 .. 0x7E). Lower cases are converted automatically into capitals and blanks (0x20) are deleted, if they are not placed between two quotation marks.
Separator between places before and after the decimal is the decimal point (0x2E). A numeric value can be given in the Hex-format if it is preceded by the "\$" sign. Values can be requested in the Hex-format if the CR is preceded additionally by the "\$" sign.

Answer strings All commands requesting a numeric value from Compax3 are acknowledged with the respective numeric value in the ASCII format followed by a CR without preceding command repetition and following statement of unit. The length of these answer strings differs depending on the value.
Commands requesting an Info-string (e.g. software version), are only acknowledged with the respective ASCII character sequence followed by a CR, without preceding command repetition. The length of these answer strings is here constant.
Commands transferring a value to Compax3 or triggering a function in Compax3 are acknowledged by:

>CR

if the value can be accepted resp. if the function can be executed at that point in time.

If this is not the case or if the command syntax was invalid, the command is acknowledged with

!xxxxCR

The 4 digit error number **xxxx** is given in the HEX format; you will find the meaning in the **appendix** (see page 312).

RS485 answer string When using RS485, each answer string is preceded by a "*" (ASCII - character: 0x2A).

Compax3 commands

Read object **RS232: O [\$] Index , [\$] Subindex [\$]**

RS485: Address O [\$] Index , [\$] Subindex [\$]

The optional "\$" after the subindex stands for "hex-output" which means that an object value can also be requested in hex;
e.g. "O \$0192,2\$": (Object 402.2)

Write object **RS232: O [\$] Index , [\$] Subindex = [\$] Value [; Value2 ; Value3 ; ...]**

RS485: Address O [\$] Index , [\$] Subindex = [\$] Value [; Value2 ; Value3 ; ...]

The optional "\$" preceding Index, Subindex and value stands for "Hex-input" which means that Index, Subindex and the value to be transferred can also be entered in hex (e.g. O \$0192,2=\$C8).

5.1.3. Binary record

The binary record with block securing is based on 5 different telegrams:

- ◆ 2 request telegrams which the control sends to Compax3 and
- ◆ 3 response telegrams which Compax3 returns to the control.

Telegram layout

Basic structure:

Start code	address	Number of data bytes - 1	Data			block securing	
SZ	A	L	D0	D1	...	Crc(Hi)	Crc(Lo)

The start code defines the frame type and is composed as follows:

Bit	7	6	5	4	3	2	1	0
Frame type	Frame identification				PLC		Gateway	address
RdObj Read object	1	0	1	0	x	1	x	x
WrObj Write object	1	1	0	0	x	1	x	x
Rsp Answer	0	0	0	0	0	1	0	1
Ack Positive command acknowledgement	0	0	0	0	0	1	1	0
Nak Negative command acknowledgement	0	0	0	0	0	1	1	1

Bits 7, 6, 5 and 4 of the start code form the telegram identification; Bit 2 is always "1".

Bits 3, 1 and 0 have different meanings for the request and response telegrams. The address is only necessary for RS484.

Request telegrams

-> Compax3

- ◆ the address bit (Bit 0 = 1) shows if the start code is followed by an address (only for RS485; for RS232 Bit 0 = 0)
- ◆ the gateway bit (Bit 1 = 1) shows if the message is to be passed on. (Please set Bit 1 = 0, as this function is not yet available)
- ◆ the PLC bit (Bit 3 = 1) allows access to objects in the PLC/Pop format
 U16, U32: for integer formats (see bus formats: Ix, Ux, V2)
 IEEE 32Bit Floating Point: for broken formats (bus formats: E2_6, C4_3, Y2, Y4; without scaling)
 With Bit 3 = 0 the objects are transmitted in the DSP format.
 DSP formats:
 24 Bit = 3 Bytes: Integer INT24 or Fractional FRACT24
 48 Bit = 6 Bytes: Real REAL48 (3 Byte Int, 3 Byte Fract) / Double Integer DINT48 / Double Fractional DFRACT48

Response telegram Compax3

- ◆ Bits 0 and 1 are used to identify the response
- ◆ Bit 3 is always 0

The maximum number of data bytes in the request telegram is 256, in the response telegram 253.

The block securing (CRC16) is made via the CCITT table algorithm for all characters.

After receiving the start code, the timeout monitoring is activated in order to avoid that Compax3 waits in vain for further codes (e.g. connection interrupted) The timeout period between 2 codes received is fixed to 5ms (5 times the code time at 9600Baud)

Write object – WrObj telegram

SZ	Adr	L	D0	D1	D2	D3 ... Dn	Crc(Hi)	Crc(Lo)
0xCX		n	Index(Hi)	Index(Lo)	Subindex	Value	0x..	0x..

Describing an object by a value.

Positive acknowledgement – Ack-telegram

SZ	L	D0	D1	Crc(Hi)	Crc(Lo)
0x06	1	0	0	0x..	0x..

Answer from Compax3 if a writing process was successful, i.e. the function could be executed and is completed in itself.

Negative acknowledgement – Nak - telegram

SZ	L	D0	D1	Crc(Hi)	Crc(Lo)
0x07	1	F-No.(Hi)	F-No.(Lo)	0x..	0x..

Answer from Compax3 if access to the object was denied (e.g. function cannot be executed at that point in time or object has no reading access). The error no. is coded according to the DriveCom profile resp. the CiA Device Profile DSP 402.

Read object – RdObj - telegram

SZ	Adr	L	D0	D1	D2	D3	D4	D5	...	Dn	Crc(Hi)	Crc(Lo)
0xAX		n	Index1(Hi)	Index1(Lo)	Subindex1	Index2(Hi)	Index2(L o)	Subindex2	...	...	0x..	0x..

Reading one or several objects

Answer – Rsp - telegram

SZ	L	D0 ... Dx-1	Dx ... Dy-1	Dy-D..	D ... D..	D ... Dn	Crc(Hi)	Crc(Lo)
0x05	n	Value1	Value 2	Value 3	Value ..	Value n	0x..	0x..

Answer from Compax3 if the object can be read.

If the object has no reading access, Compax3 answers with the Nak – telegram.

Example:**Reading object "StatusPositionActual" (o680.5):**

Request: A5 03 02 02 A8 05 E1 46

Response: 05 05 FF FF FF FF FE 2D 07 B4

Writing into an Array (o1901.1 = 2350)

Request: C5 02 08 07 6D 01 00 09 2E 00 00 00 95 D5

Response: 06 01 00 00 BA 87

Block securing: Checksum calculation for the CCITT table algorithm

The block securing for all codes is performed via the following function and the corresponding table:

The "CRC16" variable is set to "0" before sending a telegram.

Function call:

```
CRC16 = UpdateCRC16(CRC16, Character);
```

This function is called up for each Byte (Character) of the telegram.

The result forms the last two bytes of the telegram

Compax3 checks the CRC value on receipt and reports CRC error in the case of a deviation.

```
Function const unsigned int _P CRC16_table[256] = {
    0x0000, 0x1021, 0x2042, 0x3063, 0x4084, 0x50a5, 0x60c6, 0x70e7,
    0x8108, 0x9129, 0xa14a, 0xb16b, 0xc18c, 0xd1ad, 0xe1ce, 0xf1ef,
    0x1231, 0x0210, 0x3273, 0x2252, 0x52b5, 0x4294, 0x72f7, 0x62d6,
    0x9339, 0x8318, 0xb37b, 0xa35a, 0xd3bd, 0xc39c, 0xf3ff, 0xe3de,
    0x2462, 0x3443, 0x0420, 0x1401, 0x64e6, 0x74c7, 0x44a4, 0x5485,
    0xa56a, 0xb54b, 0x8528, 0x9509, 0xe5ee, 0xf5cf, 0xc5ac, 0xd58d,
    0x3653, 0x2672, 0x1611, 0x0630, 0x76d7, 0x66f6, 0x5695, 0x46b4,
    0xb75b, 0xa77a, 0x9719, 0x8738, 0xf7df, 0xe7fe, 0xd79d, 0xc7bc,
    0x48c4, 0x58e5, 0x6886, 0x78a7, 0x0840, 0x1861, 0x2802, 0x3823,
    0xc9cc, 0xd9ed, 0xe98e, 0xf9af, 0x8948, 0x9969, 0xa90a, 0xb92b,
    0x5af5, 0x4ad4, 0x7ab7, 0x6a96, 0x1a71, 0x0a50, 0x3a33, 0x2a12,
    0xdbfd, 0xcbdc, 0xfbbf, 0xeb9e, 0x9b79, 0x8b58, 0xbb3b, 0xab1a,
    0x6ca6, 0x7c87, 0x4ce4, 0x5cc5, 0x2c22, 0x3c03, 0x0c60, 0x1c41,
    0xedae, 0xfd8f, 0xcdec, 0xddcd, 0xad2a, 0xbd0b, 0x8d68, 0x9d49,
    0x7e97, 0x6eb6, 0x5ed5, 0x4ef4, 0x3e13, 0x2e32, 0x1e51, 0x0e70,
    0xff9f, 0xefbe, 0xdfdd, 0xcffc, 0xbf1b, 0xaf3a, 0x9f59, 0x8f78,
    0x9188, 0x81a9, 0xb1ca, 0xa1eb, 0xd10c, 0xc12d, 0xf14e, 0xe16f,
    0x1080, 0x00a1, 0x30c2, 0x20e3, 0x5004, 0x4025, 0x7046, 0x6067,
    0x83b9, 0x9398, 0xa3fb, 0xb3da, 0xc33d, 0xd31c, 0xe37f, 0xf35e,
    0x02b1, 0x1290, 0x22f3, 0x32d2, 0x4235, 0x5214, 0x6277, 0x7256,
    0xb5ea, 0xa5cb, 0x95a8, 0x8589, 0xf56e, 0xe54f, 0xd52c, 0xc50d,
    0x34e2, 0x24c3, 0x14a0, 0x0481, 0x7466, 0x6447, 0x5424, 0x4405,
    0xa7db, 0xb7fa, 0x8799, 0x9778, 0xe75f, 0xf77e, 0xc71d, 0xd73c,
    0x26d3, 0x36f2, 0x0691, 0x16b0, 0x6657, 0x7676, 0x4615, 0x5634,
    0xd94c, 0xc96d, 0xf90e, 0xe92f, 0x99c8, 0x89e9, 0xb98a, 0xa9ab,
    0x5844, 0x4865, 0x7806, 0x6827, 0x18c0, 0x08e1, 0x3882, 0x28a3,
    0xcb7d, 0xdb5c, 0xeb3f, 0xfb1e, 0x8bf9, 0x9bd8, 0xabbb, 0xbb9a,
    0x4a75, 0x5a54, 0x6a37, 0x7a16, 0x0af1, 0x1ad0, 0x2ab3, 0x3a92,
    0xfd2e, 0xed0f, 0xdd6c, 0xcd4d, 0xbdaa, 0xad8b, 0x9de8, 0x8dc9,
    0x7c26, 0x6c07, 0x5c64, 0x4c45, 0x3ca2, 0x2c83, 0x1ce0, 0x0cc1,
    0xef1f, 0xff3e, 0xcf5d, 0xdf7c, 0xaf9b, 0xbfba, 0x8fd9, 0x9ff8,
    0x6e17, 0x7e36, 0x4e55, 0x5e74, 0x2e93, 0x3eb2, 0x0ed1, 0x1ef0
};

unsigned int UpdateCRC16(unsigned int crc,unsigned char value) {
    unsigned int crcl6;

    crcl6 = (CRC16_table[(crc >> 8) & 0x00FF] ^ (crc << 8)
    ^ (unsigned int)(value));

    return crcl6;
}
You will find this function on the Compax3 CD under RS232_485\Function
UpdateCRC16.txt!
```

5.2 Remote diagnosis via Modem

In this chapter you can read about:

Structure275
 Configuration of local modem 1276
 Configuration of remote modem 2277
 Recommendations for preparing the modem operation278

Caution!

As the transmission via modem may be very slow and interference-prone, the operation of the Compax3 ServoManager via modem connection is on your own risk!

The function setup mode as well as the ROLL mode of the oscilloscope are not available for remote diagnosis!

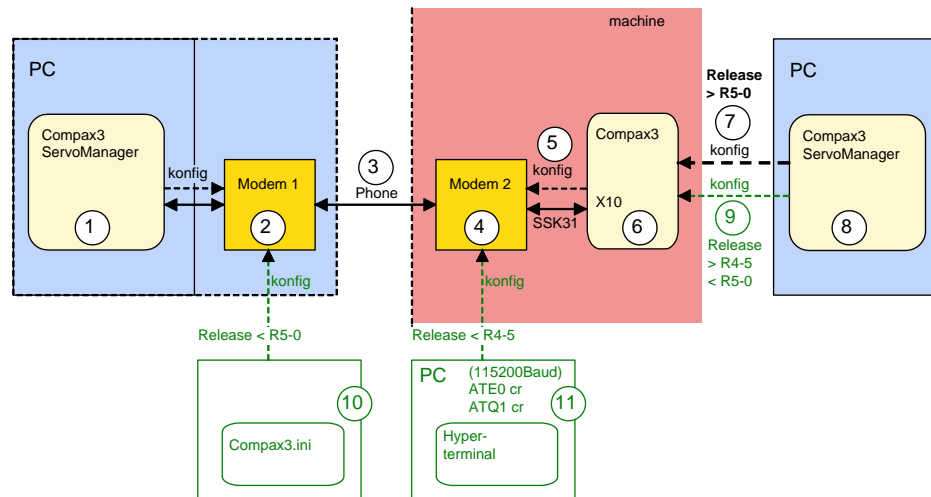
It is not recommended to use the logic analyzer in the Compax3 IEC61131-3 debugger due to the limited bandwidth.

Requirements:

For modem operation, a direct and stable telephone connection is required. Operation via a company-internal telephone system is not recommended.

5.2.1. Structure

Layout and configuration of a modem connection ServoManager - Compax3:



The green part of the drawing shows the proceeding for Compax3 release versions < R5-0!

The proceeding for Compax3 release versions < R5-0 is described in an application example (.../modem/C3_Appl_A1016_ *language*.pdf on the Compax3 CD).

Connection Compax3 ServoManager <=> Compax3

The Compax3 ServoManager (1) establishes a RS232 connection with modem 1 (PC internal or external).

Modem 1 dials modem 2 via a telephone connection (3).

Modem 2 communicates with Compax3 (6) via RS232.

Configuration


Modem 1 is configured via the Compax3 ServoManager (1)

Modem 2 can be configured via Compax3 (on place), triggered by putting **SSK31** (see page 361) on X10. For this, the device must be configured before. This can be made locally before the system / machine is delivered with the aid of the Compax3 ServoManager (8).

The transmission was tested with a TD33 modem made by "**Westermo** <http://www.westermo.com>". The configuration with this standard modem is especially simple.

Other modem types are also possible.

5.2.2. Configuration of local modem 1

- ◆ Menu "Options: Communication settings RS232/RS485..." must be opened
- ◆ Select "Connection via Modem"
- ◆ Under "name" you can enter a name for the connection
- ◆ Enter the target telephone number.
 - Note: If an ISDN telephone system is operated within a company network, an additional "0" may be required in order to get out of the local system into the company network before reaching the outside line with an additional "0".
- ◆ The timeout periods are set to reasonable standard values according to our experience.
- ◆ Select the modem type: "Westermo TD-33" or "user-defined modem"
 - ◆ For "Westermo TD-33", no further settings are required.
 - ◆ For "user-defined modem", additional settings are only required, if the modem does not support standard AT commands. Then you can enter special AT commands.
 - ◆ **Note:** When operating the local modem on a telephone system, it may be necessary to make a blind dialling. Here, the modem does not wait for the dialling tone. For the Westermo TD33, the additional command sequence is ATX3.
- ◆ Select the COM interface where the modem is connected.
- ◆ Close the window and establish the connection with button  (open/close COM port).
- ◆ The connection is interrupted when the COM port is closed.
- ◆ Select the modem type: "Westermo TD-33" or "user-defined modem"
 - ◆ For "Westermo TD-33", no further settings are required.
 - ◆ For "user-defined modem", additional settings are only required, if the modem does not support standard AT commands. Then you can enter special AT commands.
 - ◆ **Note:** When operating the local modem on a telephone system, it may be necessary to make a blind dialling. Here, the modem does not wait for the

dialling tone. For the Westermo TD33, the additional command sequence is ATX3.

5.2.3. Configuration of remote modem 2

Settings in Compax3 under "configure communication: Modem settings":

- ◆ Modem initialization = "ON": After the SSK31 modem cable has been connected, Compax3 initializes the modem
- ◆ Modem initialization after Power On = "ON": After Power on of Compax3, the device initializes the modem
- ◆ Modem check = "ON": a modem check is performed
- ◆ The timeout periods are set to reasonable standard values according to our experience.
- ◆ Select the modem type: "Westermo TD-33" or "user-defined modem"
 - ◆ For "Westermo TD-33", no further settings are required.
 - ◆ For "user-defined modem", additional settings are only required, if the modem does not support standard AT commands. Then you can enter special AT commands.
 - ◆ **Note:** When operating the local modem on a telephone system, it may be necessary to make a blind dialling. Here, the modem does not wait for the dialling tone. For the Westermo TD33, the additional command sequence is ATX3.
- ◆ in the following wizard window, a specific download of the modem configuration can be made.

Note:

If a configuration download is interrupted, the original settings in the non volatile memory of the Compax3 are still available. You have to finish the communication on the PC side and to reset the Compax3 via the 24V supply before you can start a new trial.

Reinitialization of the remote modem 2


Remove cable on Compax3 X10 and connect again!

5.2.4. Recommendations for preparing the modem operation

Preparations:

- ◆ Settings in Compax3 under "configure communication: Modem settings":
 - ◆ Modem initialization: "ON"
 - ◆ Modem initialization after Power On: "ON"
 - ◆ Modem check: "ON"
- ◆ Deposit SSK31 cable in the control cabinet.
- ◆ Install modem in the control cabinet and connect to telephone line.

Remote diagnosis required:

- ◆ On site:
 - ◆ Connect modem to Compax3 X10 via SSK31
 - ◆ Modem is automatically initialized
- ◆ Local:
 - ◆ connect modem to telephone line
 - ◆ Establish cable connection to modem (COM interface)
 - ◆ Select "connection via modem" under "options: communication settings RS232/RS485...".
 - ◆ Select modem under "selection"
 - ◆ Enter telephone number
 - ◆ Select COM interface (PC - modem)
 - ◆ Establish connection with button  (open/close COM port).

5.3 Ethernet Powerlink

In this chapter you can read about:

Ethernet Powerlink - Operating mode.....	279
CN Controlled Node (Slave)	285
Status machine	286
Controlword /Statusword	288
Acyclic parameter channel.....	295
Ethernet Powerlink - Communication profile.....	310

5.3.1. Ethernet Powerlink - Operating mode

- ◆ **CN (Controlled Node) in the Velocity Mode - velocity control:** the target velocity is specified and actual values are read back via Ethernet Powerlink.
- ◆ **CN (Controlled Node) in the Position Mode - direct positioning:** the target position is specified and actual values are read back via Ethernet Powerlink.
- ◆ **CN (Controlled Node) with set selection:** Motion sets which are stored in an array are activated via Ethernet Powerlink.

Slave with configuration via machine zero (managing Node)

Select "Slave with configuration via machine zero (managing Node)". for operating mode and mapping via master.

Then run through the wizard completely.

Additional operating modes can be set via the object "**operating mode** (see page 288)" (EPL No. 0x6060 (object 1100.5)).

5.3.1.1 CN (Controlled Node) in the Velocity Mode - velocity control

Ethernet Powerlink – Master -> Compax3

Possible assignment:

Designation	Object No.	EPL No.	Assigned words	Assignment
Controlword (Control word 1)	1100.3	0x6040	1	optional
Target velocity	1100.13	0x2044	2	optional
Operating mode	1100.5	0x6060	1	optional
Dig. Outputs (0-3)	140.3	0x6300.1	1	optional
Dig. outputs M1x option	133.3	0x6300.2	1	optional

Layout of the **Control word** (see page 288).

Compax3 -> Ethernet Powerlink – Master

Possible assignment:

Designation	Object No.	EPL No.	Assigned words	Assignment
Statusword (Status word 1)	1000.3	0x6041	1	optional
Velocity actual value	681.5	0x606C	2	optional
Torque actual value	683.1	0x6077	1	optional
Dig. inputs (0-7)	120.3	0x6100.1	1	optional
Dig. inputs M1x option	121.2	0x6100.2	1	optional
Operating mode display	1000.5	0x6061	1	optional
LastError (current Compax3 errors)	550.1	0x603F/ 0x201D.1	1	optional

Layout of the **Status word**. (see page 290)

5.3.1.2 CN (Controlled Node) in the Position Mode - direct positioning

Communication between Master and Compax3 takes place via the process data objects (PDOs)

Procedure:

Selection of the motion function: Bit 15, 13, 6 of the control word 1

Start of the motion function: Bit 4 of the control word 1

Specification of the motion parameters: Objects of the PDOs

Ethernet Powerlink – Master -> Compax3

Possible assignment:

Designation	Object No.	EPL No.	Assigned words	Assignment
Controlword (Control word 1)	1100.3	0x6040	1	optional
Target position Y4 (position command value)	1100.6	0x2044	2	optional
Profile velocity (1 decimal place)	1100.14	0x2048	1	optional
Profile velocity (3 decimal places)	1100.7	0x2046	2	optional
Profile acceleration U16	1111.10	0x202D	1	optional
Profile acceleration U32	1111.3	0x6083	2	optional
Profile deceleration U16	1111.16	0x205D	1	optional
Profile deceleration U32	1111.4	0x6084	2	optional
Dig. Outputs (0-3)	140.3	0x6300.1	1	optional
Dig. outputs M1x option	133.3	0x6300.2	1	optional
Operating mode	1100.5	0x6060	1	optional
Interpolation data (Interpolation input)	3921.1	0x60C1.1	2	optional

Layout of the **Control word** (see page 288).

The setpoint movement speeds C & D do have the same function, they differ only in the word width.

The same applies for the setpoint accelerations A & B

You should therefore only use one of these two values.

Attention: The meaning of position command value A changes with Gearing:
 With the motion function Gearing applies:
 Position setpoint = Gearing numerator
 value A

Compax3 -> Ethernet Powerlink – Master**Possible assignment:**

Designation	EPL No.	Object No.	Assigned words	Assignment
Statusword (Status word 1)	0x6041	1000.3	1	optional
Position actual value	0x6064	680.5	2	optional
Velocity actual value	0x606C	681.5	2	optional
Velocity actual value Y2 (speed actual value) (3 decimal places)	0x2023	681.7	1	optional
Torque actual value	0x6077	683.1	1	optional
Follow error actual value	0x60F4	680.6	1	
Dig. inputs (0-7)	0x6100.1	120.3	1	optional
Dig. inputs M1x option	0x6100.2	121.2	1	optional
Operating mode display	0x6061	1000.5	1	optional
LastError (current Compax3 errors)	0x603F/ 0x201D.1	550.1	1	optional

Layout of the **status word**. (see page 290)

For values not transferred the standard values defined in the configuration wizard are valid!

The jerk can be changed for example via SDO (0x2005 & 0x2006).

5.3.1.3 CN (Controlled Node) with set selection

The communication between Master and Compax3 is made via the of the PDO Procedure:
 Defining the motion sets with the Compax3 ServoManager or via the acyclic channel.
 Selecting the desired motion set via control word 2
 Start the motion with control word 1 Bit 4.

Ethernet Powerlink – Master -> Compax3

Possible assignment:

Designation	EPL No.	Object No.	Assigned words	Assignment
Controlword (Control word 1)	0x6040	1100.3	1	optional
Controlword2 (control word 2)	0x201B	1100.4	1	optional
Operating mode	0x6060	1100.5	1	optional
Dig. Outputs (0-3)	0x6300.1	140.3	1	optional
Dig. outputs M1x option	0x6300.2	133.3	1	optional

Layout of the **Control word** (see page 288).

Compax3 -> Ethernet Powerlink – Master

Possible assignment:

Designation	EPL No.	Object No.	Assigned words	Assignment
Statusword (Status word 1)	0x6041	1000.3	1	optional
Statusword2 (status word 2)	0x201C	1000.4	1	optional
Position actual value	0x6064	680.5	2	optional
Velocity actual value	0x606C	681.5	2	optional
Velocity actual value Y2	0x2023	681.7	1	optional
Torque actual value	0x6077	683.1	1	optional
Follow error actual value	0x60F4	680.6	1	optional
Dig. inputs (0-7)	0x6100.1	120.3	1	optional
Dig. inputs M1x option	0x6100.2	121.2	1	optional
Operating mode display	0x6061	1000.5	1	optional
LastError (current Compax3 errors)	0x603F/ 0x201D.1	550.1		optional

Layout of the **Status word**. (see page 290)

Defining sets: Please use the Compax3 ServoManager or the acyclic channel in order to enter the motion sets.
 Layout of the **set table** (see page 284).

Layout of the set table

The motion sets are memorized in an object table. The table has 9 columns and 32 rows.

A motion set is stored in a table row.

The assignment of the columns depends on the motion function.

General layout of the table:

	Column 1 Type: REAL Objects O1901	Column 2 Type: REAL Objects O1902	Column 3 Type: INT Objects O1903	Column 4 Type: INT Objects O1904	Column 5 Type: INT Objects O1905	Column 6 Type: DINT Objects O1906	Column 7 Type: DINT Objects O1907	Column 8 Type: DINT Objects O1908	Column 9 Type: DINT Objects O1909
Set 1	Row 1 "Array_Col1 _Row1" (1901.1)	Row 1 "Array_Col 2_Row1" (1902.1)	Row 1 "Array_Col 3_Row1" (1903.1)	Row 1 "Array_Col 4_Row1" (1904.1)	Row 1 "Array_Col5 _Row1" (1905.1)	Row 1 "Array_Col6 _Row1" (1906.1)	Row 1 "Array_Col 7_Row1" (1907.1)	Row 1 "Array_Col8 _Row1" (1908.1)	Row 1 "Array_Col9 _Row1" (1909.1)
set no. 2	...	...	...	...	...	...	...	...	...
Set 3	...	...	...	...	...	...	...	...	...
...
Set 31	Row 31 "Array_Col1 _Row31" (1901.31)	Row 31 "Array_Col 2_Row31" (1902.31)	Row 31 "Array_Col 3_Row31" (1903.31)	Row 31 "Array_Col 4_Row31" (1904.31)	Row31 "C3Array_C ol5_Row31" (1905.31)	Row 31 "Array_Col6 _Row31" (1906.31)	Row 31 "Array_Col 7_Row31" (1907.31)	Row 31 "Array_Col8 _Row31" (1908.31)	Row 31 "Array_Col9 _Row31" (1909.31)

You will find the respective object number in brackets.

Assignment of the different motion functions

Motion function	Column 1 Type: REAL Objects O1901	Column 2 Type: REAL Objects O1902	Column 4 Type: INT Objects O1904	Column 5 Type: INT Objects O1905	Column 6 Type: DINT Objects O1906	Column 7 Type: DINT Objects O1907	Column 8 Type: DINT Objects O1908
	Positions	Speeds	Programmable status bits (PSBs)	Mode	Accelerations	Deceleration / denominator	Jerk
MoveAbs (see page 124)	Target position	Speed	PSBs	1 (for MoveAbs)	Accel	Decel	Jerk
MoveRel (see page 124)	Distance	Speed	PSBs	2 (for MoveRel)	Accel	Decel	Jerk
Gearing (see page 131)	-	Numerator	PSBs	3 (for Gearing)	Accel	Denominator	-
RegSearch (see page 125)	Distance	Speed	PSBs	4 (for RegSearch)	Accel	Decel	Jerk
RegMove (see page 125)	Offset	Speed	PSBs	5 (for RegMove)	-	-	-
Velocity (see page 132)	-	Speed	PSBs	6 (for Velocity)	Accel	-	-
STOP	-	-	PSBs	7 (for Stop)	-	Decel	Jerk

The columns 3 and 9 are reserved.

Definition of the states of the programmable status bits (PSBs):

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Enable2 PSB2	Enable1 PSB1	Enable0 PSB0	Reserved	PSB2	PSB1	PSB0
="1": Set PSB ="0": leave PSB unchanged							

The Bits 0 ... 2 monitor the states of the status bits at the end of a motion set, if the bits were enabled via the respective Enable.

If Enable is set to "0", the respective PSB remains unchanged at the end of the motion set.

PSB0: Status word 2 Bit 12

PSB1: Status word 2 Bit 13

PSB2: Status word 2 Bit 14

5.3.1.4 Error reaction to a bus failure

Here you can adjust how Compax3 will respond to a **fieldbus error** (see page 312):

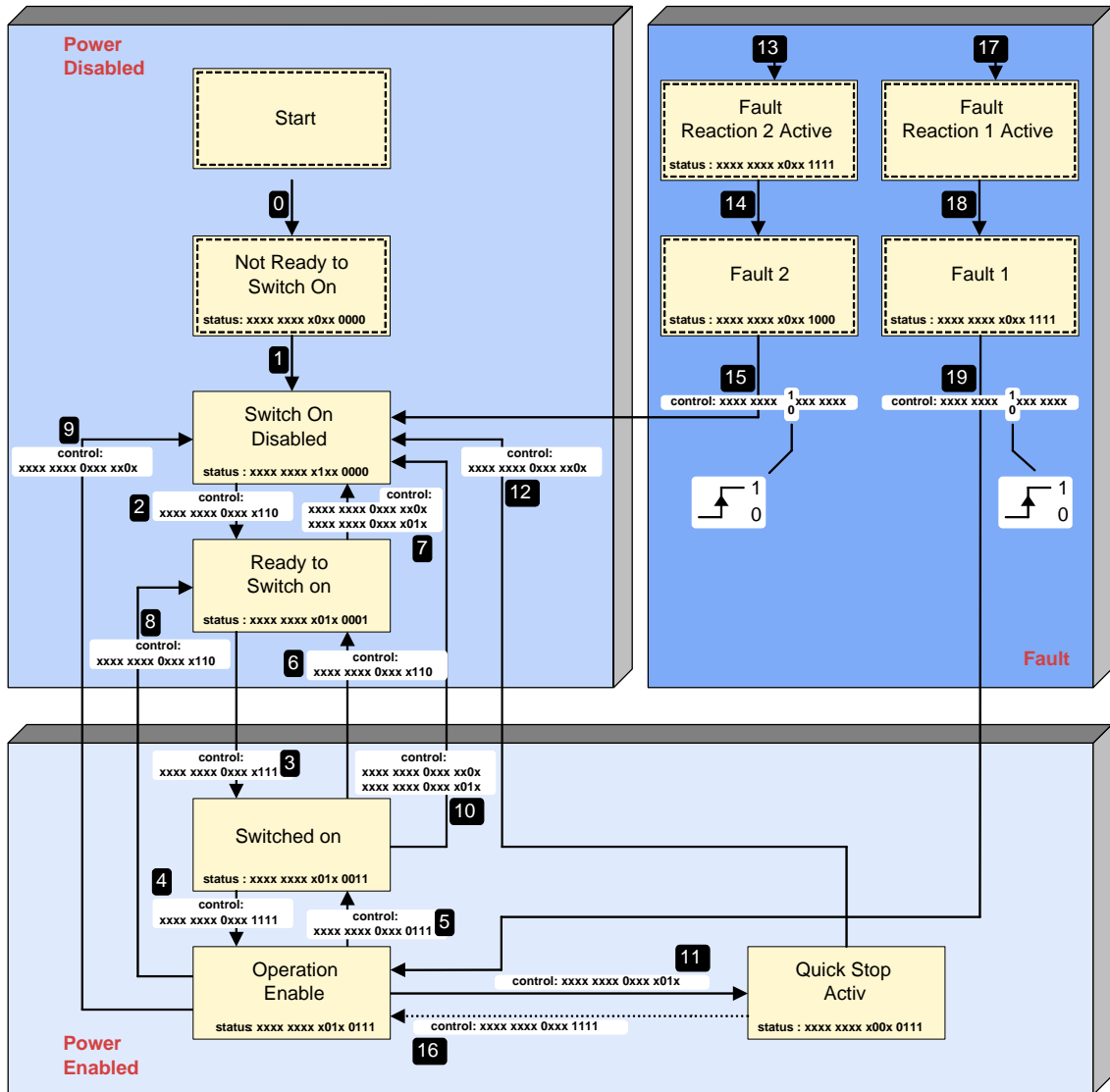
Possible settings for the error reaction are:

- ◆ No response
- ◆ downramp / stop
- ◆ Downramp / stromlos schalten (standard setting)

5.3.2. CN Controlled Node (Slave)

Compax3 is the slave of an Ethernet master; the bus configuration is made via the ServoManager

5.3.3. Status machine



0, 1, 2, ... : Status transitions

Status values:

Designation	Explanation
Not Ready to Switch On	Control voltage switched on Initialization Brake closed Not ready to turn on
Switch On Disable	Initialization completed Parameter values can be changed Power supply voltage switched off Travel commands not possible
Ready to Switch on	Power supply voltage can be switched on Parameter values can be changed Travel commands not possible
Switched on	Power supply voltage switched on Parameter values can be changed Travel commands not possible Motor de-energized
Operation enable	Motor powered Compax3 is ready for carrying out travel commands Parameter values can be changed

Quick Stop active	The "Quick Stop" function has been executed Motor powered Parameter values can be changed
Fault reaction 1 active	A fault has occurred The motor is stopped with the ERROR_decel and ERROR_jerk ramp and remains energized. Parameter values can be changed
Fault 1	Error state, motor energized, error can be read Travel commands not possible Parameter values can be changed A positive edge is expected at FAULT RESET
Fault reaction 2 active	A fault has occurred The motor is stopped with the ERROR_decel and ERROR_jerk ramp and is deenergized at standstill. Parameter values can be changed
Fault 2	Error state, motor deenergized, error can be read Travel commands not possible Parameter values can be changed A positive edge is expected at FAULT RESET

Transitions:

For various transitions, for which Compax3 leaves the status "Operation Enable" (travel commands may be active), various ramps can be set. That is:

Transition	associated ramp objects
5, 11	STOP_decel (Object 1113.1), STOP_jerk ((Object 1113.2)
8	FSTOP1_decel (Object 1116.1), FSTOP1_jerk (Object 1116.2)
9	FSTOP3_decel (Object 1118.1), FSTOP3_jerk (Object 1118.2)
13,17	ERROR_decel (Object 1125.1), ERROR_jerk (Object 1125.2)

5.3.4. Controlword /Statusword

In this chapter you can read about:

Control word 1 (Controlword 1).....288
 Statusword 1 (Statusword)290
 Interpolated Position Mode290

5.3.4.1 Control word 1 (Controlword 1)

Operating mode BA EPL No. 0x6060 (object 1100.5)						
Bit	Direct positioning (Profile Position)	Positioning with set selection (Position Record Select)	Speed control (Profile Velocity)	Machine zero (Homing)	Manual operation (Jogging)	Interpolated Position ²⁾³⁾ (ip-mode)
	BA = "1"	BA = "-2"	BA = "3"	BA = "6"	BA = "-1"	BA = "7"
0	="1": Switch on					
1	="1": Enable Voltage					
2	="0": Quick stop					
3	="1": Enable Operation					
4	="1": New set-point (Start)		Reserved	="1": Homing operation start (activate homing run)		="1": Enable ip mode
5	="1": Change set immediately ¹⁾ (dynamic positioning (see page 134))		Reserved	Reserved	="1": Jog- (Hand-)	
6	Mode 2 (see below)	Reserved	Reserved	Reserved	Reserved	
7	="1": Fault reset (Quit, with positive edge)					
8	="1": Halt (Stop without termination) (for Velocity and Gearing: Stop with termination)		="1": Halt (Stop with termination)			
9	Reserved					
10	Reserved					
11	="0": Remote Control: Control word active, i.e. control Ethernet Powerlink ="1": Local Control: Control word inactive, i.e. the control word is not read; direct control via inputs (see page 120) possible.					
12	Reserved	Reserved	Reserved			
13	Mode 1 (see below)	Reserved	Reserved			
14	="1": Endless (continuous operation) in normal operation (= "0") homing is required		Reserved			
15	Mode 0 (see below)	Reserved	Reserved			

- 1) With Bit 5 = "0" no dynamic change of record is possible - not even to a STOP record.
Only after the end of the record (position reached), the next record will be accepted.
- 2) Operating mode "interpolated" is not supported with DeviceNet (I22).
Gearing is not possible in the "interpolated" operating mode.

3) Interpolated Position Mode (see page 290)

The operating mode switching to "Interpolated Position Mode" takes place during operation (via the bus) and is not supported by the configuration in the ServoManager.
 The command position of the "Interpolated Position mode" is preset via the bus object 3921.1 "Interpolation data". This bus object can be mapped to the telegram in the "Position Mode".
 the "Interpolated Position Mode" works in SYNC operation; the cycle time is preset via bus object 0x1006; please respect the **ratings** (see page 23).

Change operating mode:

A change of the operating mode will trigger a "Stop", if the drive is still moving. Changing from "Profile Velocity" to another operating mode is only possible in currentless state.

Selection of the positioning mode in the "direct positioning" operating mode

Mode 0 CW.15	Mode1 CW.13	Mode2 CW.6	Function
0	0	0	MoveAbs (see page 124)
0	0	1	MoveRel (see page 124)
0	1	0	MoveAdd (see page 289) *
0	1	1	Velocity (see page 132)
1	0	0	Gearing (see page 131)
1	0	1	RegMove (see page 125)
1	1	0	RegSearch (see page 125)
1	1	1	Reserved

*** Relative; Example**

- ◆ Positioning mode: absolute
- ◆ Target position = 1000
- ◆ Positioning mode: relative
- ◆ Command: Target position = 200 for actual position 500
- ◆ Drive travels to 700

Additive; example

- ◆ Positioning mode: absolute
- ◆ Target position = 1000
- ◆ Positioning mode: additive
- ◆ Command: Target position = 200 for actual position arbitrary
- ◆ Drive travels to 1200

Control word 2

In the "Positioning with set selection" operating mode, the address of the motion set is specified via control word 2

Bit	Description
0	Address 0 for set selection
1	Address 1 for set selection
2	Address 2 for set selection
3	Address 3 for set selection
4	Address 4 for set selection
5 ... 15	Reserved

5.3.4.2 Statusword 1 (Statusword)

Operating mode BA EPL No. 0x6060 (object 1100.5)						
Bit	Direct positioning (Profile Position)	Positioning with set selection (Position Record Select)	Speed control (Profile Velocity)	Machine zero (Homing)	Manual operation (Jogging)	Interpolated Position 2) (ip-mode)
	BA = "1"	BA = "-2"	BA = "3"	BA = "6"	BA = "-1"	BA = "7"
0	="1": Ready to switch on					
1	="1": Switched on					
2	="1": Operation enable					
3	="1": Fault (Compax3 reports error)					
4	="0": Voltage enable					
5	="0": Quick stop					
6	="1": Switch on disable					
7	Reserved					
8	="1": Speed=0 (drive motionless)					
9	="1": Remote (Parameters can be changed via Ethernet Powerlink)					
10	="1": Target reached (corresponds to Position / Speed / Gearing reached)					
11	="1": Internal limit active					
12	="1": Setpoint acknowledge (new setpoint value is accepted)		= "1": Speed=0	= "1": Homing attained (referenced)	0	= "1": ip mode active
13	="1": Following error		0	= "1": Homing error	0	
14	0	0	0	0	0	
15	="1": Registration found (Registration mark detected)		0	0	0	

2) Operating mode "interpolated" is not supported with DeviceNet.

Status word 2

Status word 2 in the "Positioning with set selection" operating mode contains the selected set number as well as the PSBs.

Bit	Description
0	Address 0 of the current set
1	Address 1 of the current set
2	Address 2 of the current set
3	Address 3 of the current set
4	Address 4 of the current set
5 ... 11	Reserved
12	Programmable status bit 0 (PSB0)
13	Programmable status bit 1 (PSB1)
14	Programmable status bit 2 (PSB2)
15	Reserved

5.3.4.3 Interpolated Position Mode

In this chapter you can read about:

Interpolation method	290
Synchronizations method	294

Interpolation method

In this chapter you can read about:

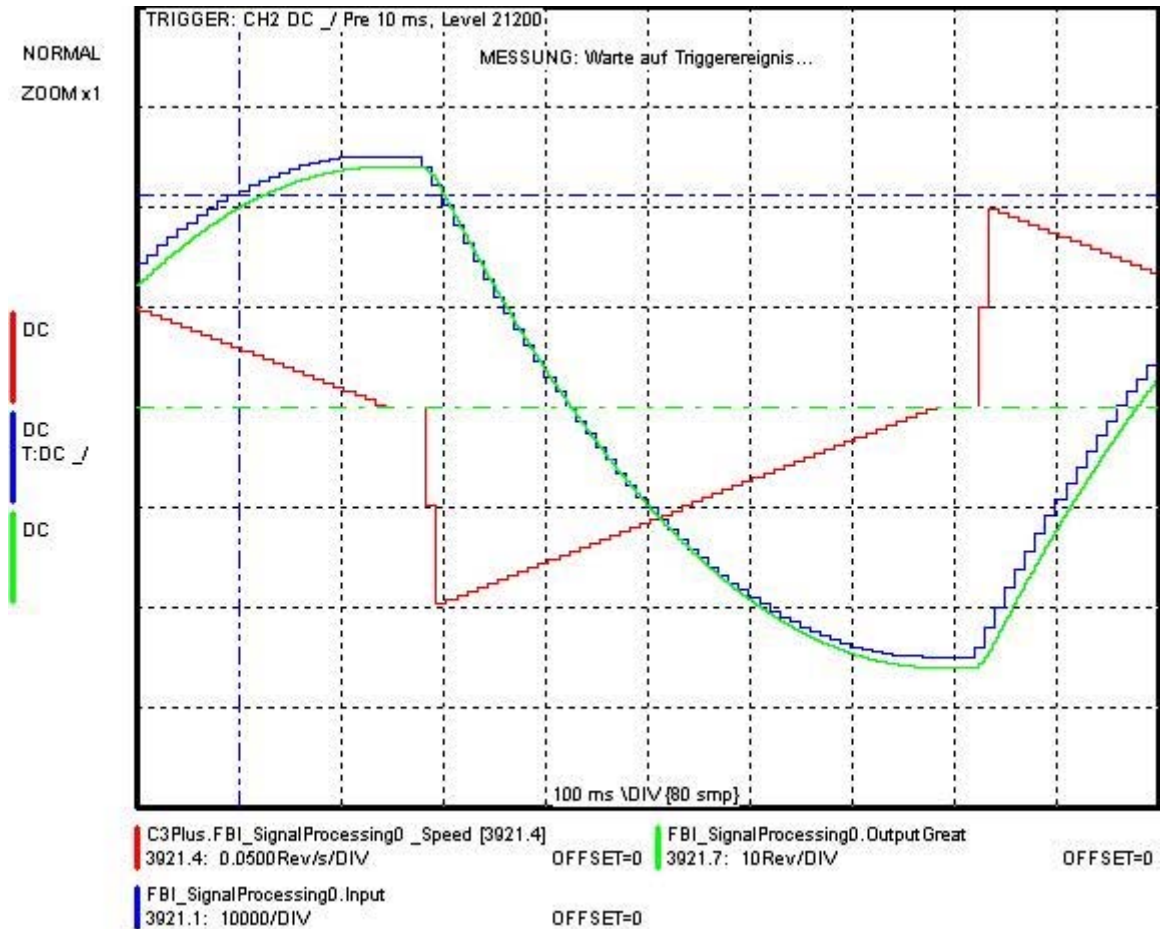
Linear Interpolation (o3925.1 = 0 oder o3925.1 = -1)	291
Quadratic interpolation (o3925.1=-2)	292
Cubical interpolation (o3925.1=-3)	293

Linear Interpolation (o3925.1 = 0 oder o3925.1 = -1)

With the transmitted position and the position in the previous bus cycle, a straight of the $Y(t)=a*t + b$ is calculated. The speed within a bus cycle remains constant. This method is only implemented for the PLL synchronization.

- ◆ **Advantage:** Support of a reset value range
- ◆ **Disadvantage:** During the transition to a new bus cycle, a speed leap may occur.

Example:

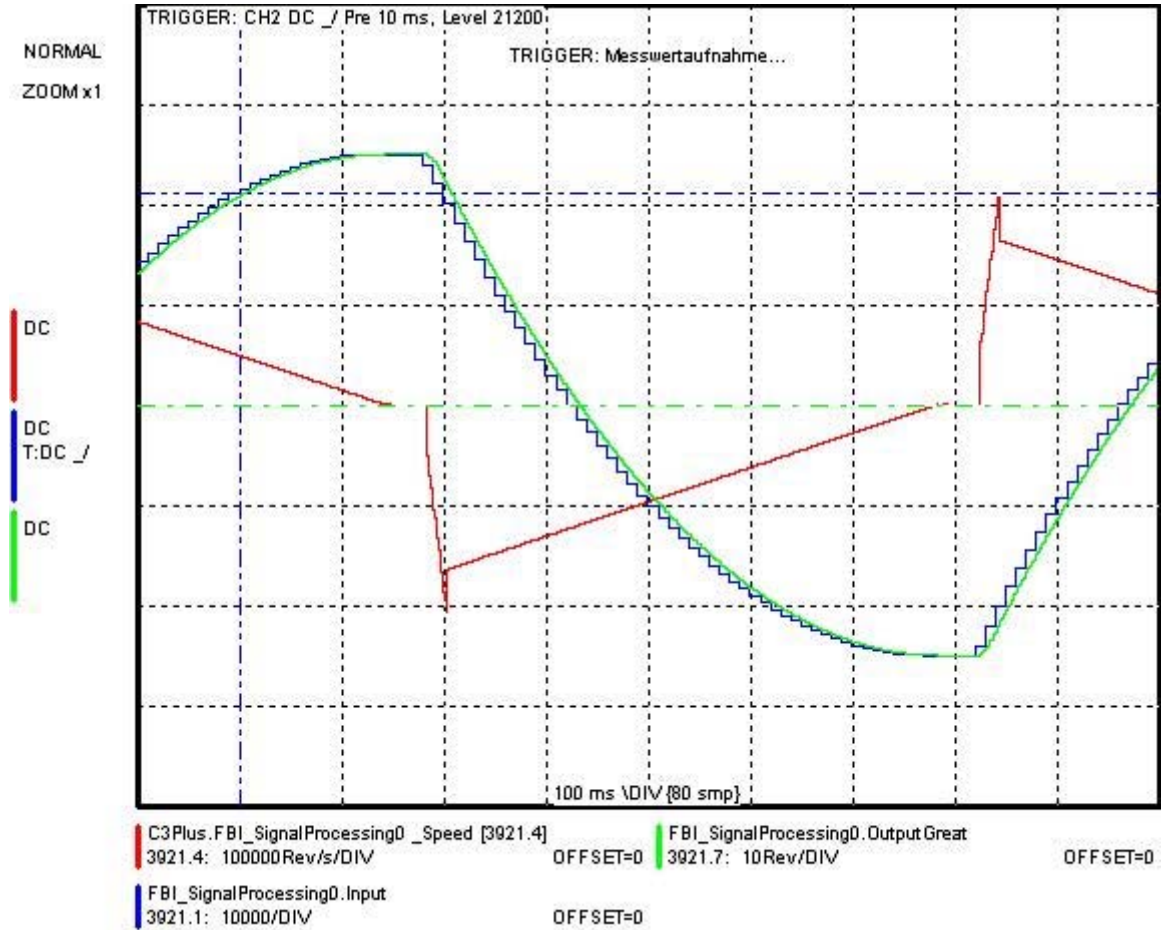


Quadratic interpolation (o3925.1=-2)

With the aid of the position received last and the positions from the two previous bus cycles, the polynomial coefficients of the polynomial $Y(t) = a * t^2 + b * t + c$ are determined. The speed within a bus cycle is a first order function, i.e. the acceleration is constant.

- ◆ **Advantage:** consistent course of speed
- ◆ **Disadvantage:** The Interpolation method does not support a reset value range.

Example:

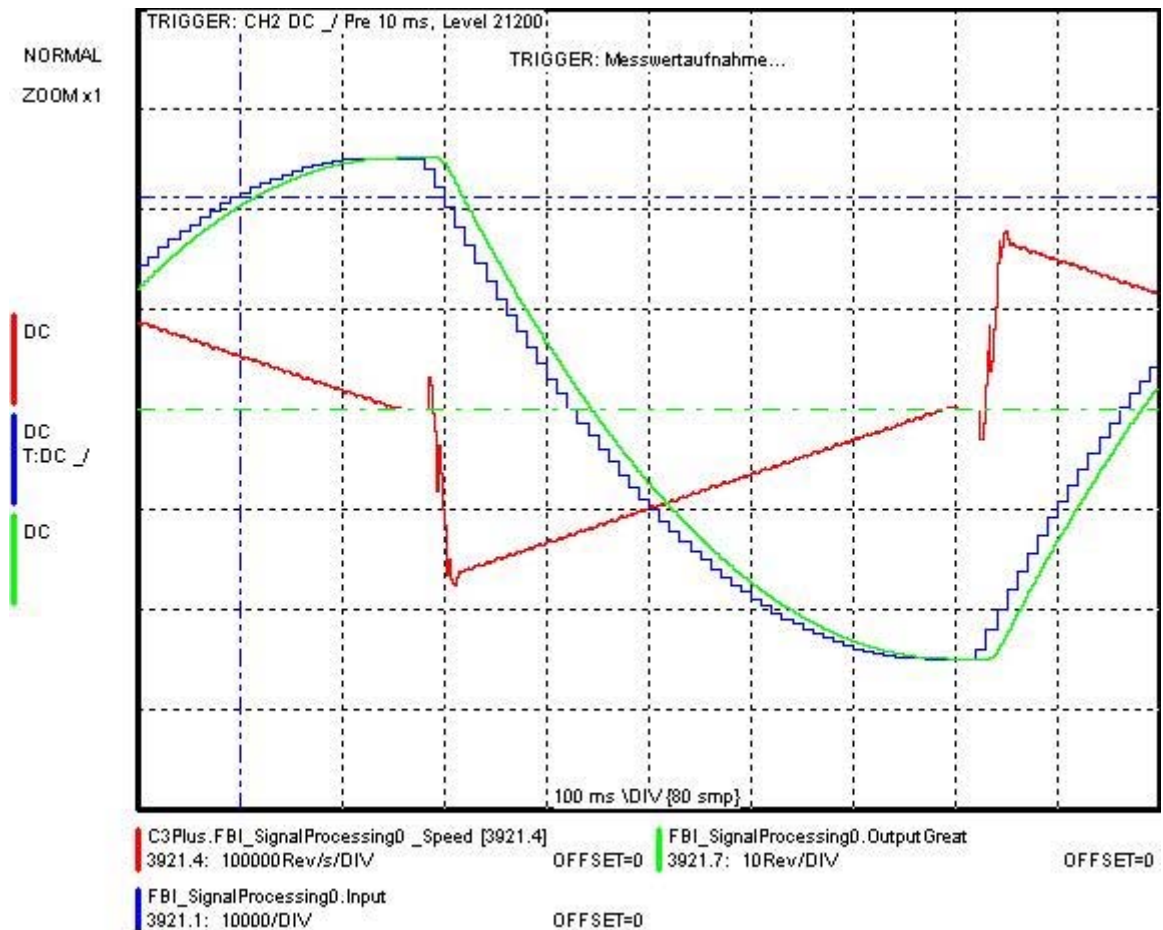


Cubical interpolation (o3925.1=-3)

With the aid of the last position received, and the three previous values, the polynomial coefficients of the polynomial $Y(t) = a * t^3 + b * t^2 + c * t$ are determined. The speed within a bus cycle can change quadratically, i.e. the acceleration is a first order function.

- ◆ **Advantages:** consistent course of speed and acceleration
- ◆ **Disadvantages:** This method may lead to overshoot in the interpolated position.. The Interpolation method does not support a reset value range.

Example:



Synchronizations method

Selection of the synchronization method

the selection is made via object 820.24. The selection is only accepted, if the bus cycle time (Bus object 0x1006) is written anew. Changes of the synchronization method and of the bus cycle time should only be made while the controller is deactivated.

PLL synchronization (Object 820.24 = 0)

During the PLL synchronization, the system clock of the slave device is synchronized to the system clock of the master with the aid of a phase control loop. This ensures that all devices are running in the same time frame.

Advantages: exact synchronization of the setpoint acceptance from the master, synchronized acquisition of the actual values

Disadvantages: relatively high requirements for the periodicity of the sync-telegram, i.e. the jitter must be small. For CANSync on Compax3, the maximum permitted jitter is about 50µs.

Timestamp method (Object 820.24 = 1)

During the timestamp method, the slave is not synchronized to the master clock. Instead, the time between two subsequent sync-telegrams is measured. The received position demand values or the values derived from them (e.g. speed) are scaled with the measured time.

Advantages: relatively insensitive to jitter

Disadvantages: the actual value acquisition is not synchronized to the master. This may lead to "beats".

Linear interpolation is not possible with the timestamp method.

5.3.5. Acyclic parameter channel

In this chapter you can read about:

Service Data Objects (SDO)	295
Object up-/download via Ethernet Powerlink	297
Ethernet Powerlink Objects	298

5.3.5.1 Service Data Objects (SDO)

Asynchronous access to the object directory of Compax3 is implemented with the help of the SDOs. The SDOs serve for parameter configuration and status interrogation. Access to an individual object takes place via the Ethernet Powerlink index and subindex of the object directory.

Attention!

A SDO is a confirmed service, therefore the SDO reply telegram must always be awaited before a new telegram may be transmitted.

CiA405_SDO_Error (Abort Code): UDINT

In the case of an incorrect SDO transmission, the error cause is returned via the "abort code".

Abort Code	Description
0x0503 0000	" Toggle Bit" was not alternated
0x0504 0000	SDO protocol "time out"
0x0504 0001	Client/server command designator invalid or unknown
0x0504 0002	Unknown block size (block mode only)
0x0504 0003	Unknown block number (block mode only)
0x0504 0004	CRC error (block mode only)
0x0504 0005	Outside of memory
0x0601 0000	Access to this object is not supported
0x0601 0001	Attempted read access to a write only object
0x0601 0002	Attempted write access to a read only object
0x0602 0000	The object does not exist in the object directory
0x0604 0041	The object cannot be "mapped" in a PDO
0x0604 0042	The size and number of the "mapped" objects exceeds the maximum PDO length
0x0604 0043	General parameter incompatibility
0x0604 0047	General incompatibility in the device
0x0606 0000	Access infringement due to a hardware error
0x0607 0010	Data type does not fit, length of the service parameter does not fit
0x0607 0012	Data type does not fit, length of the service parameter too large
0x0607 0013	Data type does not fit, length of the service parameter too small
0x0609 0011	Subindex does not exist
0x0609 0030	Outside parameter value range (only for write access operations)
0x0609 0031	Parameter value too large
0x0609 0032	Parameter value too small
0x0609 0036	Maximum value smaller than minimum value
0x0800 0000	General error
0x0800 0020	Date cannot be transmitted or saved
0x0800 0021	Date cannot be transmitted or saved due to local device management
0x0800 0022	Date cannot be transmitted or stored due to device status
0x0800 0023	Dynamic generation of the object directory is impossible or no object directory exists (the object directory is created from a file and an error occurs due to a defective file)

5.3.5.2 Object up-/download via Ethernet Powerlink

The up-/download takes place via the Ethernet Powerlink objects C3_Request (Index 0x2200) and C3_Response (Index 0x2201). These have the data type data type octet string with a length of 20 bytes (octets). Write/read of a C3 object is carried out by writing of C3_Request with the corresponding data. When a C3 object is read, the data appear in the C3_Response object .

Meaning of the data from C3_Request

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	...	...	Byte 19	Byte 20
Request header				C3 object data (write)							
AK	Subindex	Index		D1	D2	...	...	D15	D16

AK: Job identifier; 3=read, 4= write

OD1..OD16: Object data; OD1 = High, OD16 = Low

Meaning of the data from C3_Response

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	...	...	Byte 19	Byte 20
Reply header				C3 object data (read)							
-	-	-	-	OD1	OD2	...	...	OD15	OD16

OD1..OD16: Object data; OD1 = High, OD16 = Low

Upload

Ethernet Powerlink	O 1	O 2	O 3	O 4	O 5	O 6	O 7	O 8	...	O 20	
Access	Object		C3 object request/reply				C3 object data				
1. Write C3 object 20.2 with the value 0											
Write	0x2200.0	4	2	0	20	0	0	0	x	...	x
2. read next C3 object index/subindex in C3 object 20.5											
Write	0x2200.0	3	5	0	20	x	x	x	x	...	x
Read	0x2201.0	x	x	x	x	I_hi	I_lo	Subi	x	...	x
3. read the C3 object with the in index/subindex read in the C3 object 20.5											
Write	0x2200.0	3	Subi	I_hi	I_lo	x	x	x	x	...	x
Read	0x2201.0	x	x	x	x	D1	D2	D3	D4	...	D16
4. Store C3 object index, subindex and data D1...D16 in table											
5. Repeat steps 2 to 4 until I_hi = I_lo = Subi = 0xFF											

Download: Write the entire table of C3 objects.

Ethernet Powerlink	O 1	O 2	O 3	O 4	O 5	O 6	O 7	O 8	...	O 20	
Access	Object		C3 object request/reply				C3 object data				
1. Write C3 object from the table											
Write	0x2200.0	4	Subi	I_hi	I_lo	D1	D2	D3	D4	...	D16
2. Repeat step 1 until the end of the table											

5.3.5.3 Ethernet Powerlink Objects

In this chapter you can read about:

Standardized and manufacturer-specific objects sorted according to EPL No.....	299
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Set objects to valid Please note that certain objects are not valid (read by Compax3) immediately after a change. This is described in the heading "Valid after".
These objects are converted to internal variables by Compax3 with the command "Set objects to valid".

Save objects permanently It should also be noted that modified objects are not permanently stored, i.e. the changes are lost after the power (24 VDC) is turned off.
With the object "Store objects permanently" the objects are stored power supply fail-safe in flash memory.

Standardized and manufacturer-specific objects sorted according to EPL No.

No.	Object name	Object	CANopen Index	Bus format	Valid beginning
2100.20	C3.ControllerTuning_ActuatingSpeedSignalFilter_us	Control signal filter of velocity control		U16	VP
2100.21	C3.ControllerTuning_FilterAccel_us	Filter - Actual acceleration		U16	VP
2100.11	C3.ControllerTuning_FilterAccel2	Filter actual acceleration 2		U16	VP
2230.20	C3.D_CurrentController_Ld_Lq_Ratio	Ratio direct to quadrature inductance		U16	VP
2230.24	C3.D_CurrentController_VoltageDecouplingEnable	Activation of the voltage decoupling		I16	VP
990.1	C3.Delay_MasterDelay	Setpoint delay for bus master		I16	Immediately
84.4	C3.DeviceSupervision_DeviceAdr	Current RS485 address of the C3M		U16	-
84.3	C3.DeviceSupervision_DeviceCounter	Number of devices in the C3M combination		U16	-
84.5	C3.DeviceSupervision_OperatingTime	Hours of operation of the C3MP in s		U32	-
84.2	C3.DeviceSupervision_ThisDevice	Device number in the C3M combination		U16	-
85.1	C3.Diagnostics_DeviceState	C3MP operating status		V2	-
120.2	C3.DigitalInput_Value	Status of digital inputs		V2	-
87.1	C3.ErrorHistoryNumber_1	Error 1		U16	-
86.1	C3.ErrorHistoryPointer_LastEntry	Pointer to current error		U16	-
88.1	C3.ErrorHistoryTime_1	Error point in time 1		U32	-
2020.1	C3.ExternalSignal_Position	Position from external signal source		C4_3	-
2010.20	C3.FeedForward_EMF	EMC feedforward		U16	VP
2011.5	C3.FeedForwardExternal_FilterAccel_us	Filter time constant ext. Acceleration		U16	VP
2011.4	C3.FeedForwardExternal_FilterSpeed_us	Filter time constant ext. Velocity		U16	VP
410.6	C3.LimitPosition_LoadControlMaxPosDiff	Position difference load-motor (error threshold)		C4_3	VP
2220.22	C3.Q_CurrentController_BackEMF	Parameter motor force constant		I16	VP
2220.20	C3.Q_CurrentController_Inductance	Parameter motor inductance		I16	VP
2220.21	C3.Q_CurrentController_Resistance	Parameter motor resistance		I16	VP
2210.17	C3.SpeedController_ActualBandwidth	Replacement time constant for the velocity control		I32	-
2120.7	C3.SpeedObserver_DisturbanceAdditionEnable	Switch to enable disturbance compensation		BOOL	VP
2120.5	C3.SpeedObserver_DisturbanceFilter	Time constant disturbance filter		U32	VP
2120.1	C3.SpeedObserver_TimeConstant	Rapidity of the speed monitor		U32	VP
682.5	C3.StatusAccel_Actual	Status of actual acceleration unfiltered		I32	-
682.6	C3.StatusAccel_ActualFilter	Status of filtered actual acceleration		I32	-
682.7	C3.StatusAccel_FeedForwardAccel	Status acceleration feed forward		C4_3	-
690.5	C3.StatusAutocommutation_Iterations	Current increase steps automatic commutation		U16	-
688.2	C3.StatusCurrent_Actual	Status of actual current RMS (torque producing)		E2_6	-
688.19	C3.StatusCurrent_ActualDINT	Actual current r.m.s.		I32	-
688.8	C3.StatusCurrent_ControlDeviationIq	Status of control deviation of current control RMS		C4_3	-
688.31	C3.StatusCurrent_DecouplingVoltageUd	Signal decoupling of direct current controller		C4_3	-
688.32	C3.StatusCurrent_FeedForwardbackEMF	Signal EMC feedforward		C4_3	-
688.14	C3.StatusCurrent_FeedForwardCurrentJerk	Status of current & jerk feedforward		C4_3	-
688.9	C3.StatusCurrent_PhaseU	Status of current phase U		C4_3	-
688.10	C3.StatusCurrent_PhaseV	Status of current phase V		C4_3	-
688.1	C3.StatusCurrent_Reference	Status of setpoint current RMS (torque forming)		E2_6	-
688.18	C3.StatusCurrent_ReferenceDINT	Target current r.m.s.		I32	-
688.13	C3.StatusCurrent_ReferenceJerk	Status of demand jerk setpoint generator		C4_3	-
688.11	C3.StatusCurrent_ReferenceVoltageUq	Status of current control control signal		C4_3	-
688.22	C3.StatusCurrent_ReferenceVoltageVector	Provided voltage pointer		C4_3	-

688.30	C3.StatusCurrent_VoltageUd	Provided voltage of direct current controller		C4_3	-
688.29	C3.StatusCurrent_VoltageUq	Provided voltage of quadrature current controller		C4_3	-
683.5	C3.StatusDevice_ObservedDisturbance	Status of observed disturbance		C4_3	-
680.12	C3.StatusPosition_DemandController	Status demand position without absolute reference		C4_3	-
680.23	C3.StatusPosition_LoadControlActual	Actual position of the load		C4_3	-
680.20	C3.StatusPosition_LoadControlDeviation	Position difference load-motor (unfiltered)		C4_3	-
680.22	C3.StatusPosition_LoadControlDeviationFiltered	Position difference load-motor (filtered)		C4_3	-
680.21	C3.StatusPosition_LoadControlDeviationMax	Maximum position difference load-motor		C4_3	-
681.9	C3.StatusSpeed_ActualFiltered	Status actual speed filtered		C4_3	-
681.12	C3.StatusSpeed_ActualScaled	Filtered actual speed		C4_3	-
681.13	C3.StatusSpeed_DemandScaled	Setpoint speed of the setpoint generator		C4_3	-
681.10	C3.StatusSpeed_DemandSpeedController	Status demand speed controller input		C4_3	-
681.11	C3.StatusSpeed_FeedForwardSpeed	Status speed feed forward		C4_3	-
681.20	C3.StatusSpeed_LoadControl	Speed of the load feedback (unfiltered)		C4_3	-
681.21	C3.StatusSpeed_LoadControlFiltered	Speed of the load feedback (filtered)		C4_3	-
2190.2	C3Plus.AutoCommutationControl_InitialCurrent	Start current of automatic commutation		U16	VP
2190.4	C3Plus.AutoCommutationControl_MotionReduction	Motion reduction Automatic commutation		U16	VP
2190.3	C3Plus.AutoCommutationControl_PositionThreshold	Motion limit for automatic commutation		U16	VP
2190.1	C3Plus.AutoCommutationControl_Ramptime	Ramp slope current slope AK		U16	VP
85.3	C3Plus.Diagnostics_DCbus_Current	C3MP DC intermediate current		I16	-
85.2	C3Plus.Diagnostics_DCbus_Voltage	C3MP DC intermediate voltage		I16	-
85.5	C3Plus.Diagnostics_RectifierLoad	C3MP usage in %		I16	-
85.4	C3Plus.Diagnostics_TemperatureHeatSink	C3MP temperature of heat dissipator		I16	-
2020.7	C3Plus.ExternalSignal_Accel_Munits	Acceleration of the external signal source		I32	-
2020.6	C3Plus.ExternalSignal_Speed_Munits	Speed value of the external signal source		C4_3	-
1130.13	C3Plus.HOMING_edge_position	Distance MN (zero) initiator - motor zero		C4_3	Immediately
2201.2	C3Plus.LoadControl_Command	Load control command mode		I16	Immediately
2201.1	C3Plus.LoadControl_Enable	Enable load control		I16	Immediately
2201.11	C3Plus.LoadControl_FilterLaggingPart	Time constant of position difference filter		U32	VP
2201.3	C3Plus.LoadControl_Status	Load control status bits		I16	-
2201.12	C3Plus.LoadControl_VelocityFilter	Time constant of the load-speed filter		I16	VP
2150.2	C3Plus.NotchFilter_BandwidthFilter1	Bandwidth of notch filter 1		I16	VP
2150.5	C3Plus.NotchFilter_BandwidthFilter2	Bandwidth of notch filter 2		I16	VP
2150.3	C3Plus.NotchFilter_DepthFilter1	Depth of notch filter 1		I32	VP
2150.6	C3Plus.NotchFilter_DepthFilter2	Depth of notch filter 2		I32	VP
2150.1	C3Plus.NotchFilter_FrequencyFilter1	Center frequency of notch filter 1		I16	VP
2150.4	C3Plus.NotchFilter_FrequencyFilter2	Center frequency of notch filter 2		I16	VP
1211.13	C3Plus.PG2POSITION_direction	Manipulation of the motion direction in reset mode		I32	Immediately
1111.13	C3Plus.POSITION_direction	Manipulation of the motion direction in reset mode		I32	Immediately
2200.20	C3Plus.PositionController_DeadBand	Deadband of position controller		C4_3	VP
2200.21	C3Plus.PositionController_FrictionCompensation	Friction compensation		I32	VP
2200.11	C3Plus.PositionController_TrackingErrorFilter	Following error filter of the position controller		U16	VP
2200.24	C3Plus.PositionController_TrackingErrorFilter_us	Time constant following error filter of position controller		U16	VP
670.4	C3Plus.StatusTorqueForce_ActualForce	Status of actual force		I32	-
670.2	C3Plus.StatusTorqueForce_ActualTorque	Status of actual torque		I32	-
110.1	C3Plus.Switch_DeviceFunction	Value of the function switch on C3M		U16	-

2109.1	C3Plus.TrackingfilterHEDA_TRFSpeed	Time constant tracking filter HEDA-process position		I16	VP
2107.1	C3Plus.TrackingfilterPhysicalSource_TRFSpeed	Time constant tracking filter physical source		U16	VP
2110.4	C3Plus.TrackingfilterSG1_AccelFilter	Filter effect of acceleration filter setpoint encoder		U16	VP
2110.7	C3Plus.TrackingfilterSG1_AccelFilter_us	Filter time constant acceleration setpoint generator		U16	VP
2110.3	C3Plus.TrackingfilterSG1_FilterSpeed	Filter effect of speed filter setpoint encoder		U16	VP
2110.6	C3Plus.TrackingfilterSG1_FilterSpeed_us	Filter time constant velocity setpoint generator		U16	VP
2110.1	C3Plus.TrackingfilterSG1_TRFSpeed	Time constant tracking filter setpoint encoder		I16	VP
1130.7	C3Plus.HOMING_edge_sensor_distance	Initiator adjustment	0x2000	C4_3	Immediately
1113.2	C3Plus.STOP_jerk	Jerk for STOP	0x2001	U32	Immediately
1116.1	C3Plus.FSTOP1_decel	Deceleration for FSTOP1	0x2002	U32	Immediately
1116.2	C3Plus.FSTOP1_jerk	Jerk for FSTOP1	0x2003	U32	Immediately
1118.2	C3Plus.FSTOP3_jerk	Jerk for FSTOP3	0x2004	U32	Immediately
1111.5	C3Plus.POSITION_jerk_accel	Acceleration jerk for positioning	0x2005	U32	Immediately
1111.6	C3Plus.POSITION_jerk_decel	Deceleration jerk for positioning	0x2006	U32	Immediately
1128.1	C3Plus.JOG_accel	Acceleration for JOG +/-	0x2007	U32	Immediately
1128.3	C3Plus.JOG_speed	Speed for JOG +/-	0x2008	C4_3	Immediately
402.1	C3.Limit_SpeedPositive	Maximum permissible positive speed	0x2009	I16	VP
402.2	C3.Limit_SpeedNegative	Maximum permissible negative speed	0x200A	I16	VP
402.3	C3.Limit_CurrentPositive	Maximum permissible positive current	0x200B	I16	VP
402.4	C3.Limit_CurrentNegative	Maximum permissible negative current	0x200C	I16	VP
1118.1	C3Plus.FSTOP3_decel	Deceleration for FSTOP3	0x200D	U32	Immediately
682.4	C3.StatusAccel_DemandValue	Status demand acceleration	0x200E	I32	-
685.1	C3.StatusVoltage_AuxiliaryVoltage	Status of auxiliary voltage	0x200F	E2_6	-
1128.2	C3Plus.JOG_jerk	Jerk for JOG +/-	0x2010	U32	Immediately
683.2	C3.StatusDevice_ActualDeviceLoad	Status of device load	0x2011	E2_6	-
683.3	C3.StatusDevice_ActualMotorLoad	Status of long-term motor load	0x2012	E2_6	-
684.2	C3.StatusTemperature_Motor	Status of motor temperature	0x2013	U16	-
684.1	C3.StatusTemperature_PowerStage	Status of power output stage temperature	0x2014	U16	-
1125.2	C3Plus.ERROR_jerk	Jerk upon Error	0x2015	U32	Immediately
210.10	C3.ValidParameter_Global	Set objects to valid	0x2016.10	U16	Immediately
20.1	C3.ObjectDir_Objekts-->FLASH	Store objects permanently (bus)	0x2017	I16	Immediately
1125.1	C3Plus.ERROR_decel	Deceleration upon error	0x2018	U32	Immediately
1100.4	C3Plus.DeviceControl_Controlword_2	Control word 2	0x201B	V2	Immediately
1000.4	C3Plus.DeviceState_Statusword_2	Status word 2	0x201C	V2	Immediately
681.7	C3.StatusSpeed_Actual_Y2	Status of the actual speed in the Y2 format	0x2023	Y2	-
685.3	C3.StatusVoltage_AnalogInput0	Status of analog input 0	0x2025	Y2	-
685.4	C3.StatusVoltage_AnalogInput1	Status of analog input 1	0x2026	Y2	-
681.6	C3.StatusSpeed_Error	Status control deviation of speed	0x2027	C4_3	-
1100.6	C3Plus.DeviceControl_DemandValue1	Device demand value A	0x202A/0x2044/0x607A/	Y4	Immediately

1100.7	C3Plus.DeviceControl_DemandValue2	Device demand value D	0x202B/0x2046/0x6081	Y4	Immediately
1100.14	C3Plus.DeviceControl_DemandValue2_Y2	Device demand value	0x202C/0x2068	Y2	Immediately
1111.10	C3Plus.POSITION_accel_U16	Acceleration for Positioning in U16 Format	0x202D	U16	Immediately
1111.16	C3Plus.POSITION_decel_U16	Deceleration for Positioning in U16 Format	0x205D	U16	Immediately
820.24	C3.CANopen_SyncMode	Configuration of the bus synchronization process	0x205E	I16	Immediately
3300.8	C3Plus.TouchProbe_IgnoreZone_Start	Beginning of Registration lock-out zone (StartIgnore)	0x2066	C4_3	Immediately
3300.9	C3Plus.TouchProbe_IgnoreZone_End	End of Registration lock-out zone (StopIgnore)	0x2067	C4_3	Immediately
1100.13	C3Plus.DeviceControl_DemandValue8	Setpoint value	0x206A/0x60FF	Y4	Immediately
402.6	C3.Limit_CurrentFine	Factor for the current limits	0x2093	I16	Immediately
683.8	C3.StatusDevice_MotorCurrent	Motor current in per thousand of the actual current limit	0x2094	I16	-
1.21	C3.Device_FirmwareRelease	Version of firmware package	0x20FF	I32	Immediately
2100.2	C3.ControllerTuning_Stiffness	Stiffness (speed controller)	0x2100.2	U16	VP
2100.3	C3.ControllerTuning_Damping	Damping (rotation speed controller)	0x2100.3	U16	VP
2100.4	C3.ControllerTuning_Inertia	Moment of Inertia	0x2100.4	U16	VP
2100.5	C3.ControllerTuning_FilterSpeed	Filter - Actual velocity	0x2100.5	U16	VP
2100.6	C3.ControllerTuning_FilterAccel	Filter - Actual acceleration	0x2100.6	U16	VP
2100.7	C3.ControllerTuning_SpeedDFactor	D-component of speed controller	0x2100.7	U16	VP
2100.8	C3.ControllerTuning_CurrentBandwidth	Current regulator bandwidth	0x2100.8	U16	VP
2100.9	C3.ControllerTuning_CurrentDamping	Current loop - Damping	0x2100.9	U16	VP
2010.1	C3.FeedForward_Speed	Velocity feed-forward	0x2101.1	U16	VP
2010.2	C3.FeedForward_Accel	Acceleration feed-forward	0x2101.2	U16	VP
2010.4	C3.FeedForward_Current	Current feed-forward	0x2101.4	U16	VP
2010.5	C3.FeedForward_Jerk	Jerk feed-forward	0x2101.5	U16	VP
2011.1	C3.FeedForwardExternal_FilterSpeed	External Speed Feed Forward Filter Time Constant	0x2102.1	U16	VP
2011.2	C3.FeedForwardExternal_FilterAccel	External Acceleration Feed Forward Filter Time Constant	0x2102.2	U16	VP
1900.1	C3Array.Pointer_Row	Pointer to table row	0x2300	U16	Immediately
1901.1	C3Array.Col01_Row01	variable Column 1 Row 1	0x2301.1	Y4	Immediately
1902.1	C3Array.Col02_Row01	variable Column 2 Row 1	0x2302.1	Y2	Immediately
1903.1	C3Array.Col03_Row01	variable Column 3 Row 1	0x2303.1	I16	Immediately
1904.1	C3Array.Col04_Row01	variable Column 4 Row 1	0x2304.1	I16	Immediately
1905.1	C3Array.Col05_Row01	variable Column 5 Row 1	0x2305.1	I16	Immediately
1906.1	C3Array.Col06_Row01	variable Column 6 Row 1	0x2306.1	I32	Immediately
1907.1	C3Array.Col07_Row01	variable Column 7 Row 1	0x2307.1	I32	Immediately
1908.1	C3Array.Col08_Row01	variable Column 8 Row 1	0x2308.1	I32	Immediately
1909.1	C3Array.Col09_Row01	variable Column 9 Row 1	0x2309.1	I32	Immediately
1910.1	C3Array.Indirect_Col01	Indirect table access Column 1	0x2311	Y4	Immediately
550.1	C3Plus.ErrorHistory_LastError	Current error (n)	0x603F/0x201D.1	U16	-
1100.3	C3Plus.DeviceControl_Controlword_1	Control word CW	0x6040	V2	Immediately
1000.3	C3Plus.DeviceState_Statusword_1	Status word SW	0x6041	V2	Immediately

1100.20	C3Plus.DeviceControl_QuickStopMode	Quick Stop operating mode	0x605A	I16	Immediately
1100.5	C3Plus.DeviceControl_OperationMode	Operating mode	0x6060	I16	Immediately
1000.5	C3Plus.DeviceState_ActualOperationMode	Operating mode display	0x6061	I16	Immediately
680.5	C3.StatusPosition_Actual	Status actual position	0x6064	C4_3	-
420.2	C3.PositioningAccuracy_FollowingErrorWindow	Following error limit	0x6065	C4_3	VP
420.3	C3.PositioningAccuracy_FollowingErrorTimeout	Following Error Time	0x6066	U16	Immediately
420.1	C3.PositioningAccuracy_Window	Positioning window for position reached	0x6067	C4_3	VP
420.7	C3.PositioningAccuracy_WindowTime	In Position Window Time	0x6068	U16	Immediately
681.4	C3.StatusSpeed_DemandValue	Status demand speed of setpoint generator	0x606B	C4_3	-
681.5	C3.StatusSpeed_Actual	Status actual speed unfiltered	0x606C	C4_3	-
683.1	C3.StatusDevice_ActualCurrent	Status of actual current value	0x6077	E2_6	-
685.2	C3.StatusVoltage_BusVoltage	Status DC bus voltage	0x6079	E2_6	-
1111.1	C3Plus.POSITION_position	Target position	0x607A	C4_3	Immediately
1130.5	C3Plus.HOMING_home_offset	Machine reference offset	0x607C	C4_3	Immediately
410.3	C3.LimitPosition_Negative	negative end limit	0x607D.1	C4_3	Immediately
410.2	C3.LimitPosition_Positive	positive end limit	0x607D.2	C4_3	Immediately
1111.2	C3Plus.POSITION_speed	Speed for positioning	0x6081	C4_3	Immediately
1111.3	C3Plus.POSITION_accel	Acceleration for positioning	0x6083	U32	Immediately
1127.1	C3Plus.SPEED_accel	Acceleration / deceleration in speed control operating mode	0x6083	U32	Immediately
1111.4	C3Plus.POSITION_decel	Deceleration for positioning	0x6084	U32	Immediately
1113.1	C3Plus.STOP_decel	Deceleration upon STOP	0x6085	U32	Immediately
1130.4	C3Plus.HOMING_mode	Adjusting the homing mode	0x6098	U16	Immediately
1130.3	C3Plus.HOMING_speed	Speed for homing	0x6099.1	C4_3	Immediately
1130.1	C3Plus.HOMING_accel	Acceleration / deceleration homing run	0x609A	U32	Immediately
3925.1	C3.FBI_Interpolation_SubModeSelect	Interpolation method	0x60C0.0	I16	Immediately
680.6	C3.StatusPosition_FollowingError	Status of following error	0x60F4	C4_3	-
680.4	C3.StatusPosition_DemandValue	Status demand position	0x60FC	C4_3	-
1127.3	C3Plus.SPEED_speed	Setpoint speed in speed control operating mode	0x60FF	C4_3	Immediately
120.3	C3.DigitalInput_DebouncedValue	Status of digital inputs	0x6100.1	V2	-
121.2	C3.DigitalInputAddition_Value	Input word of I/O option	0x6100.2	V2	-
133.3	C3.DigitalOutputAddition_Value	Output word for I/O option	0x6300.2	V2	Immediately

Standardized and manufacturer-specific objects sorted according to object names
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No.	Object name	Object	CANopen Index	Bus format	Valid beginning
820.24	C3.CANopen_SyncMode	Configuration of the bus synchronization process	0x205E	I16	Immediately
2100.20	C3.ControllerTuning_ActuatingSpeedSignalFilter_us	Control signal filter of velocity control		U16	VP
2100.8	C3.ControllerTuning_CurrentBandwidth	Current regulator bandwidth	0x2100.8	U16	VP
2100.9	C3.ControllerTuning_CurrentDamping	Current loop - Damping	0x2100.9	U16	VP
2100.3	C3.ControllerTuning_Damping	Damping (rotation speed controller)	0x2100.3	U16	VP
2100.6	C3.ControllerTuning_FilterAccel	Filter - Actual acceleration	0x2100.6	U16	VP
2100.21	C3.ControllerTuning_FilterAccel_us	Filter - Actual acceleration		U16	VP
2100.11	C3.ControllerTuning_FilterAccel2	Filter actual acceleration 2		U16	VP
2100.5	C3.ControllerTuning_FilterSpeed	Filter - Actual velocity	0x2100.5	U16	VP
2100.4	C3.ControllerTuning_Inertia	Moment of Inertia	0x2100.4	U16	VP
2100.7	C3.ControllerTuning_SpeedDFactor	D-component of speed controller	0x2100.7	U16	VP
2100.2	C3.ControllerTuning_Stiffness	Stiffness (speed controller)	0x2100.2	U16	VP
2230.20	C3.D_CurrentController_Ld_Lq_Ratio	Ratio direct to quadrature inductance		U16	VP
2230.24	C3.D_CurrentController_VoltageDecouplingEnable	Activation of the voltage decoupling		I16	VP
990.1	C3.Delay_MasterDelay	Setpoint delay for bus master		I16	Immediately
1.21	C3.Device_FirmwareRelease	Version of firmware package	0x20FF	I32	Immediately
84.4	C3.DeviceSupervision_DeviceAdr	Current RS485 address of the C3M		U16	-
84.3	C3.DeviceSupervision_DeviceCounter	Number of devices in the C3M combination		U16	-
84.5	C3.DeviceSupervision_OperatingTime	Hours of operation of the C3MP in s		U32	-
84.2	C3.DeviceSupervision_ThisDevice	Device number in the C3M combination		U16	-
85.1	C3.Diagnostics_DeviceState	C3MP operating status		V2	-
120.3	C3.DigitalInput_DebouncedValue	Status of digital inputs	0x6100.1	V2	-
120.2	C3.DigitalInput_Value	Status of digital inputs		V2	-
121.2	C3.DigitalInputAddition_Value	Input word of I/O option	0x6100.2	V2	-
133.3	C3.DigitalOutputAddition_Value	Output word for I/O option	0x6300.2	V2	Immediately
87.1	C3.ErrorHistoryNumber_1	Error 1		U16	-
86.1	C3.ErrorHistoryPointer_LastEntry	Pointer to current error		U16	-
88.1	C3.ErrorHistoryTime_1	Error point in time 1		U32	-
2020.1	C3.ExternalSignal_Position	Position from external signal source		C4_3	-
3925.1	C3.FBI_Interpolation_SubModeSelect	Interpolation method	0x60C0.0	I16	Immediately
2010.2	C3.FeedForward_Accel	Acceleration feed-forward	0x2101.2	U16	VP
2010.4	C3.FeedForward_Current	Current feed-forward	0x2101.4	U16	VP
2010.20	C3.FeedForward_EMF	EMC feedforward		U16	VP
2010.5	C3.FeedForward_Jerk	Jerk feed-forward	0x2101.5	U16	VP
2010.1	C3.FeedForward_Speed	Velocity feed-forward	0x2101.1	U16	VP
2011.2	C3.FeedForwardExternal_FilterAccel	External Acceleration Feed Forward Filter Time Constant	0x2102.2	U16	VP
2011.5	C3.FeedForwardExternal_FilterAccel_us	Filter time constant ext. Acceleration		U16	VP
2011.1	C3.FeedForwardExternal_FilterSpeed	External Speed Feed Forward Filter Time Constant	0x2102.1	U16	VP
2011.4	C3.FeedForwardExternal_FilterSpeed_us	Filter time constant ext. Velocity		U16	VP
402.6	C3.Limit_CurrentFine	Factor for the current limits	0x2093	I16	Immediately
402.4	C3.Limit_CurrentNegative	Maximum permissible negative current	0x200C	I16	VP
402.3	C3.Limit_CurrentPositive	Maximum permissible positive current	0x200B	I16	VP
402.2	C3.Limit_SpeedNegative	Maximum permissible negative speed	0x200A	I16	VP
402.1	C3.Limit_SpeedPositive	Maximum permissible positive speed	0x2009	I16	VP
410.6	C3.LimitPosition_LoadControlMaxPosDiff	Position difference load-motor (error threshold)		C4_3	VP
410.3	C3.LimitPosition_Negative	negative end limit	0x607D.1	C4_3	Immediately

410.2	C3.LimitPosition_Positive	positive end limit	0x607D.2	C4_3	Immediately
20.1	C3.ObjectDir_Objekts-->FLASH	Store objects permanently (bus)	0x2017	I16	Immediately
420.3	C3.PositioningAccuracy_FollowingErrorTimeout	Following Error Time	0x6066	U16	Immediately
420.2	C3.PositioningAccuracy_FollowingErrorWindow	Following error limit	0x6065	C4_3	VP
420.1	C3.PositioningAccuracy_Window	Positioning window for position reached	0x6067	C4_3	VP
420.7	C3.PositioningAccuracy_WindowTime	In Position Window Time	0x6068	U16	Immediately
2220.22	C3.Q_CurrentController_BackEMF	Parameter motor force constant		I16	VP
2220.20	C3.Q_CurrentController_Inductance	Parameter motor inductance		I16	VP
2220.21	C3.Q_CurrentController_Resistance	Parameter motor resistance		I16	VP
2210.17	C3.SpeedController_ActualBandwidth	Replacement time constant for the velocity control		I32	-
2120.7	C3.SpeedObserver_DisturbanceAdditionEnable	Switch to enable disturbance compensation		BOOL	VP
2120.5	C3.SpeedObserver_DisturbanceFilter	Time constant disturbance filter		U32	VP
2120.1	C3.SpeedObserver_TimeConstant	Rapidity of the speed monitor		U32	VP
682.5	C3.StatusAccel_Actual	Status of actual acceleration unfiltered		I32	-
682.6	C3.StatusAccel_ActualFilter	Status of filtered actual acceleration		I32	-
682.4	C3.StatusAccel_DemandValue	Status demand acceleration	0x200E	I32	-
682.7	C3.StatusAccel_FeedForwardAccel	Status acceleration feed forward		C4_3	-
690.5	C3.StatusAutocommutation_Iterations	Current increase steps automatic commutation		U16	-
688.2	C3.StatusCurrent_Actual	Status of actual current RMS (torque producing)		E2_6	-
688.19	C3.StatusCurrent_ActualDINT	Actual current r.m.s.		I32	-
688.8	C3.StatusCurrent_ControlDeviationIq	Status of control deviation of current control RMS		C4_3	-
688.31	C3.StatusCurrent_DecouplingVoltageUd	Signal decoupling of direct current controller		C4_3	-
688.32	C3.StatusCurrent_FeedForwardbackEMF	Signal EMC feedforward		C4_3	-
688.14	C3.StatusCurrent_FeedForwardCurrentJerk	Status of current & jerk feedforward		C4_3	-
688.9	C3.StatusCurrent_PhaseU	Status of current phase U		C4_3	-
688.10	C3.StatusCurrent_PhaseV	Status of current phase V		C4_3	-
688.1	C3.StatusCurrent_Reference	Status of setpoint current RMS (torque forming)		E2_6	-
688.18	C3.StatusCurrent_ReferenceDINT	Target current r.m.s.		I32	-
688.13	C3.StatusCurrent_ReferenceJerk	Status of demand jerk setpoint generator		C4_3	-
688.11	C3.StatusCurrent_ReferenceVoltageUq	Status of current control control signal		C4_3	-
688.22	C3.StatusCurrent_ReferenceVoltageVector	Provided voltage pointer		C4_3	-
688.30	C3.StatusCurrent_VoltageUd	Provided voltage of direct current controller		C4_3	-
688.29	C3.StatusCurrent_VoltageUq	Provided voltage of quadrature current controller		C4_3	-
683.1	C3.StatusDevice_ActualCurrent	Status of actual current value	0x6077	E2_6	-
683.2	C3.StatusDevice_ActualDeviceLoad	Status of device load	0x2011	E2_6	-
683.3	C3.StatusDevice_ActualMotorLoad	Status of long-term motor load	0x2012	E2_6	-
683.8	C3.StatusDevice_MotorCurrent	Motor current in per thousand of the actual current limit	0x2094	I16	-
683.5	C3.StatusDevice_ObservedDisturbance	Status of observed disturbance		C4_3	-
680.5	C3.StatusPosition_Actual	Status actual position	0x6064	C4_3	-
680.12	C3.StatusPosition_DemandController	Status demand position without absolute reference		C4_3	-
680.4	C3.StatusPosition_DemandValue	Status demand position	0x60FC	C4_3	-
680.6	C3.StatusPosition_FollowingError	Status of following error	0x60F4	C4_3	-
680.23	C3.StatusPosition_LoadControlActual	Actual position of the load		C4_3	-
680.20	C3.StatusPosition_LoadControlDeviation	Position difference load-motor (unfiltered)		C4_3	-
680.22	C3.StatusPosition_LoadControlDeviationFiltered	Position difference load-motor (filtered)		C4_3	-
680.21	C3.StatusPosition_LoadControlDeviationMax	Maximum position difference load-motor		C4_3	-

681.5	C3.StatusSpeed_Actual	Status actual speed unfiltered	0x606C	C4_3	-
681.7	C3.StatusSpeed_Actual_Y2	Status of the actual speed in the Y2 format	0x2023	Y2	-
681.9	C3.StatusSpeed_ActualFiltered	Status actual speed filtered		C4_3	-
681.12	C3.StatusSpeed_ActualScaled	Filtered actual speed		C4_3	-
681.13	C3.StatusSpeed_DemandScaled	Setpoint speed of the setpoint generator		C4_3	-
681.10	C3.StatusSpeed_DemandSpeedController	Status demand speed controller input		C4_3	-
681.4	C3.StatusSpeed_DemandValue	Status demand speed of setpoint generator	0x606B	C4_3	-
681.6	C3.StatusSpeed_Error	Status control deviation of speed	0x2027	C4_3	-
681.11	C3.StatusSpeed_FeedForwardSpeed	Status speed feed forward		C4_3	-
681.20	C3.StatusSpeed_LoadControl	Speed of the load feedback (unfiltered)		C4_3	-
681.21	C3.StatusSpeed_LoadControlFiltered	Speed of the load feedback (filtered)		C4_3	-
684.2	C3.StatusTemperature_Motor	Status of motor temperature	0x2013	U16	-
684.1	C3.StatusTemperature_PowerStage	Status of power output stage temperature	0x2014	U16	-
685.3	C3.StatusVoltage_AnalogInput0	Status of analog input 0	0x2025	Y2	-
685.4	C3.StatusVoltage_AnalogInput1	Status of analog input 1	0x2026	Y2	-
685.1	C3.StatusVoltage_AuxiliaryVoltage	Status of auxiliary voltage	0x200F	E2_6	-
685.2	C3.StatusVoltage_BusVoltage	Status DC bus voltage	0x6079	E2_6	-
210.10	C3.ValidParameter_Global	Set objects to valid	0x2016.10	U16	Immediately
1901.1	C3Array.Col01_Row01	variable Column 1 Row 1	0x2301.1	Y4	Immediately
1902.1	C3Array.Col02_Row01	variable Column 2 Row 1	0x2302.1	Y2	Immediately
1903.1	C3Array.Col03_Row01	variable Column 3 Row 1	0x2303.1	I16	Immediately
1904.1	C3Array.Col04_Row01	variable Column 4 Row 1	0x2304.1	I16	Immediately
1905.1	C3Array.Col05_Row01	variable Column 5 Row 1	0x2305.1	I16	Immediately
1906.1	C3Array.Col06_Row01	variable Column 6 Row 1	0x2306.1	I32	Immediately
1907.1	C3Array.Col07_Row01	variable Column 7 Row 1	0x2307.1	I32	Immediately
1908.1	C3Array.Col08_Row01	variable Column 8 Row 1	0x2308.1	I32	Immediately
1909.1	C3Array.Col09_Row01	variable Column 9 Row 1	0x2309.1	I32	Immediately
1910.1	C3Array.Indirect_Col01	Indirect table access Column 1	0x2311	Y4	Immediately
1900.1	C3Array.Pointer_Row	Pointer to table row	0x2300	U16	Immediately
2190.2	C3Plus.AutoCommutationControl_InitialCurrent	Start current of automatic commutation		U16	VP
2190.4	C3Plus.AutoCommutationControl_MotionReduction	Motion reduction Automatic commutation		U16	VP
2190.3	C3Plus.AutoCommutationControl_PositionThreshold	Motion limit for automatic commutation		U16	VP
2190.1	C3Plus.AutoCommutationControl_Ramptime	Ramp slope current slope AK		U16	VP
1100.3	C3Plus.DeviceControl_Controlword_1	Control word CW	0x6040	V2	Immediately
1100.4	C3Plus.DeviceControl_Controlword_2	Control word 2	0x201B	V2	Immediately
1100.6	C3Plus.DeviceControl_DemandValue1	Device demand value A	0x202A/0x2044/0x607A/	Y4	Immediately
1100.7	C3Plus.DeviceControl_DemandValue2	Device demand value D	0x202B/0x2046/0x6081	Y4	Immediately
1100.14	C3Plus.DeviceControl_DemandValue2_Y2	Device demand value	0x202C/0x2068	Y2	Immediately
1100.13	C3Plus.DeviceControl_DemandValue8	Setpoint value	0x206A/0x60FF	Y4	Immediately
1100.5	C3Plus.DeviceControl_OperationMode	Operating mode	0x6060	I16	Immediately
1100.20	C3Plus.DeviceControl_QuickStopMode	Quick Stop operating mode	0x605A	I16	Immediately

1000.5	C3Plus.DeviceState_ActualOperationMode	Operating mode display	0x6061	I16	Immediately
1000.3	C3Plus.DeviceState_Statusword_1	Status word SW	0x6041	V2	Immediately
1000.4	C3Plus.DeviceState_Statusword_2	Status word 2	0x201C	V2	Immediately
85.3	C3Plus.Diagnostics_DCbus_Current	C3MP DC intermediate current		I16	-
85.2	C3Plus.Diagnostics_DCbus_Voltage	C3MP DC intermediate voltage		I16	-
85.5	C3Plus.Diagnostics_RectifierLoad	C3MP usage in %		I16	-
85.4	C3Plus.Diagnostics_TemperatureHeatSink	C3MP temperature of heat dissipator		I16	-
1125.1	C3Plus.ERROR_decel	Deceleration upon error	0x2018	U32	Immediately
1125.2	C3Plus.ERROR_jerk	Jerk upon Error	0x2015	U32	Immediately
550.1	C3Plus.ErrorHistory_LastError	Current error (n)	0x603F/ 0x201D.1	U16	-
2020.7	C3Plus.ExternalSignal_Accel_Munits	Acceleration of the external signal source		I32	-
2020.6	C3Plus.ExternalSignal_Speed_Munits	Speed value of the external signal source		C4_3	-
1116.1	C3Plus.FSTOP1_decel	Deceleration for FSTOP1	0x2002	U32	Immediately
1116.2	C3Plus.FSTOP1_jerk	Jerk for FSTOP1	0x2003	U32	Immediately
1118.1	C3Plus.FSTOP3_decel	Deceleration for FSTOP3	0x200D	U32	Immediately
1118.2	C3Plus.FSTOP3_jerk	Jerk for FSTOP3	0x2004	U32	Immediately
1130.1	C3Plus.HOMING_accel	Acceleration / deceleration homing run	0x609A	U32	Immediately
1130.13	C3Plus.HOMING_edge_position	Distance MN (zero) initiator - motor zero		C4_3	Immediately
1130.7	C3Plus.HOMING_edge_sensor_distance	Initiator adjustment	0x2000	C4_3	Immediately
1130.5	C3Plus.HOMING_home_offset	Machine reference offset	0x607C	C4_3	Immediately
1130.4	C3Plus.HOMING_mode	Adjusting the homing mode	0x6098	U16	Immediately
1130.3	C3Plus.HOMING_speed	Speed for homing	0x6099.1	C4_3	Immediately
1128.1	C3Plus.JOG_accel	Acceleration for JOG +/-	0x2007	U32	Immediately
1128.2	C3Plus.JOG_jerk	Jerk for JOG +/-	0x2010	U32	Immediately
1128.3	C3Plus.JOG_speed	Speed for JOG+/-	0x2008	C4_3	Immediately
2201.2	C3Plus.LoadControl_Command	Load control command mode		I16	Immediately
2201.1	C3Plus.LoadControl_Enable	Enable load control		I16	Immediately
2201.11	C3Plus.LoadControl_FilterLaggingPart	Time constant of position difference filter		U32	VP
2201.3	C3Plus.LoadControl_Status	Load control status bits		I16	-
2201.12	C3Plus.LoadControl_VelocityFilter	Time constant of the load-speed filter		I16	VP
2150.2	C3Plus.NotchFilter_BandwidthFilter1	Bandwidth of notch filter 1		I16	VP
2150.5	C3Plus.NotchFilter_BandwidthFilter2	Bandwidth of notch filter 2		I16	VP
2150.3	C3Plus.NotchFilter_DepthFilter1	Depth of notch filter 1		I32	VP
2150.6	C3Plus.NotchFilter_DepthFilter2	Depth of notch filter 2		I32	VP
2150.1	C3Plus.NotchFilter_FrequencyFilter1	Center frequency of notch filter 1		I16	VP
2150.4	C3Plus.NotchFilter_FrequencyFilter2	Center frequency of notch filter 2		I16	VP
1211.13	C3Plus.PG2POSITION_direction	Manipulation of the motion direction in reset mode		I32	Immediately
1111.3	C3Plus.POSITION_accel	Acceleration for positioning	0x6083	U32	Immediately
1111.10	C3Plus.POSITION_accel_U16	Acceleration for Positioning in U16 Format	0x202D	U16	Immediately

1111.4	C3Plus.POSITION_decel	Deceleration for positioning	0x6084	U32	Immediately
1111.16	C3Plus.POSITION_decel_U16	Deceleration for Positioning in U16 Format	0x205D	U16	Immediately
1111.13	C3Plus.POSITION_direction	Manipulation of the motion direction in reset mode		I32	Immediately
1111.5	C3Plus.POSITION_jerk_accel	Acceleration jerk for positioning	0x2005	U32	Immediately
1111.6	C3Plus.POSITION_jerk_decel	Deceleration jerk for positioning	0x2006	U32	Immediately
1111.1	C3Plus.POSITION_position	Target position	0x607A	C4_3	Immediately
1111.2	C3Plus.POSITION_speed	Speed for positioning	0x6081	C4_3	Immediately
2200.20	C3Plus.PositionController_DeadBand	Deadband of position controller		C4_3	VP
2200.21	C3Plus.PositionController_FrictionCompensation	Friction compensation		I32	VP
2200.11	C3Plus.PositionController_TrackingErrorFilter	Following error filter of the position controller		U16	VP
2200.24	C3Plus.PositionController_TrackingErrorFilter_us	Time constant following error filter of position controller		U16	VP
1127.1	C3Plus.SPEED_accel	Acceleration / deceleration in speed control operating mode	0x6083	U32	Immediately
1127.3	C3Plus.SPEED_speed	Setpoint speed in speed control operating mode	0x60FF	C4_3	Immediately
670.4	C3Plus.StatusTorqueForce_ActualForce	Status of actual force		I32	-
670.2	C3Plus.StatusTorqueForce_ActualTorque	Status of actual torque		I32	-
1113.1	C3Plus.STOP_decel	Deceleration upon STOP	0x6085	U32	Immediately
1113.2	C3Plus.STOP_jerk	Jerk for STOP	0x2001	U32	Immediately
110.1	C3Plus.Switch_DeviceFunction	Value of the function switch on C3M		U16	-
3300.9	C3Plus.TouchProbe_IgnoreZone_End	End of Registration lock-out zone (StopIgnore)	0x2067	C4_3	Immediately
3300.8	C3Plus.TouchProbe_IgnoreZone_Start	Beginning of Registration lock-out zone (StartIgnore)	0x2066	C4_3	Immediately
2109.1	C3Plus.TrackingfilterHEDA_TRFSpeed	Time constant tracking filter HEDA-process position		I16	VP
2107.1	C3Plus.TrackingfilterPhysicalSource_TRFSpeed	Time constant tracking filter physical source		U16	VP
2110.4	C3Plus.TrackingfilterSG1_AccelFilter	Filter effect of acceleration filter setpoint encoder		U16	VP
2110.7	C3Plus.TrackingfilterSG1_AccelFilter_us	Filter time constant acceleration setpoint generator		U16	VP
2110.3	C3Plus.TrackingfilterSG1_FilterSpeed	Filter effect of speed filter setpoint encoder		U16	VP
2110.6	C3Plus.TrackingfilterSG1_FilterSpeed_us	Filter time constant velocity setpoint generator		U16	VP
2110.1	C3Plus.TrackingfilterSG1_TRFSpeed	Time constant tracking filter setpoint encoder		I16	VP

Detailed object list

A detailed object list can be found in the corresponding online help.

In this chapter you can read about:

Integer formats.....309
 Unsigned - Formats309
 Fixed point format E2_6.....309
 Fixed point format C4_3309
 Bit sequence V2.....310
 Byte string OS.....310

Integer formats

Twos complement representation;
 The highest order bit (MSB) is the bit after the sign bit (VZ) in the first octet.
 VZ == 0: positive numbers and zero; VZ == 1: negative numbers

Type	Bit	8	7	6	5	4	3	2	1
Integer 8 length: 1 Byte		VZ	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
Integer 16	MSB	VZ	2 ¹⁴	2 ¹³	2 ¹²	2 ¹¹	2 ¹⁰	2 ⁹	2 ⁸
Length: 1 Word	LSB	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
Integer 32	MSB	VZ	2 ³⁰	2 ²⁹	2 ²⁸	2 ²⁷	2 ²⁶	2 ²⁵	2 ²⁴
Length: 2 Words		2 ²³	2 ²²	2 ²¹	2 ²⁰	2 ¹⁹	2 ¹⁸	2 ¹⁷	2 ¹⁶
		2 ¹⁵	2 ¹⁴	2 ¹³	2 ¹²	2 ¹¹	2 ¹⁰	2 ⁹	2 ⁸
	LSB	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰

Unsigned - Formats

Type	Bit	8	7	6	5	4	3	2	1
Unsigned 8 Length: 1 Byte		2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
Unsigned 16	MSB	2 ¹⁵	2 ¹⁴	2 ¹³	2 ¹²	2 ¹¹	2 ¹⁰	2 ⁹	2 ⁸
Length: 1 Word	LSB	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
Unsigned 32	MSB	2 ³¹	2 ³⁰	2 ²⁹	2 ²⁸	2 ²⁷	2 ²⁶	2 ²⁵	2 ²⁴
Length: 2 Words		2 ²³	2 ²²	2 ²¹	2 ²⁰	2 ¹⁹	2 ¹⁸	2 ¹⁷	2 ¹⁶
		2 ¹⁵	2 ¹⁴	2 ¹³	2 ¹²	2 ¹¹	2 ¹⁰	2 ⁹	2 ⁸
	LSB	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰

Fixed point format E2_6

Linear fixed point value with six binary places after the decimal point. 0 corresponds to 0, 256 corresponds to 2¹⁴ (0x4000).
 Twos complement representation;
 MSB is the bit after the sign bit
 VZ == 0: positive numbers and zero;
 VZ == 1: negative numbers

Type	Bit	8	7	6	5	4	3	2	1
E2_6	MSB	VZ	2 ⁸	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²
Length: 1 Word	LSB	2 ¹	2 ⁰	2 ⁻¹	2 ⁻²	2 ⁻³	2 ⁻⁴	2 ⁻⁵	2 ⁻⁶

Fixed point format C4_3

Linear fixed point value with three decimal places after the decimal point. 0 corresponds to 0 and 0,001 corresponds to 2⁰ (0x0000 0001).
 Structure like data type Integer32, value of the bits reduced by a factor of 1000.
 Length: 2 Words

Bit sequence V2

The V2 bus format is a bit sequence with a length of 16 bits.

Byte string OS

Octet string OS: String with variable length.

5.3.6. Ethernet Powerlink - Communication profile

The communication objects described in this chapter are either set to sensible standard values or they are set under menu control with the help of the ServoManager.

The communication objects described below must be modified only for special deviating settings.

The Ethernet Powerlink communication profile can be found in the corresponding help system.

6. Status values

In this chapter you can read about:

D/A-Monitor.....	311
Status values	311

A list of the status values supports you in optimization and commissioning. Open the optimization function in the C3 ServoManager (double-click on optimization in the tree)

You will find the available status values in the lower right part of the window under selection (TAB) "Status values"

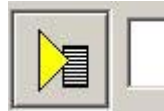
You can pull them into the oscilloscope (upper part of the left side) or into the status display (upper part of the right side) by the aid of the mouse (drag and drop). The status values are divided into 2 groups (user levels):

standard: here you can find all important status values

advanced: advanced status values, require a better knowledge

Switching of the user level

The user level can be changed in the optimization window (left hand side lower part under selection (TAB) "optimization") with the following button.



6.1 D/A-Monitor

A part of the status values can be output via the D/A monitor channel 0 (X11/4) and channel 1 (X11/3). In the following status list under D/A monitor output: possible / not possible).

The reference for the output voltage can be entered individually in the reference unit of the status value.

Example: Output Object 2210.2: (actual position unfiltered)

In order to get an output voltage of 10V at 3000min^{-1} , please enter 50Umd/s ($=3000\text{min}^{-1}$) as "value of the signal at 10V".

Hint

The unit of measurement of the D/A monitor values differs from the unit of measurement of the status values.

6.2 Status values

Additional information on the topic of "status values" can be found in the online help of the device.

7. Error

Standard error reactions:

Reaction 2: Downramp with "de-energize" **then apply brake** (see page 268) and finally de-energize.

For errors with standard reaction 2 the **error reaction can be changed** (see page 132).

Reaction 5: switch-off of the current immediately (without ramp), application of the brake.

Caution! A Z-axis may drop down due to the brake delay times

Most pending errors can be acknowledged with Quit!

The following errors must be acknowledged with Power on:

0x7381, 0x7382, 0x7391, 0x7392, 0x73A0

**Object 550.1 displays error:
value 1 means "no error".**

The errors as well as the error history can be viewed in the C3 ServoManager under optimization (at the top right of the optimization window).

7.1 Error list

Detailed information on the topic of the "error list" can be found in the online help of the device.

8. Order code

In this chapter you can read about:

Order code device: Compax3	314
Order code for mains module: Compax3MP	315
Accessories order code	315

8.1 Order code device: Compax3

Example: C3S025V2F10H10T10M00

	C3							
Device model: Compax3								
Single axis	S							
Highpower	H							
Multi-axis device	M							
Device currents static/dynamic; supply voltage								
2.5A / 5A ; 230VAC (single phase)	S	025	V2					
6.3A / 12.6A ; 230VAC (single phase)	S	063	V2					
10A / 20A ; 230VAC (three phase)	S	100	V2					
15A / 30A ; 230VAC (three phase)	S	150	V2					
1.5A / 4.5A ; 400VAC (three phase)	S	015	V4					
3.8A / 7.5A ; 400VAC (three phase)	S	038	V4					
7.5A / 15.0A ; 400VAC (three phase)	S	075	V4					
15.0A / 30.0A ; 400VAC (three phase)	S	150	V4					
30.0A / 60.0A ; 400VAC (three phase)	S	300	V4					
50A / 75A ; 400VAC (three phase)	H	050	V4					
90A / 135A ; 400VAC (three phase)	H	090	V4					
125A / 187.5A ; 400VAC (three phase)*	H	125	V4					
155A / 232.5A ; 400VAC (three phase)*	H	155	V4					
5.0A / 10.0A ; 400VAC (three phase)	M	050	D6					
10A / 20A ; 400VAC (three phase)	M	100	D6					
15A / 30A ; 400VAC (three phase)	M	150	D6					
Feedback:								
Resolver					F10			
SinCos© (Hiperface)					F11			
Encoder, Sine-cosine with/without hall					F12			
Interface:								
Step/direction / analog input					I10	T10	M00	
Positioning with inputs/outputs					I11	T11	M00	
Positioning via I/Os or RS232 / RS485/USB					I12			
Profibus DP V0/V1/V2 (12Mbaud)					I20			
CANopen					I21			
DeviceNet					I22			
Ethernet Powerlink					I30			
C3 powerPLmC (Multi-axis control)					C10		M00	
C3 powerPLmC (Multi-axis control) with Profibus					C13		M00	
Technology functions:								
Positioning						T11		
Motion control programmable according to IEC61131-3						T30		
Motion control programmable according to IEC61131-3 & electronic cam extension						T40		
Options:								
no additional supplement							M00	
Expansion 12 digital I/Os & HEDA (Motionbus)							M10	
HEDA (Motionbus)							M11	
Expansion, 12 digital I/Os							M12	
Safety technology only C3M: (In preparation)								
no safety technology					D6			S0

*external voltage supply for ventilator fan required. Available in two versions for single phase feed:

Standard: 220/240VAC: 140W,

On request: 110/120VAC: 130W

8.2 Order code for mains module: Compax3MP

Example: C3MP10D6USBM00

Device model: Compax3M

Power module

Nominal power; supply voltage

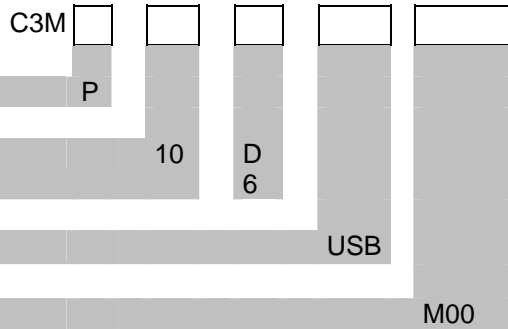
10kW; 400VAC (3-phase)

Interface:

USB connection

Options:

no additional supplement



8.3 Accessories order code

Order Code connection set for Compax3S

for C3S0xxV2	ZBH 02/01	ZBH	0 2 / 0 1		
for C3S0xxV4 / S150V4 / S1xxV2	ZBH 02/02	ZBH	0 2 / 0 2		
for C3S300V4	ZBH 02/03	ZBH	0 2 / 0 3		

Order Code connection set for Compax3MP/Compax3M

for C3M050D6, C3M100D6, C3M150D6	ZBH 04/01	ZBH	0 4 / 0 1
for C3MP10	ZBH 04/03	ZBH	0 4 / 0 3

Order code for feedback cables

for Resolver ⁽²⁾	for MH / SMH motors	REK	4 2 / ... ₁
for Resolver ⁽²⁾	for MH / SMH motors (cable chain compatible)	REK	4 1 / ... ₁
for SinCos® – Feedback devices ⁽²⁾	for MH / SMH motors (cable chain compatible)	GBK	2 4 / ... ₁
for EnDat 2.1 ⁽²⁾	for MH / SMH motors (cable chain compatible)	GBK	3 8 / ... ₁
Encoder – Compax3		GBK	2 3 / ... ₁
for LXR linear motors	(cable chain compatible)	GBK	3 3 / ... ₁
for BLMA linear motors	(cable chain compatible)	GBK	3 2 / ... ₁

Order code for motor cables⁽²⁾

for SMH / MH56 / MH70 / MH105 ⁽³⁾	(1.5mm ² ; up to 13.8A)	MOK	5 5 / ... ₁
for SMH / MH56 / MH70 / MH105 ⁽³⁾	(1.5mm ² ; up to 13.8A) (cable chain compatible)	MOK	5 4 / ... ₁
for SMH / MH56 / MH70 / MH105 ⁽³⁾	(2.5mm ² ; up to 18.9A)	MOK	5 6 / ... ₁
for SMH / MH56 / MH70 / MH105 ⁽³⁾	(2.5mm ² ; up to 18.9A) (cable chain compatible)	MOK	5 7 / ... ₁
for MH145 / MH205 ⁽⁴⁾	(1.5mm ² ; up to 13.8A)	MOK	6 0 / ... ₁

for MH145 / MH205 ⁽⁴⁾	(1.5mm ² ; up to 13.8A)	(cable chain compatible)	MOK	6 3 / ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(2.5mm ² ; up to 18.9A)		MOK	5 9 / ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(2.5mm ² ; up to 18.9A)	(cable chain compatible)	MOK	6 4 / ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(6mm ² ; up to 32.3A)	(cable chain compatible)	MOK	6 1 / ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(10mm ² ; up to 47.3A)	(cable chain compatible)	MOK	6 2 / ⁽¹⁾

Order Code braking resistors

for C3S063V2 or C3S075V4	56Ω / 0.18kW _{cont}	BRM	0 5 / 0 1	
for C3S075V4	56Ω / 0.57kW _{cont}	BRM	0 5 / 0 2	
for C3S025V2 or C3S038V4	100Ω / 60W _{cont}	BRM	0 8 / 0 1	
for C3S150V4	47Ω / 0.57kW _{cont}	BRM	1 0 / 0 1	
for C3S150V2 and C3S300V4	4/01:15Ω / 0.57kW _{cont} 4/02:15Ω / 0.74kW _{cont}	BRM	0 4 / 0 ...	
for C3S300V4	4/03:15Ω / 1.5kW _{cont}			
for C3S100V2	22Ω / 0.45kW _{cont}	BRM	0 9 / 0 1	
for C3H0xxV4	27Ω / 3.5kW _{cont}	BRM	1 1 / 0 1	
for C3MP10D6	30Ω / 0.5kW _{cont}	BRM	1 3 / 0 1	
for C3MP10D6, 2x15Ω in series	15Ω / 0.5kW _{cont}	BRM	1 4 / 0 1	
for C3H1xxV4	18Ω / 4.5kW _{cont}	BRM	1 2 / 0 1	

Order code mains filter Compax3S / Compax3H

for C3S025V2 or S063V2		NFI	0 1 / 0 1	
for C3S0xxV4, S150V4 or S1xxV2		NFI	0 1 / 0 2	
for C3S300V4		NFI	0 1 / 0 3	
for C3H050V4		NFI	0 2 / 0 1	
for C3H090V4		NFI	0 2 / 0 2	
for C3H1xxV4		NFI	0 2 / 0 3	

Order code mains filter Compax3MP

for C3MP10	Reference axis combination 3x480V 25A 6x10m motor cable length	NFI	0 3 / 0 1	
for C3MP10	Reference axis combination 3x480V 25A 6x50m motor cable length	NFI	0 3 / 0 2	

Order code for motor output filter (for Compax3S, Compax3M >20m motor cable)

up to 6,3 A rated motor current		MDR	0 1 / 0 4	
Up to 16 A rated motor current		MDR	0 1 / 0 1	
up to 30 A rated motor current		MDR	0 1 / 0 2	

Order code for interface cables and plugs

PC – Compax3 (RS232)		SSK	0 1 / ⁽¹⁾	
PC - Compax3MP (USB)		SSK	3 3 /	
on X11 (Ref/Analog) and X13 at C3F001D2	with flying leads	SSK	2 1 / ⁽¹⁾	

on X12 / X22 (I/Os digital)	with flying leads	SSK	2 2 / ⁽¹⁾
on X11 (Ref /Analog)	for I/O terminal block	SSK	2 3 / ⁽¹⁾
on X12 / X22 (I/Os digital)	for I/O terminal block	SSK	2 4 / ⁽¹⁾
PC ⇔ POP (RS232)		SSK	2 5 / ⁽¹⁾
Compax3 ⇔ POP (RS485) for several C3H on request		SSK	2 7 / .. / .. ⁽⁶⁾
Compax3 HEDA ⇔ Compax3 HEDA or PC ⇔ C3powerPLmC Compax3 I30 ⇔ Compax3 I30 or C3M-multi-axis communication		SSK	2 8 / .. / .. ⁽⁵⁾
Compax3 X11 ⇔ Compax3 X11 (encoder coupling of 2 axes)		SSK	2 9 / ⁽¹⁾
Compax3 X10 ⇔ Modem		SSK	3 1 / ...
Compax3H adapter cable ⇔ SSK01 (length 15cm, delivered with the device)		SSK	3 2 / 2 0
Compax3H X10 RS232 connection control ⇔ Programming interface (delivered with the device)		VBK	1 7 / 0 1
Bus terminal connector (for the 1st and last Compax3 in the HEDA Bus/or multi-axis system).		BUS	0 7 / 0 1
Profibus cable ⁽²⁾	non prefabricated	SSL	0 1 / ⁽¹⁾
Profibus plug		BUS	0 8 / 0 1
CAN-Bus cable ⁽²⁾	non prefabricated	SSL	0 2 / ⁽¹⁾
CANbus connector		BUS	1 0 / 0 1

Order Code operating module

Operating module (for Compax3S)		BDM	0 1 / 0 1
---------------------------------	--	-----	-----------

Order Code terminal block

for I/Os without luminous indicator	for X11, X12, X22	EAM	0 6 / 0 1
for I/Os with luminous indicator	for X12, X22	EAM	0 6 / 0 2

Order Code decentralized input terminals

PIO 2DI 24VDC 3.0ms	2-channel digital input terminal	PIO	4 0 0
PIO 4DI 24VDC 3.0ms	4-channel digital input terminal	PIO	4 0 2
PIO 8DI 24VDC 3.0ms	8-channel digital input terminal	PIO	4 3 0
PIO 2AI DC ± 10V differential input	2 channel analog input terminal (± 10V differential input)	PIO	4 5 6
PIO 4AI 0-10VDC S.E.	4 channel analog input terminal (0-10V signal voltage)	PIO	4 6 8
PIO 2AI 0 -20mA differential input	2 channel analog input terminal (0 -20mA differential input)	PIO	4 8 0

Order Code decentralized output terminals

PIO 2DO 24VDC 0.5A	2 channel digital output terminal (output voltage 0.5A)	PIO	5 0 1
PIO 4DO 24VDC 0.5A	4 channel digital output terminal (output voltage 0.5A)	PIO	5 0 4
PIO 8DO 24VDC 0.5A	8 channel digital output terminal (output voltage 0.5A)	PIO	5 3 0
PIO 2AO 0-10VDC	2 channel analog output terminal (0-10V signal voltage)	PIO	5 5 0
PIO 2AO 0 -20mA	2 channel analog output terminal (0-20mA signal voltage)	PIO	5 5 2
PIO 2AO DC ± 10V	2 channel analog output terminal (± 10V signal voltage)	PIO	5 5 6

Order Code CANopen Fieldbus Coupler

CANopen Standard	max. vectorial sum current for bus terminals 1650mA at 5V	PIO	3 3 7
------------------	---	-----	-------

CANopen ECO

max. vectorial sum current for bus terminals 650mA at 5V

PIO 3 4 7

⁽⁴⁾ Length code 1

Length [m]	1,0	2,5	5,0	7,5	10,0	12,5	15,0	20,0	25,0	30,0	35,0	40,0	45,0	50,0
Order code	01	02	03	04	05	06	07	08	09	10	11	12	13	14

Example:

SSK01/09: length 25m

⁽²⁾ Colours according to DESINA⁽³⁾ with motor plug⁽⁴⁾ with cable eye for motor terminal box⁽⁶⁾ Length code 2 for SSK28

Length [m]	0,17	0,25	0,5	1,0	3,0	5,0	10,0
Order code	23	20	21	01	22	03	05

⁽⁶⁾ Order code: **SSK27/nn/..**

Length A (Pop - 1. Compax3) variable (the last two numbers according to the length code for cable, for example SSK27/nn/01)

Length B (1. Compax3 - 2. Compax3 - ... - n. Compax3) fixed 50 cm (only if there is more than 1 Compax3, i.e. nn greater than 01)

Number n (the last two digits)

Examples:

SSK27/05/.. for connecting from Pop to 5 Compax3.

SSK27/01/.. for connection from Pop to one Compax3

MOK55 and MOK54 can also be used for linear motors LXR406, LXR412 and BLMA.

9. Compax3 Accessories

In this chapter you can read about:

Parker servo motors	320
EMC measures	322
Connections to the motor.....	328
External braking resistors	337
Connection set for Compax3S.....	350
Connection set for Compax3MP/Compax3M	352
Operator control module BDM	353
EAM06: Terminal block for inputs and outputs	353
Interface cable	356
Options M1x.....	362

9.1 Parker servo motors

In this chapter you can read about:

Direct drives320
 Rotary servo motors321

9.1.1. Direct drives

In this chapter you can read about:

Feedback systems for direct drives320
 Linear motors321
 Torque motors321

9.1.1.1 Feedback systems for direct drives

The Feedback option F12 makes it possible to operate linear motors as well as torque motors. Compax3 supports the following feedback systems:

Special encoder systems for direct drives	Option F12
Analog hall sensors	<ul style="list-style-type: none"> ◆ Sine - cosine signal (max. 5V_{ss}¹; typical 1V_{ss}) 90° offset ◆ U-V Signal (max. 5V_{ss}²; typical 1V_{ss}) 120° offset.
Encoder (linear or rotatory)	<ul style="list-style-type: none"> ◆ Sine-cosine (max. 5V_{ss}³; typical 1V_{ss}) (max. 400kHz) or ◆ TTL (RS422) (max. 5MHz) with the following modes of commutation: <ul style="list-style-type: none"> ◆ automatic commutation (see page 320) or ◆ Digital hall sensors (e.g. DiCoder®)
Digital, bidirectional interface	<ul style="list-style-type: none"> ◆ All EnDat 2.1 or EnDat 2.2 feedback systems with incremental track (sine-cosine track) ◆ linear or rotary ◆ max. 400kHz Sine-Cosine
Distance coded feedback systems	<ul style="list-style-type: none"> ◆ Distance coding with 1V_{SS} - Interface ◆ Distance coding with RS422 - Interface (Encoder)

The motor performs automatic commutation after:

- ◆ Power on,
- ◆ A configuration download or
- ◆ An IEC program download

The time duration (typically 5-10 sec) of automatic commutation can be optimized with the start current (see in the optimization display of the C3 ServoManager; given as a percentage of the reference current). Note that values that are too high will cause Error 0x73A6 to be triggered.

Typically the motor moves by 4% of the pitch length or, with rotary direct drives 4% of 360°/number of pole pairs - maximum 50%.

¹ Max. differential input between SIN- (X13/7) and SIN+ (X13/8).

² Max. differential input between SIN- (X13/7) and SIN+ (X13/8).

³ Max. differential input between SIN- (X13/7) and SIN+ (X13/8).

Note the following conditions for automatic commutation

- ◆ During automatic commutation the end limits are not monitored.
- ◆ Actively working load torques are not permitted during automatic commutation.
- ◆ Static friction deteriorates the effect of automatic commutation.
- ◆ With the exception of missing commutation information, the controller/motor combination is configured and ready for operation (parameters correctly assigned for the linear motor/drive). The feedback and the direction of the field of rotation in effect must match.
- ◆ The auto-commutating function must be adapted to fit the mechanics if necessary during commissioning.

9.1.1.2 Linear motors

Parker offers you a number of systems of linear motor drives:

<u>Linear motors</u>	Feed force (continuous/dynamic)	Stroke length:
LMDT ironless linear servo motors:	26 ... 1,463N	almost any
LMI iron-cored linear servo motors:	52 ... 6,000N	64 ... 999mm
Linear motors of the LXR series:	315N / 1,000N	up to 3m
Linear motor module BLMA:	605N / 1,720N	up to 6m

9.1.1.3 Torque motors

Parker offers you an extensive range of torque motors that can be adapted to your application. Please contact us for information.
Additional information can be found on the **Internet** <http://www.parker-automation.com> in the direct drives section.

9.1.2. Rotary servo motors

Parker offers you an extensive range of servo motors that can be adapted to your application. Please contact us for information.
Additional information can be found on the **Internet**
(http://www.parker.com/euro_emd/EME/Literature_List/dokumentationen/SMH_MH_Cat%20engl.pdf)
or on the CD supplied in the documentations file:
Catalogue = SMH_MH_Kat engl.pdf
User guide = SMH_MH-Manual engl.pdf

Suitable servo motors for Compax3H are available on request!

9.2 EMC measures

In this chapter you can read about:

Mains filter322
 Motor output filter326
 Mains filter327

9.2.1. Mains filter

For radio disturbance suppression and for complying with the emission limit values for **CE conform operation** (see page 16) we offer mains filters:

Observe the maximum permitted length of the connection between the mains filter and the device:

- ◆ unshielded <0.5m;
- ◆ shielded < 5m (fully shielded on ground – e.g. ground of control cabinet)

Order code mains filter Compax3S / Compax3H

for C3S025V2 or S063V2	NFI	0 1	/	0 1
for C3S0xxV4, S150V4 or S1xxV2	NFI	0 1	/	0 2
for C3S300V4	NFI	0 1	/	0 3
for C3H050V4	NFI	0 2	/	0 1
for C3H090V4	NFI	0 2	/	0 2
for C3H1xxV4	NFI	0 2	/	0 3

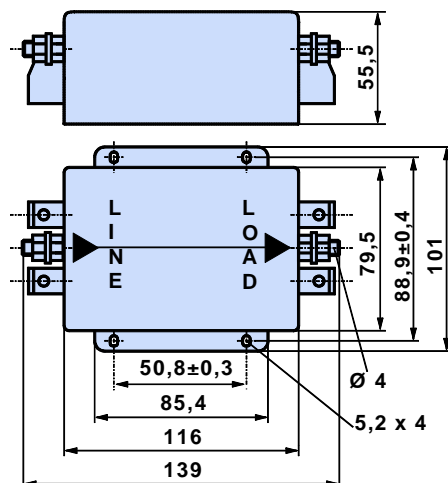
Order code mains filter Compax3MP

for C3MP10	Reference axis combination 3x480V 25A 6x10m motor cable length	NFI	0 3	/	0 1
for C3MP10	Reference axis combination 3x480V 25A 6x50m motor cable length	NFI	0 3	/	0 2

9.2.1.1 Mains filter NFI01/01

for Compax3 S025 V2 and Compax3 S063 V2

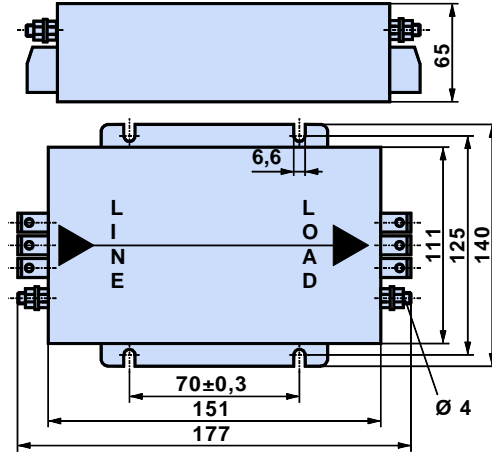
Dimensional drawing:



9.2.1.2 Mains filter NFI01/02

for Compax3 S0xx V4, Compax3 S150 V4 and Compax3 S1xx V2

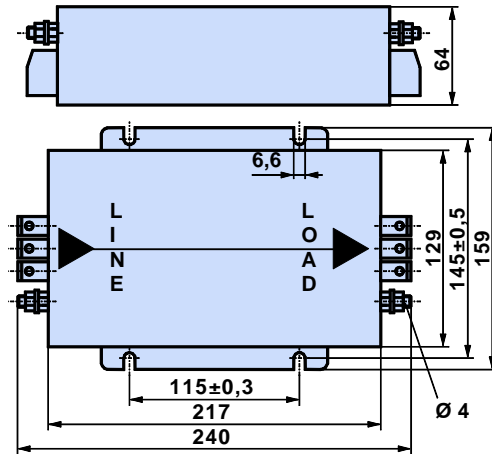
Dimensional drawing:



9.2.1.3 Mains filter for NFI01/03

for Compax3 S300

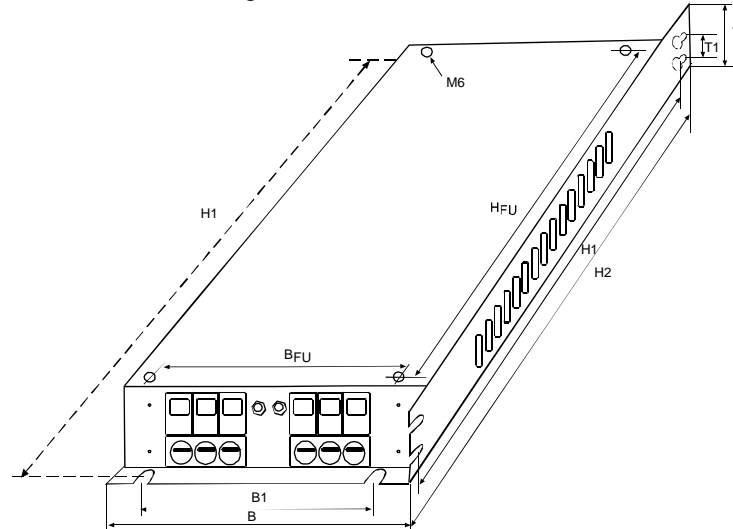
Dimensional drawing:



9.2.1.4 Mains filter NFI02/0x

Filter for mounting below the Compax3 Hxxx V4 housing

Dimensional drawing:



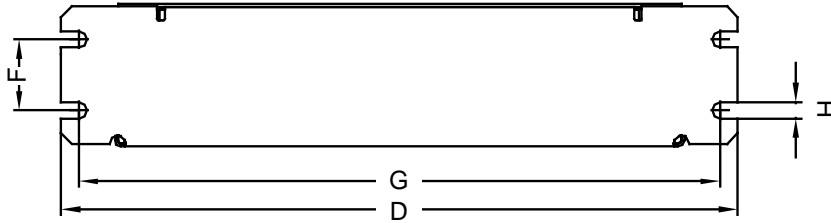
Stated in mm	Filter type	Dimensions				Hole distances		Distances		Weight	Grounding clamp	Connection clamp		
		B	H	H2	T	B1	H1	T1	BFU	HFU	kg			
	C3H050V4	NFI02/01	233	515	456	70	186	495	40	150	440	4,3	M6	16mm ²
	C3H090V4	NFI02/02	249	715	649	95	210	695	40	150	630	8,5	M8	50mm ²
	C3H1xxV4	NFI02/03	249	830	719	110				150	700	15,0	M10	95mm ²

9.2.1.5 Mains filter NFI03/01

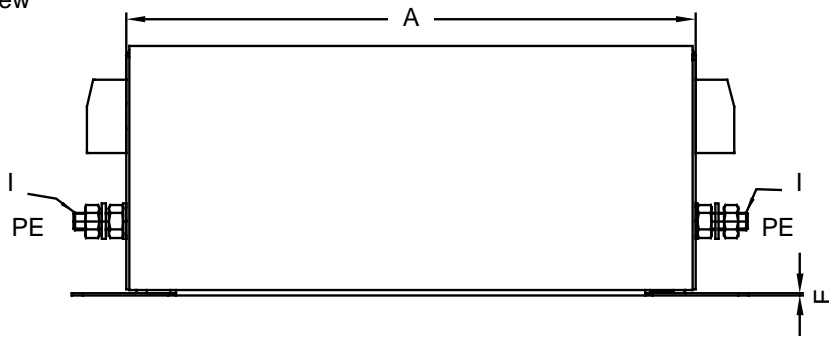
for Compx3MP10D6

Dimensional drawing:

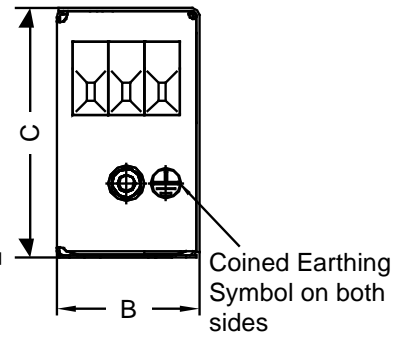
Bottom view



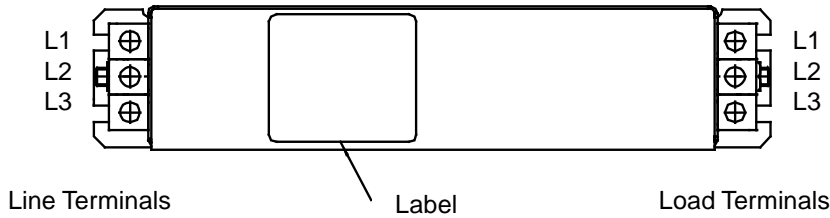
Side view



Front view



Top view



Filter type									Weight	GND(I)	Connection clamp
NFI03/01	A	B	C	D	E	F	G	H	kg		
	240	50	85	270	0,8	30	255	5,4	1,5	M5	10mm ²

Stated in mm

9.2.1.6 Mains filter NFI03/02

for Compx3MP10D6

Dimensional drawing:
On request

9.2.2. Motor output filter

In this chapter you can read about:

Motor output filter MDR01/04.....326
 Motor output filter MDR01/01.....326
 Motor output filter MDR01/02.....327
 Wiring of the motor output filter.....327

We offer motor output filters for disturbance suppression when the motor connecting cables are long (>20m):

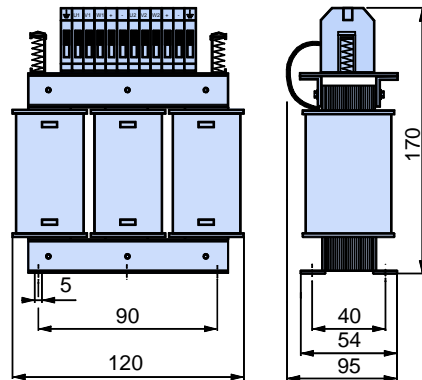
Order code for motor output filter (for Compax3S, Compax3M >20m motor cable)

			/		
up to 6,3 A rated motor current	MDR	0	1	/	0 4
Up to 16 A rated motor current	MDR	0	1	/	0 1
up to 30 A rated motor current	MDR	0	1	/	0 2

9.2.2.1 Motor output filter MDR01/04

up to 6.3A nominal motor current (3.6mH)

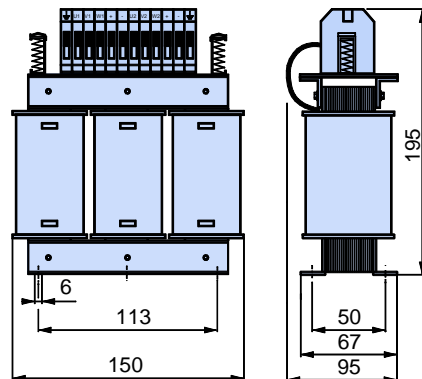
Dimensional drawing:



9.2.2.2 Motor output filter MDR01/01

Up to 16 A nominal motor current (2mH)

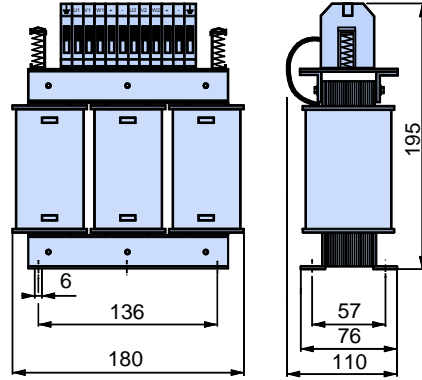
Dimensional drawing:



9.2.2.3 Motor output filter MDR01/02

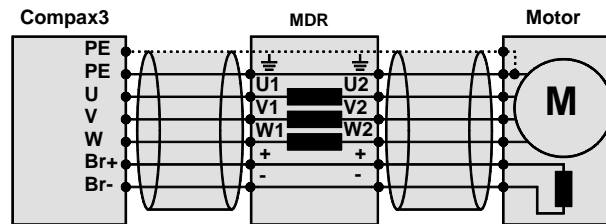
up to 30A nominal motor current (1.1mH)

Dimensional drawing:



Weight: 5.8kg

9.2.2.4 Wiring of the motor output filter



9.2.3. Mains filter

Mains filters serve for reducing the low-frequency interferences on the mains side. Further information on request.

9.3 Connections to the motor

In this chapter you can read about:

Resolver cable329
 SinCos© cable330
 EnDat cable331
 Overview of motor cables331
 Motor cable with plug332
 Motor cable for terminal box333
 Encoder cable336

Under the designation "REK.." (resolver cables) and "MOK.." (motor cables) we can deliver motor connecting cables in various lengths to order. If you wish to make up your own cables, please consult the cable plans shown below:

Order code for motor cables⁽²⁾

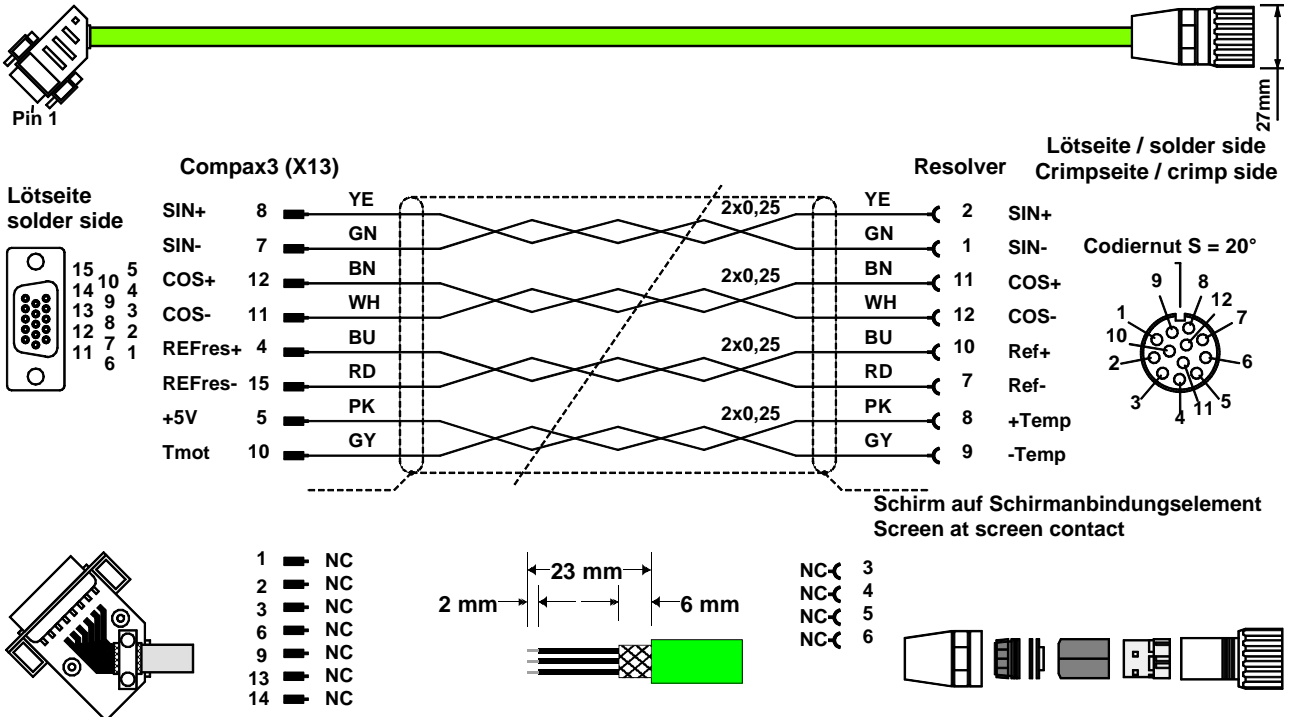
for SMH / MH56 / MH70 / MH105 ⁽³⁾	(1.5mm ² ; up to 13.8A)		MOK	5	5	/ ⁽¹⁾
for SMH / MH56 / MH70 / MH105 ⁽³⁾	(1.5mm ² ; up to 13.8A)	(cable chain compatible)	MOK	5	4	/ ⁽¹⁾
for SMH / MH56 / MH70 / MH105 ⁽³⁾	(2.5mm ² ; up to 18.9A)		MOK	5	6	/ ⁽¹⁾
for SMH / MH56 / MH70 / MH105 ⁽³⁾	(2.5mm ² ; up to 18.9A)	(cable chain compatible)	MOK	5	7	/ ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(1.5mm ² ; up to 13.8A)		MOK	6	0	/ ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(1.5mm ² ; up to 13.8A)	(cable chain compatible)	MOK	6	3	/ ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(2.5mm ² ; up to 18.9A)		MOK	5	9	/ ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(2.5mm ² ; up to 18.9A)	(cable chain compatible)	MOK	6	4	/ ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(6mm ² ; up to 32.3A)	(cable chain compatible)	MOK	6	1	/ ⁽¹⁾
for MH145 / MH205 ⁽⁴⁾	(10mm ² ; up to 47.3A)	(cable chain compatible)	MOK	6	2	/ ⁽¹⁾

Order code for feedback cables

for Resolver ⁽²⁾	for MH / SMH motors		REK	4	2	/ ⁽¹⁾
for Resolver ⁽²⁾	for MH / SMH motors	(cable chain compatible)	REK	4	1	/ ⁽¹⁾
for SinCos© – Feedback devices ⁽²⁾	for MH / SMH motors	(cable chain compatible)	GBK	2	4	/ ⁽¹⁾
for EnDat 2.1 ⁽²⁾	for MH / SMH motors	(cable chain compatible)	GBK	3	8	/ ⁽¹⁾
Encoder – Compax3			GBK	2	3	/ ⁽¹⁾
for LXR linear motors		(cable chain compatible)	GBK	3	3	/ ⁽¹⁾
for BLMA linear motors		(cable chain compatible)	GBK	3	2	/ ⁽¹⁾

9.3.1. Resolver cable

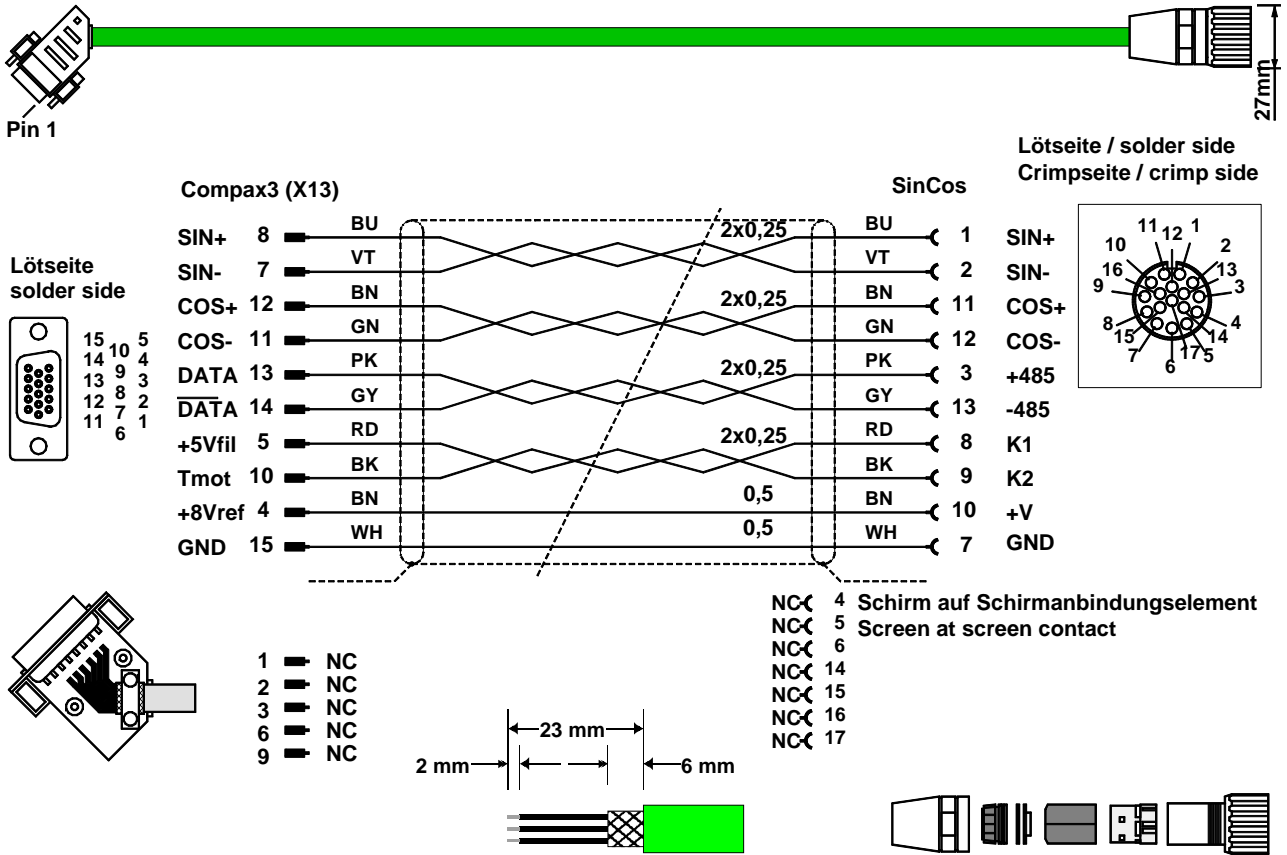
REK42/..



The same cable (with changed conductor coloring) is available under the designation REK41/.. in a version which is suitable for cable chain systems. You will find the length code in the **accessories order code** (see page 315).

9.3.2. SinCos© cable

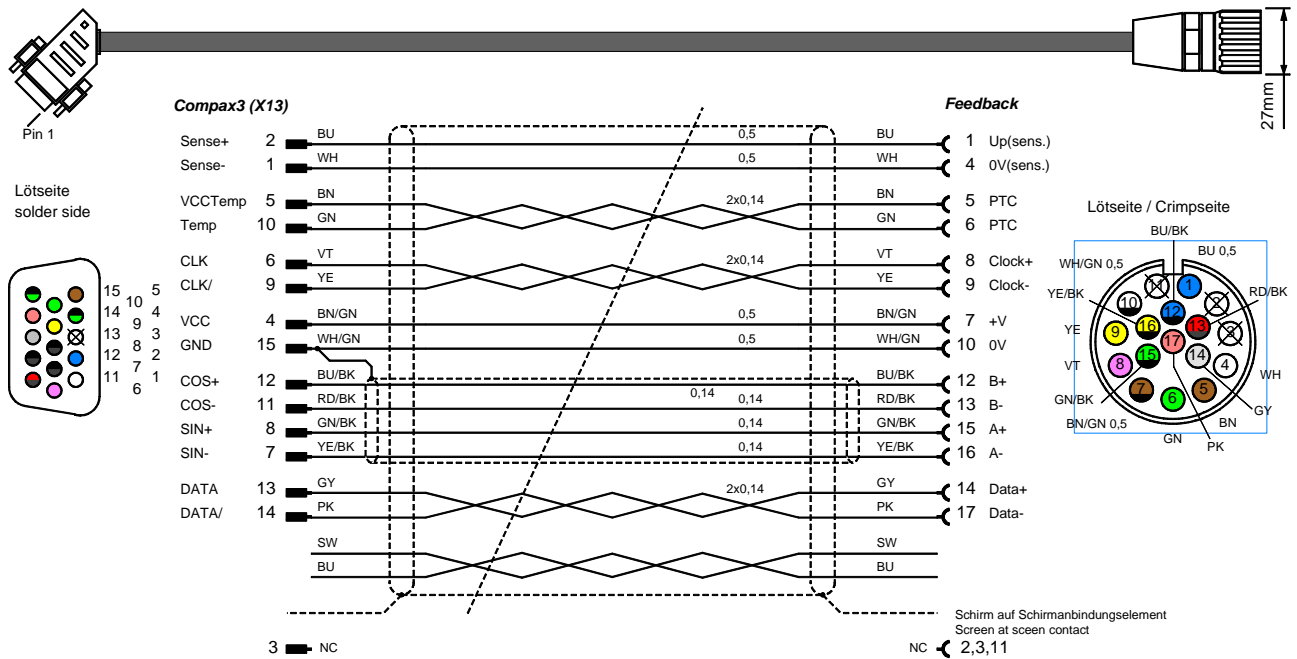
GBK24/...: Cable chain compatible



You will find the length code in the **accessories order code** (see page 315).

9.3.3. EnDat cable

GBK38/...: (cable chain compatible)

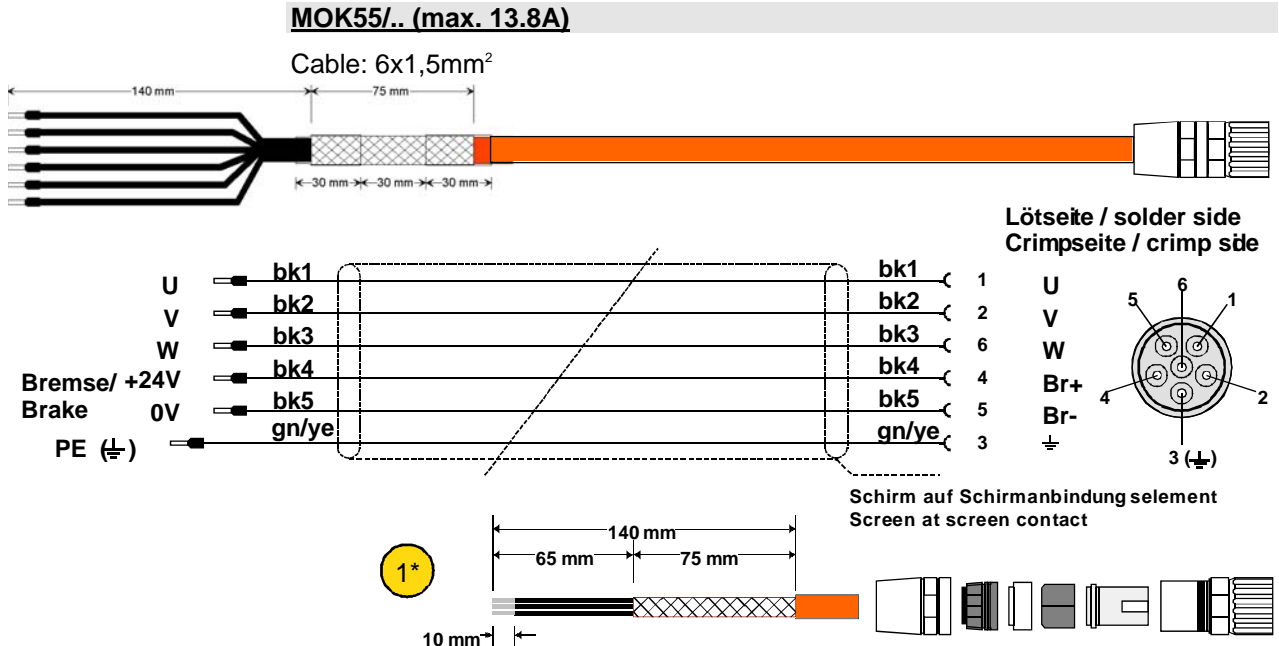


You will find the length code in the **accessories order code** (see page 315).

9.3.4. Overview of motor cables

Cross-section / max. permanent load	Motor connector SMH motors MH56, MH70, MH105		Motor terminal box MH145, MH205	
	standard	cable chain compatible	standard	cable chain compatible
1.5mm ² / up to 13.8A	MOK55	MOK54	MOK60	MOK63
2.5mm ² / up to 18.9A	MOK56	MOK57	MOK59	MOK64
6mm ² / up to 32.3A	-	-	-	MOK61
10mm ² / up to 47.3A	-	--	-	MOK62

9.3.5. Motor cable with plug



- 1* ♦ Strip cable on 140mm
- ♦ Cut off shield for about 65mm, loosen, fold back over external cover (for about 75mm) and fix with insulating tape.
- ♦ Fix 2x approx. 30mm shrinking hose (adhesive)
- ♦ Strip ends of lines for 10mm and fix terminal sleeves 1.5

MOK54/... (max. 13.8A) cable chain compatible

Same structure (conductor coloring may be changed) as MOK55/.. available in cable chain compatible version.

MOK56/... (max. 18.9A)

Same structure (conductor coloring/designations may be changed) as MOK55/.. but with 6x2.5mm² .

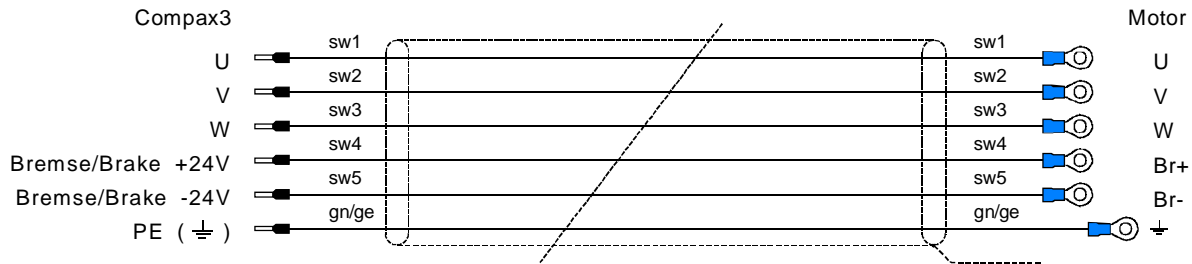
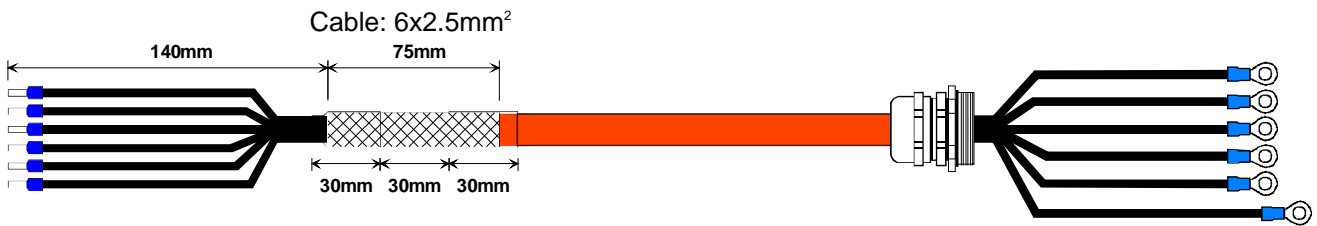
MOK57/... (max. 18.9A) cable chain compatible

Same structure (conductor coloring / designation may be changed) as MOK55, but with 4x2.5 + 2x1mm² and cable chain compatible.

You will find the length code in the **accessories order code** (see page 315).

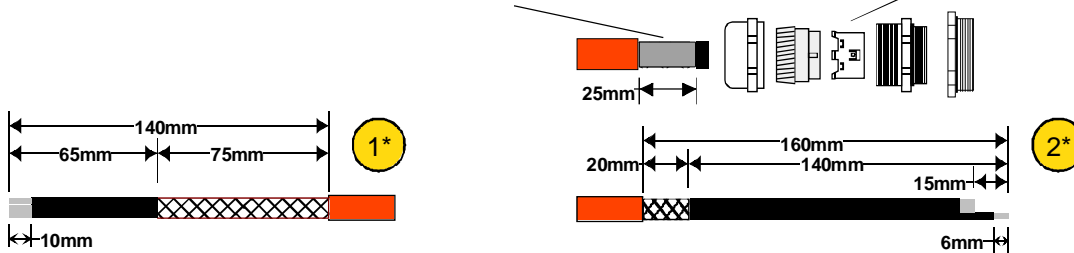
9.3.6. Motor cable for terminal box

Design on the example of MOK59/... (max. 18.9A) standard

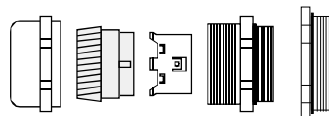


Abschirmband kleben d
screen tape sticking

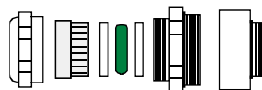
Schirm auf Schirmanbindung selement
Screen at screen contact



MOK59/..., MOK60/..., MOK63/..., MOK64/..



MOK62/..., MOK61/..



- 1* ♦ Strip cable on 140mm
- ♦ Cut off shield for about 65mm, loosen, fold back over external cover (for about 75mm) and fix with insulating tape.
 - ♦ Fix 2x approx. 30mm shrinking hose (adhesive)
 - ♦ Strip ends of lines for 10mm and fix terminal sleeves 2.5
- 2* ♦ Strip cable on 160mm
- ♦ Cut off shield for 140mm, fix rest on a length of 20mm with isolating tape (width 25mm, length 80mm)
 - ♦ Cut off bck1, bck2, bck3, bck4, bck5 by approx. 15mm (gn/ye about 15mm longer)
 - ♦ Strip end of lines for about 6mm and fix with cable eyes M6

Please note the two different shield connection elements!

Additional motor cables for the terminal box with similar layout:

MOK62/.. (max. 47.3A) cable chain compatible with 4x10mm² + 2x1mm²

MOK61/...: (max. 32.3A) cable chain compatible with 4x6mm² + 2x1mm²

MOK60/.. (max. 13.8A) standard with 6x1,5mm²

MOK63/.. (max. 13.8A) cable chain compatible with 6x1.5mm²

MOK64/.. (max. 18.9A) cable chain compatible with 6x2.5mm²

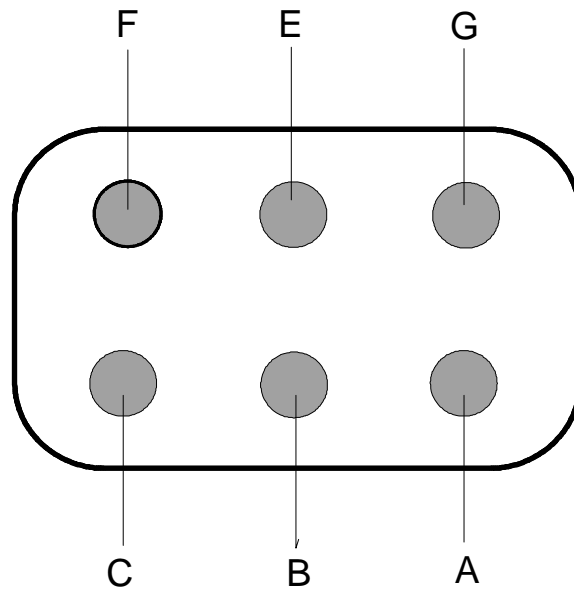
Designation of the conductors

The designations of the conductors varies according to the cable type:

U	U1	sw1	black
V	V2	sw2	brown
W	W3	sw3	blue
BR+	BR1	sw4	red
BR-	BR2	sw5	green

You will find the length code in the **accessories order code** (see page 315).

9.3.6.1 Connection of terminal box MH145 & MH205

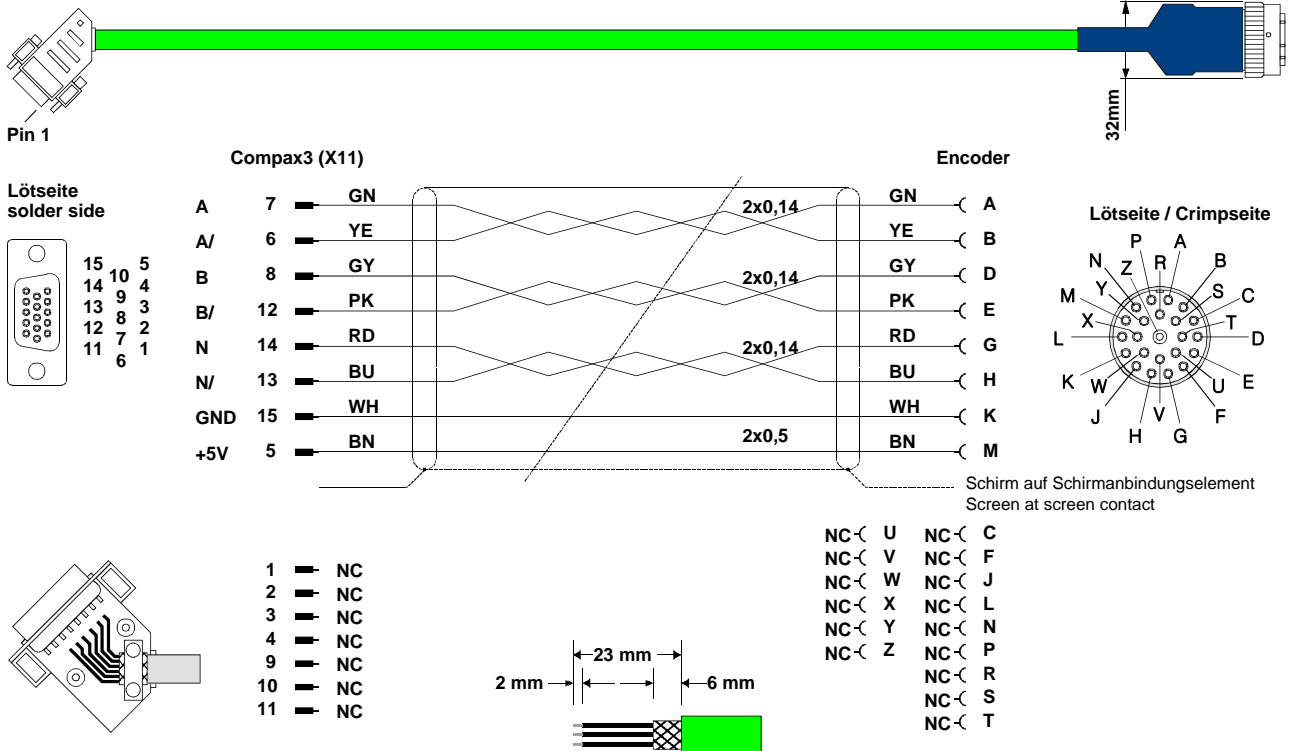


Terminal	Assignment
A	Phase U
B	Phase V
C	Phase W
E	PE
F	Brake (+ red for MH205)
G	Brake (- blue for MH205)

Additional designations can be found on the connection cable clamping board - motor (interal).

9.3.7. Encoder cable

GBK23/... Connection Encoder - Compax3




You will find the length code in the **accessories order code** (see page 315).

9.4 External braking resistors

In this chapter you can read about:

Permissible braking pulse powers of the braking resistors.....	338
Dimensions of the braking resistors.....	347

Danger!	Hazards when handling braking resistors!
	<p>Housing temperature up to 200°C!</p> <p>Dangerous voltage!</p> <p>The device may be operated only in the mounted state!</p> <p>The external braking resistors must be installed such that contact with the human body is prevented.</p> <p>Install the connecting leads at the bottom.</p> <p>Observe the instructions on the resistors (warning plate).</p>

Please note that the length of the supply cable must not exceed 2m!

Braking resistors for Compax3

Braking Resistor (see page 337)	Device	Rated Power
BRM08/01 (100Ω)	Compax3S025V2 Compax3S015V4 Compax3S038V4	60W
BRM05/01 (56Ω)	Compax3S063V2 Compax3S075V4	180W
BRM05/02 (56Ω)	Compax3S075V4	570W
BRM10/01 (47Ω)	Compax3S150V4	570W
BRM04/01 (15Ω)	Compax3S300V4 Compax3S150V2	570W
BRM04/02 (15Ω)	Compax3S300V4 Compax3S150V2	740W
BRM04/03 (15Ω)	Compax3S300V4	1500W
BRM09/01 (22Ω)	Compax3S100V2	570W
BRM11/01 (27Ω)	Compax3H0xxV4	3500W
BRM13/01 (30Ω)	Compax3MP10D6	500 W
BRM14/01 (15Ω)	Compax3MP10D6*	500 W
BRM12/01 (18Ω)	Compax3H1xxV4	4500W

*for Compax3MP10D6 2x15Ω in series

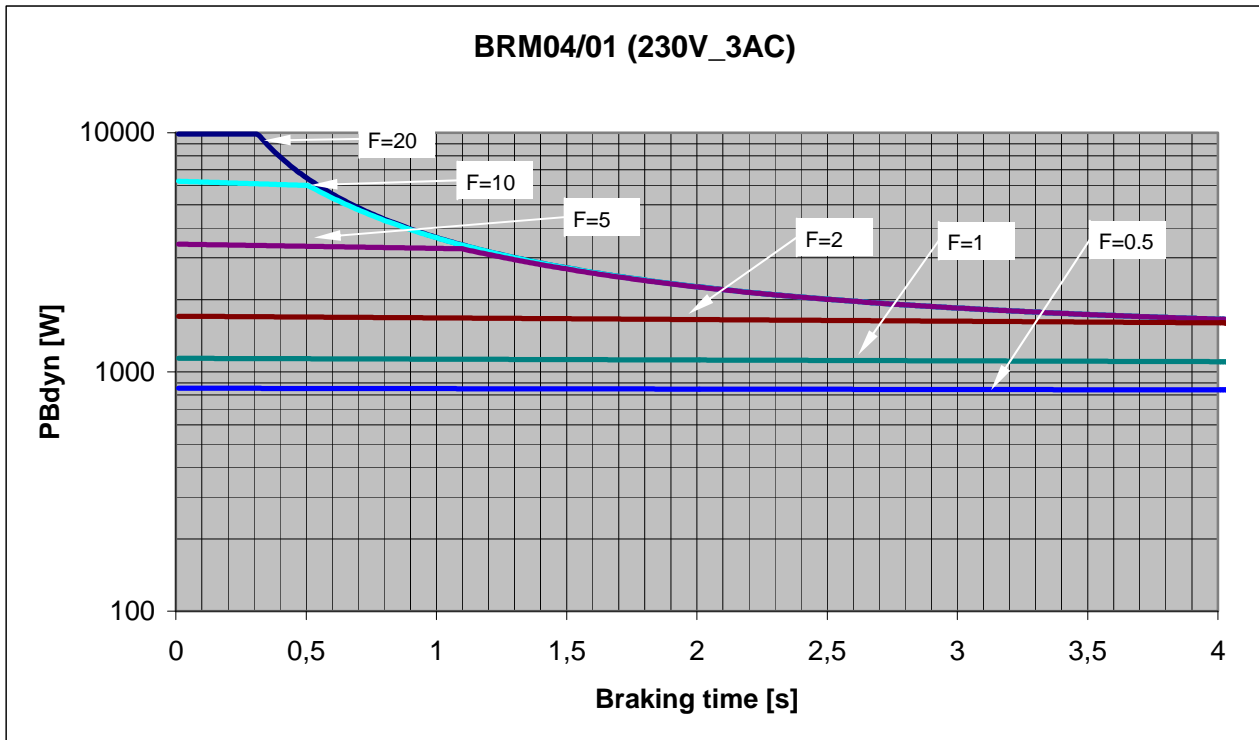
9.4.1. Permissible braking pulse powers of the braking resistors

In this chapter you can read about:

Calculation of the BRM cooling time	339
Permissible braking pulse power: BRM08/01 with C3S015V4 / C3S038V4	340
Permissible braking pulse power: BRM08/01 with C3S025V2	340
Permissible braking pulse power: BRM09/01 with C3S100V2	341
Permissible braking pulse power: BRM10/01 with C3S150V4	341
Permissible braking pulse power: BRM05/01 with C3S063V2	342
Permissible braking pulse power: BRM05/01 with C3S075V4	342
Permissible braking pulse power: BRM05/02 with C3S075V4	343
Permissible braking pulse power: BRM04/01 with C3S150V2	343
Permissible braking pulse power: BRM04/01 with C3S300V4	344
Permissible braking pulse power: BRM04/02 with C3S150V2	344
Permissible braking pulse power: BRM04/02 with C3S300V4	345
Permissible braking pulse power: BRM04/03 with C3S300V4	345
Permissible braking pulse power: BRM11/01 with C3H0xxV4	346
Permissible braking pulse power: BRM12/01 with C3H1xxV4	346
Permissible braking pulse power: BRM13/01 with C3MP10D6	347
Permissible braking pulse power: BRM14/01 with C3MP10D6	347

The diagrams show the permissible braking pulse powers of the braking resistors in operation with the assigned Compax3.

9.4.1.1 Calculation of the BRM cooling time



F = Factor

Cooling time = F * braking time

Example 1: For a braking time of 1s, a braking power of 1kW is required. The Diagram shows the following:

The required values can be found in the range between characteristic F = 0.5 and F = 1. In order to achieve operating safety, please select the higher factor, this means that the required cooling time is 1s.

F * Braking time = cooling time

$$1 * 1s = 1s$$

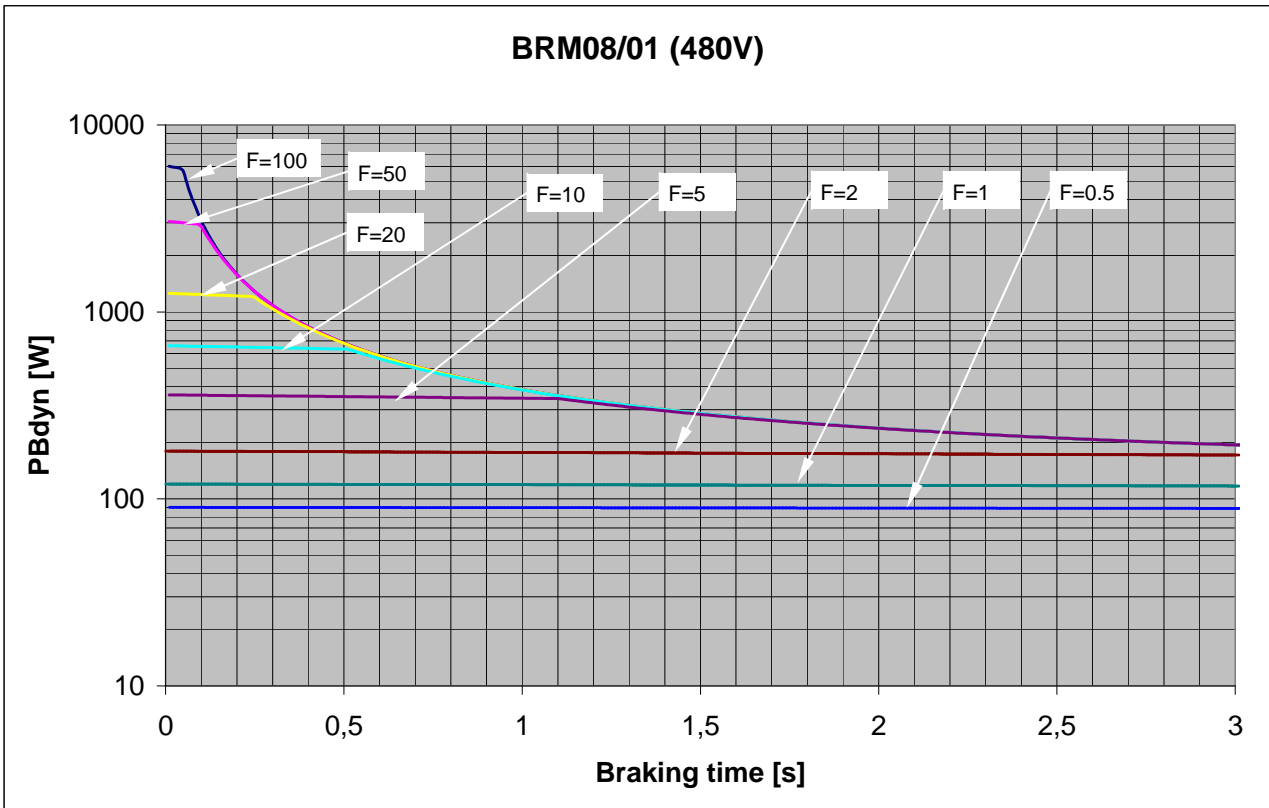
Example 2: For a braking time of 0.5s, a braking power of 3kW is required. The Diagram shows the following:

The required values can be found in the range between characteristic F = 2 and F = 5. In order to achieve operating safety, please select the higher factor, this means that the required cooling time is 2.5s.

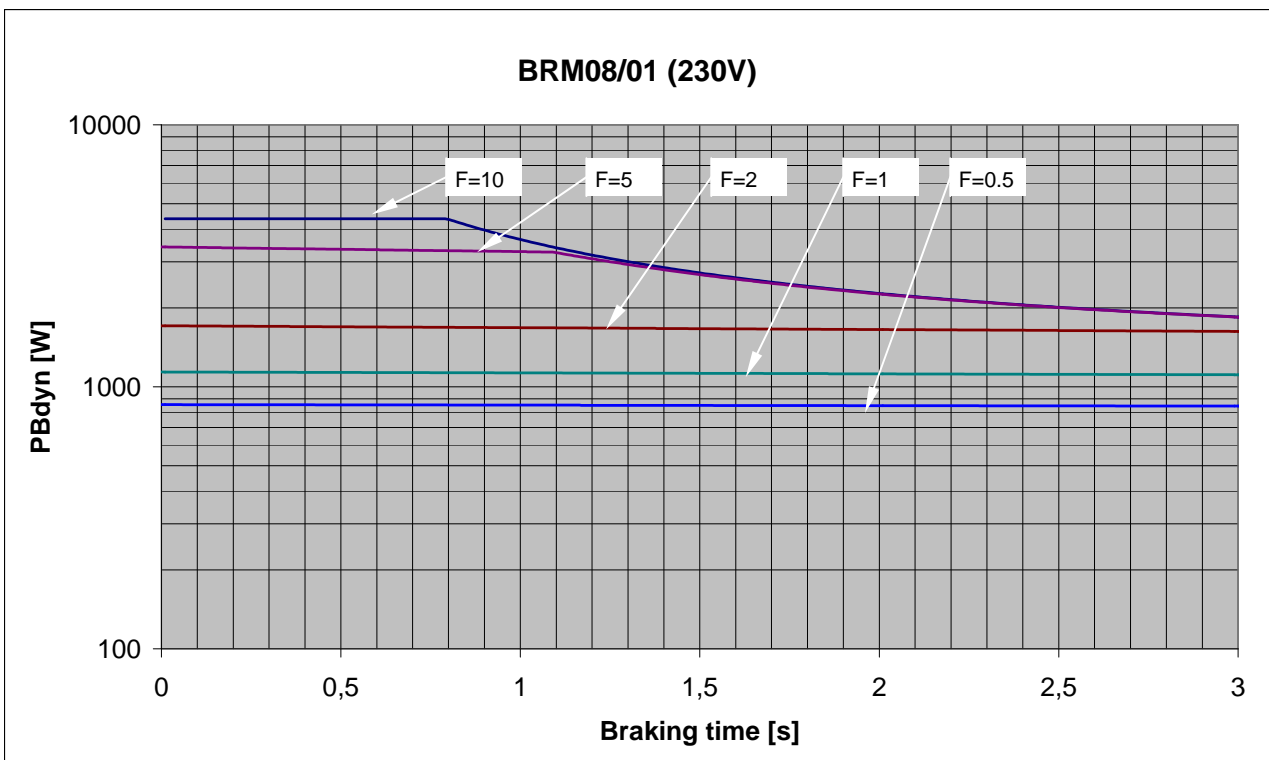
F * Braking time = cooling time

$$5 * 0.5s = 2.5s$$

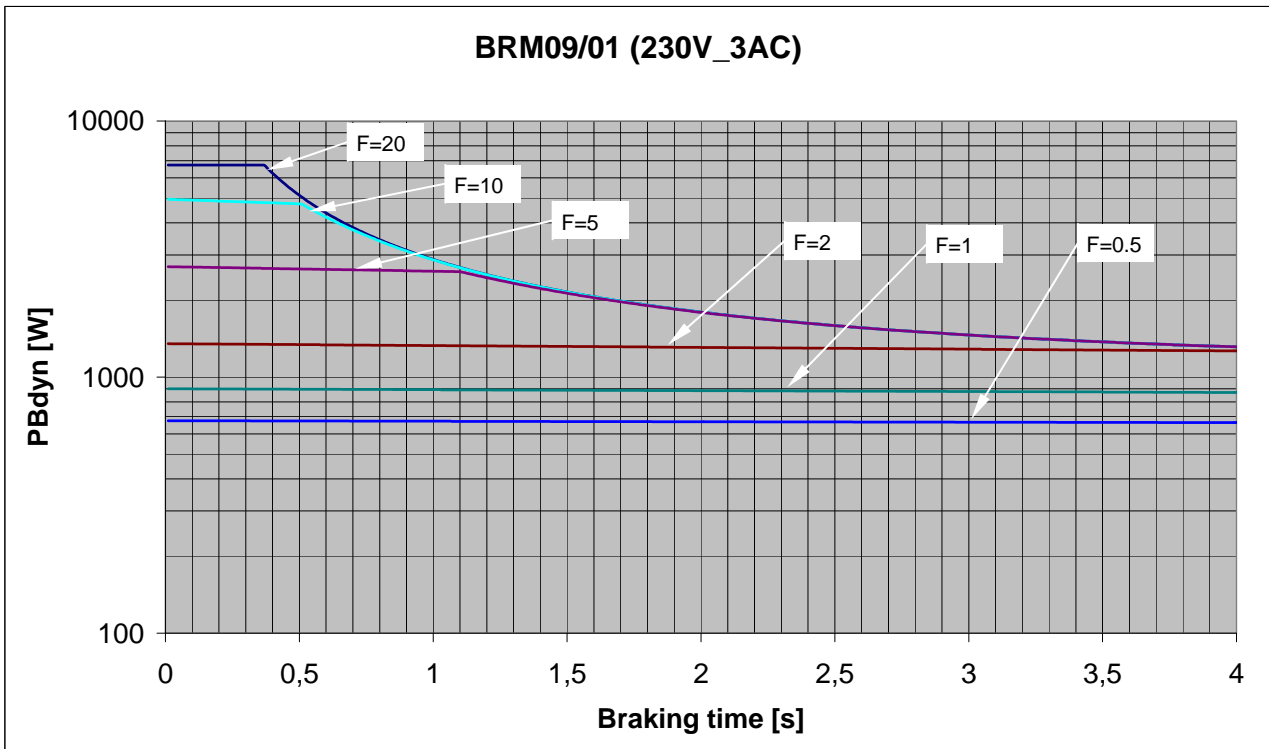
9.4.1.2 Permissible braking pulse power: BRM08/01 with C3S015V4 / C3S038V4



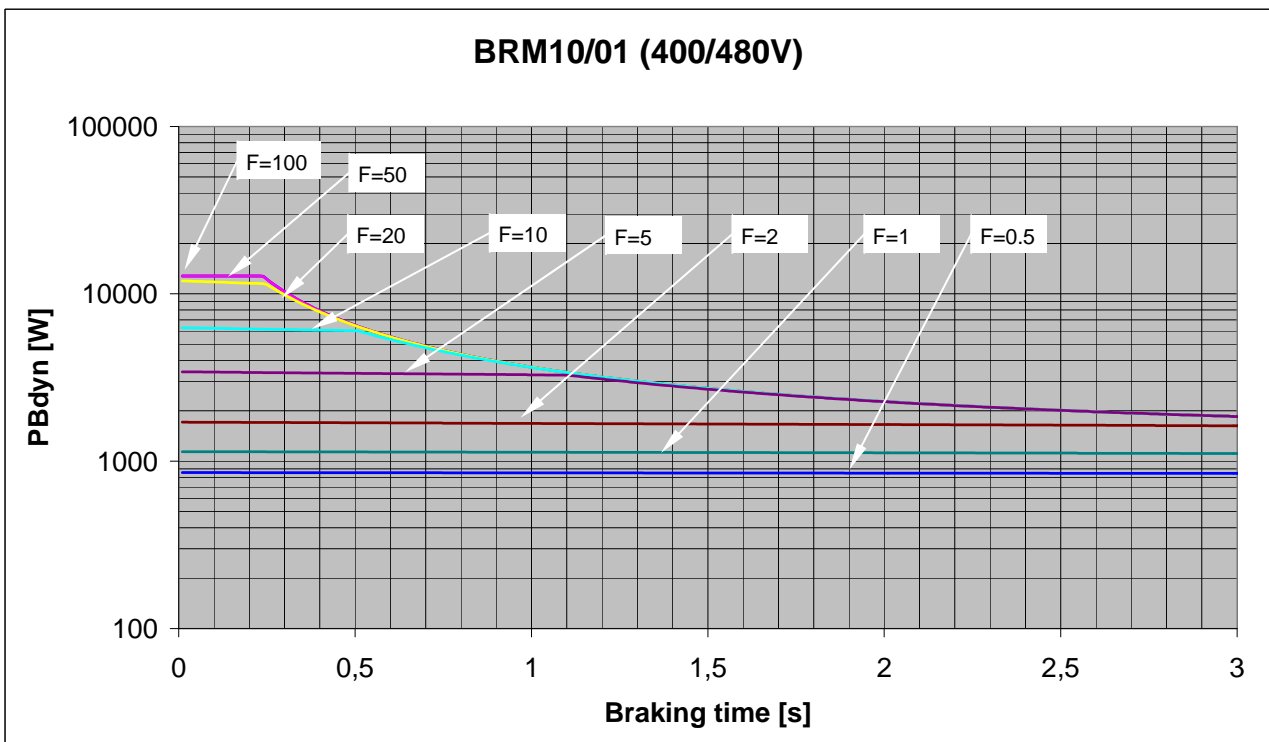
9.4.1.3 Permissible braking pulse power: BRM08/01 with C3S025V2



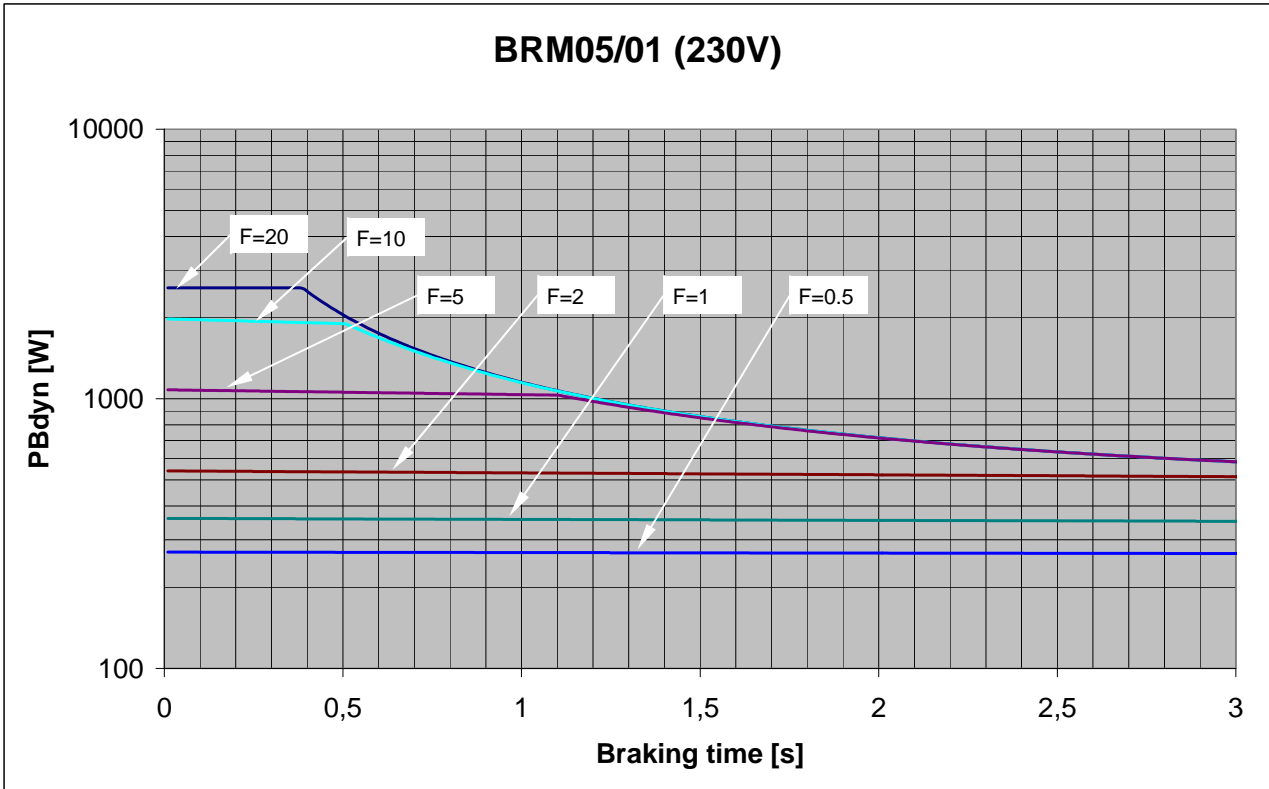
9.4.1.4 Permissible braking pulse power: BRM09/01 with C3S100V2



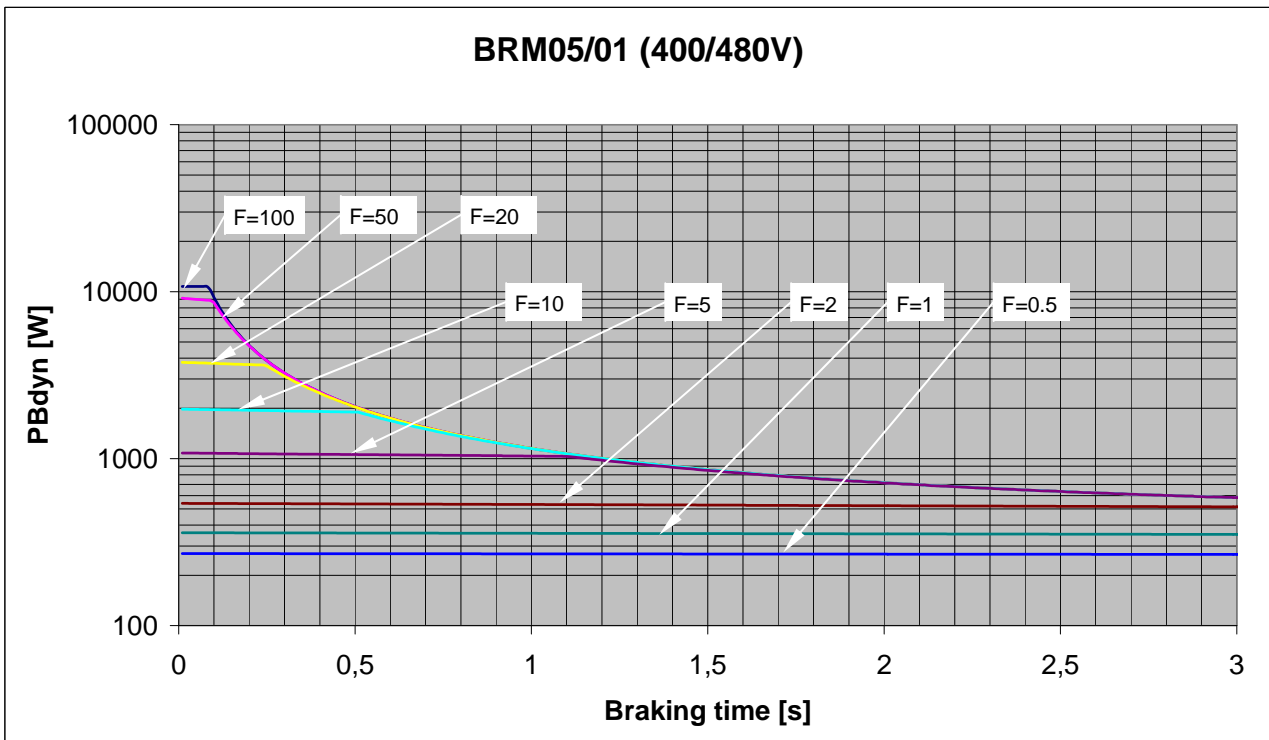
9.4.1.5 Permissible braking pulse power: BRM10/01 with C3S150V4



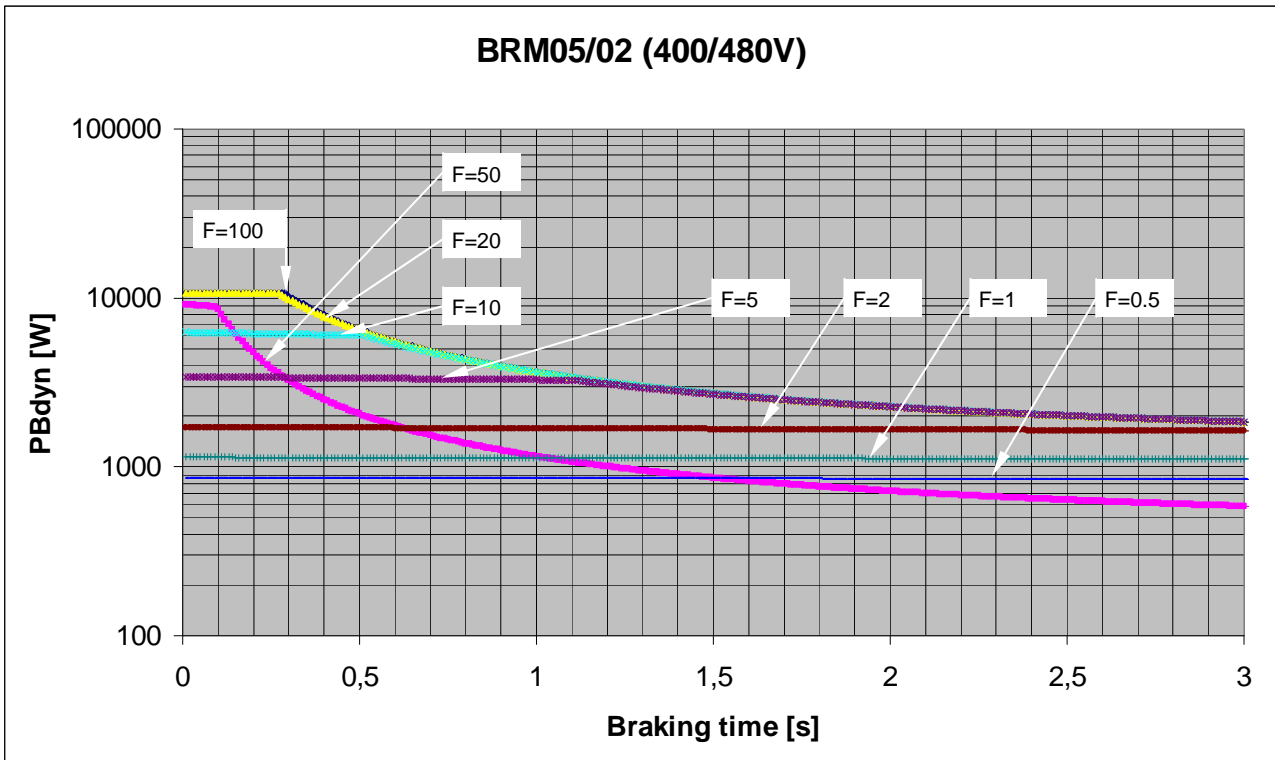
9.4.1.6 Permissible braking pulse power: BRM05/01 with C3S063V2



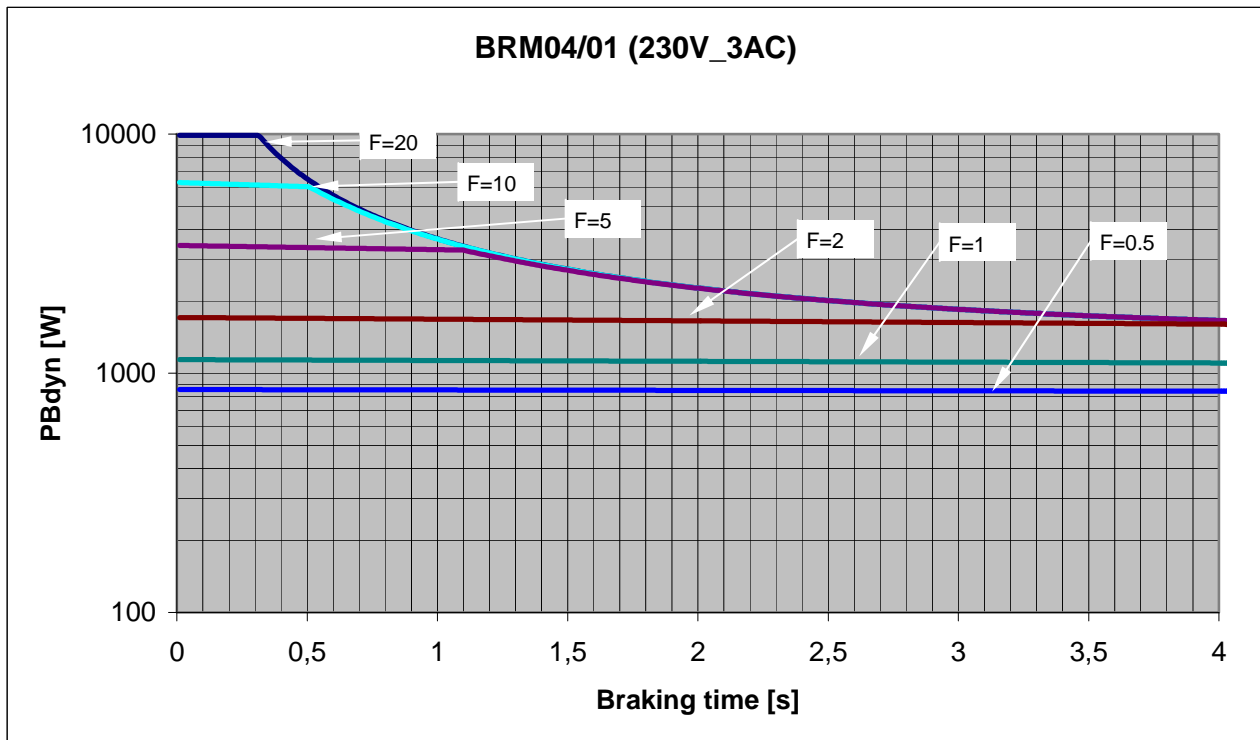
9.4.1.7 Permissible braking pulse power: BRM05/01 with C3S075V4



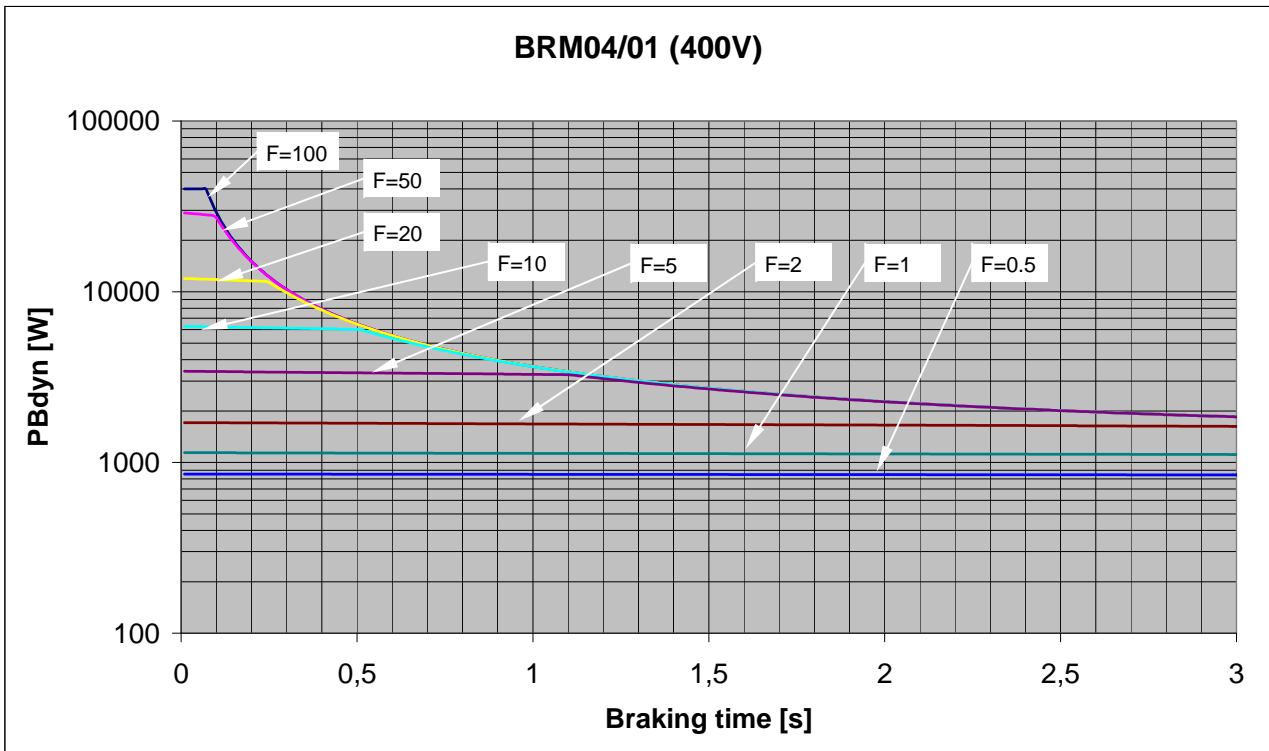
9.4.1.8 Permissible braking pulse power: BRM05/02 with C3S075V4



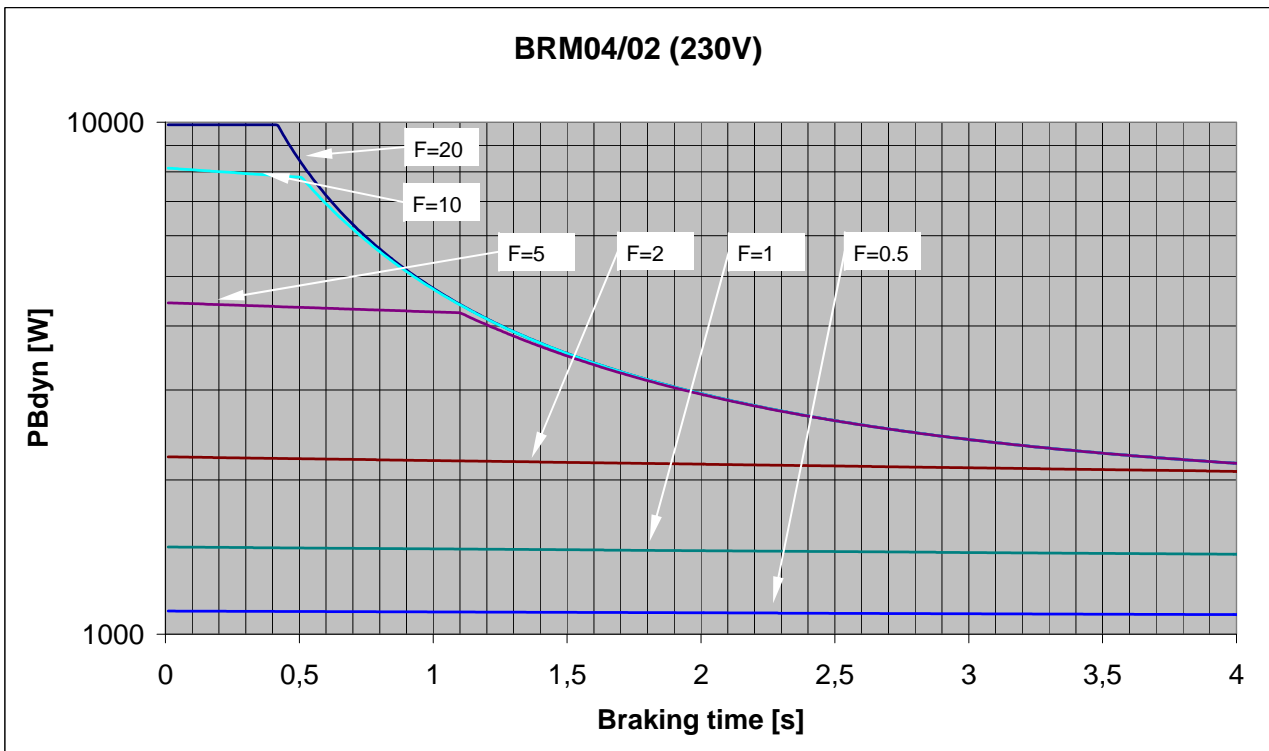
9.4.1.9 Permissible braking pulse power: BRM04/01 with C3S150V2



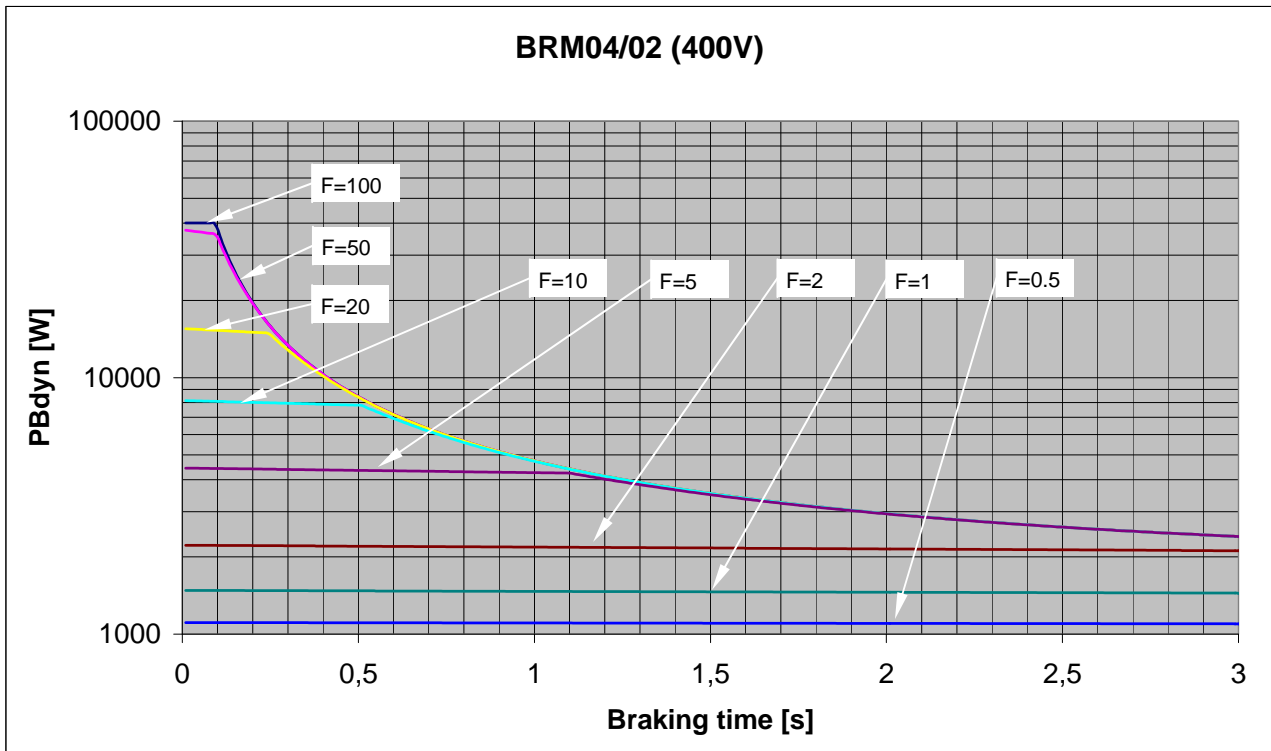
9.4.1.10 Permissible braking pulse power: BRM04/01 with C3S300V4



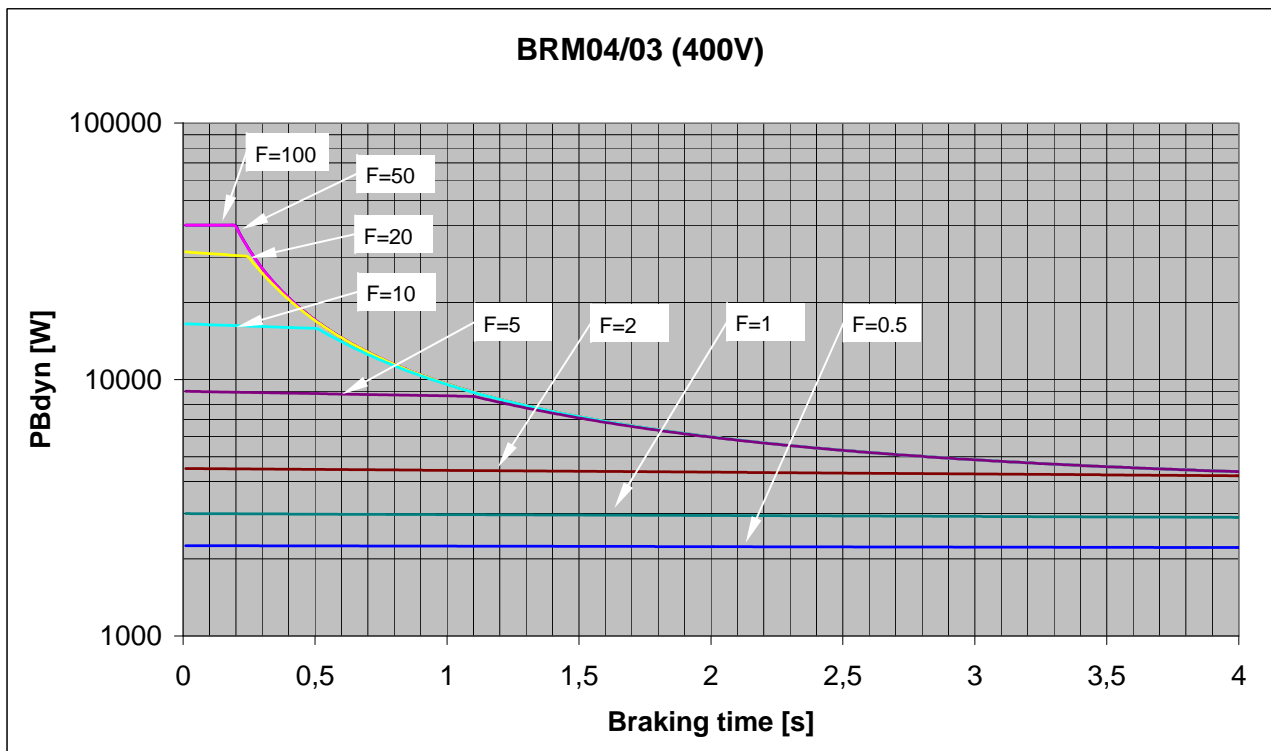
9.4.1.11 Permissible braking pulse power: BRM04/02 with C3S150V2



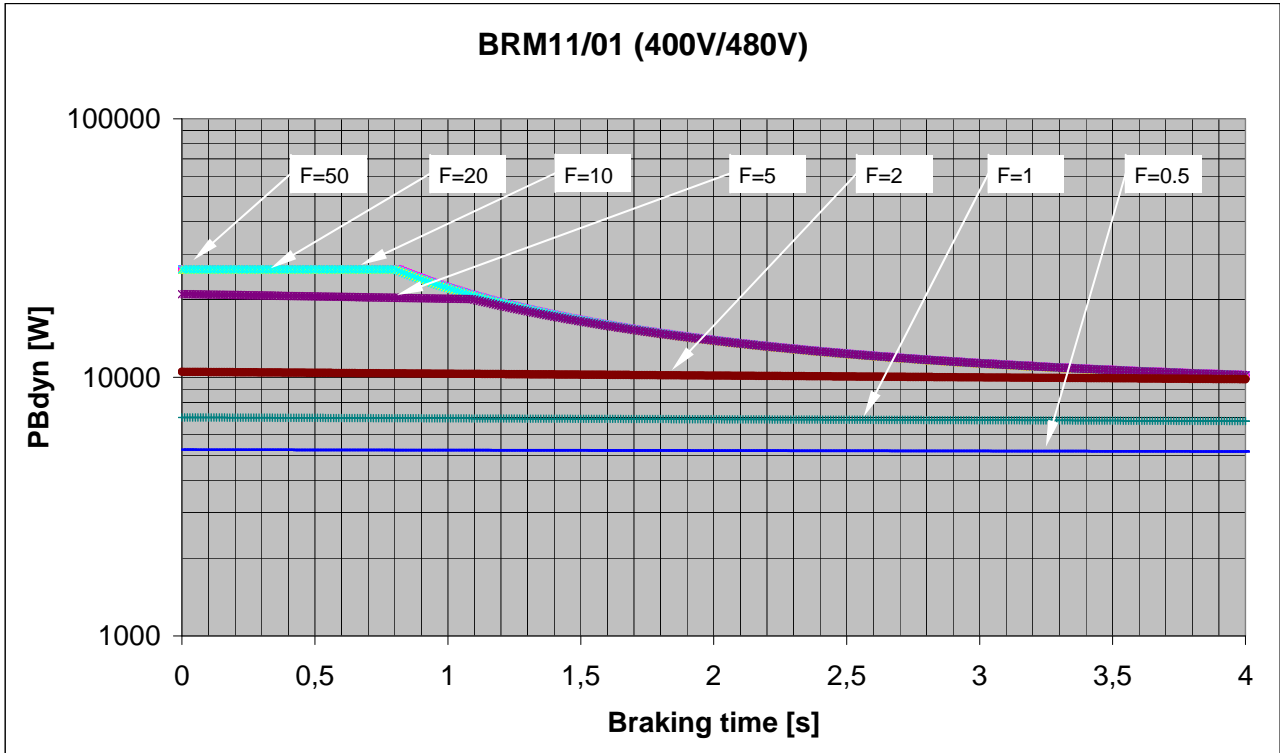
9.4.1.12 Permissible braking pulse power: BRM04/02 with C3S300V4



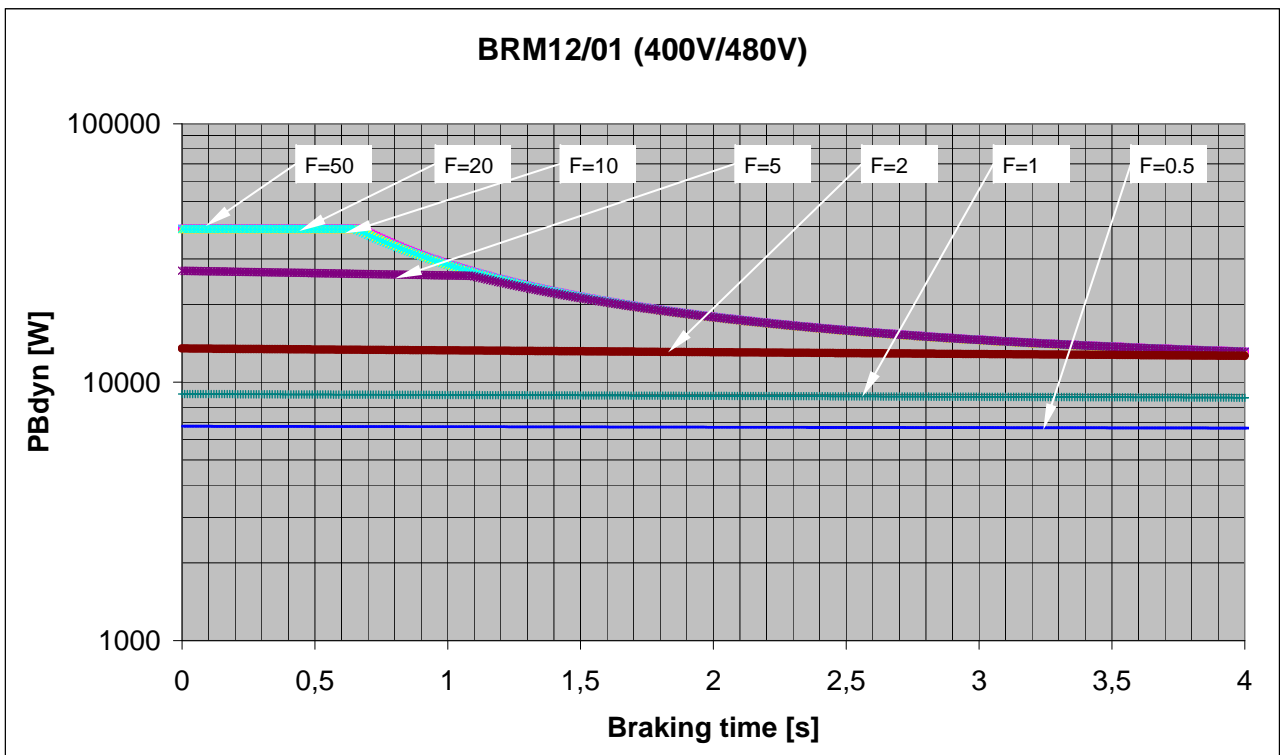
9.4.1.13 Permissible braking pulse power: BRM04/03 with C3S300V4



9.4.1.14 Permissible braking pulse power: BRM11/01 with C3H0xxV4



9.4.1.15 Permissible braking pulse power: BRM12/01 with C3H1xxV4



9.4.1.16 Permissible braking pulse power: BRM13/01 with C3MP10D6

On request

9.4.1.17 Permissible braking pulse power: BRM14/01 with C3MP10D6

On request

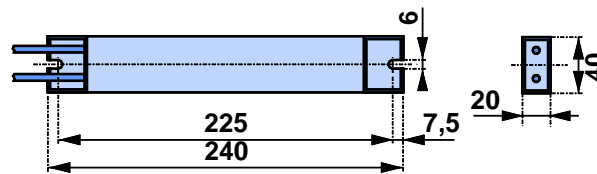
9.4.2. Dimensions of the braking resistors

In this chapter you can read about:

BRM8/01 braking resistors	347
BRM5/01 braking resistor	347
Braking resistor BRM5/02, BRM9/01 & BRM10/01	348
Braking resistor BRM4/0x	348
Braking resistor BRM11/01 & BRM12/01	349
Braking resistor BRM13/01 & BRM14/01	349

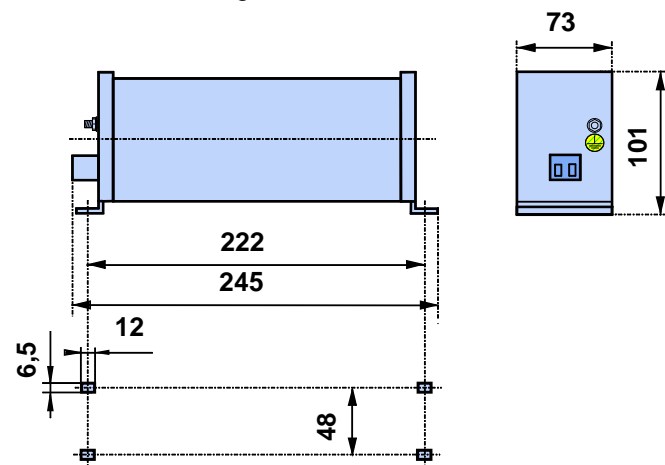
9.4.2.1 BRM8/01 braking resistors

Dimensional drawing:



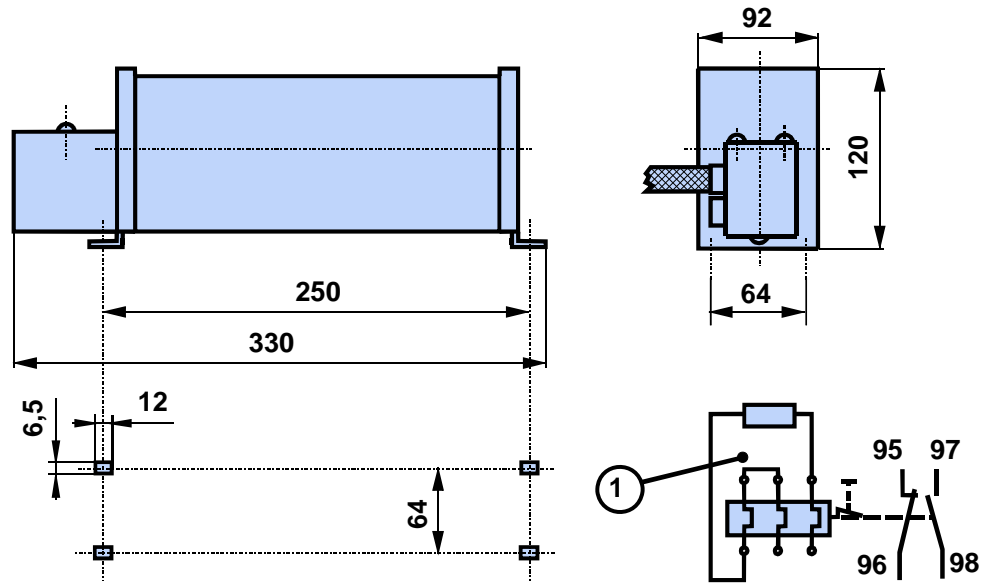
9.4.2.2 BRM5/01 braking resistor

Dimensional drawing:



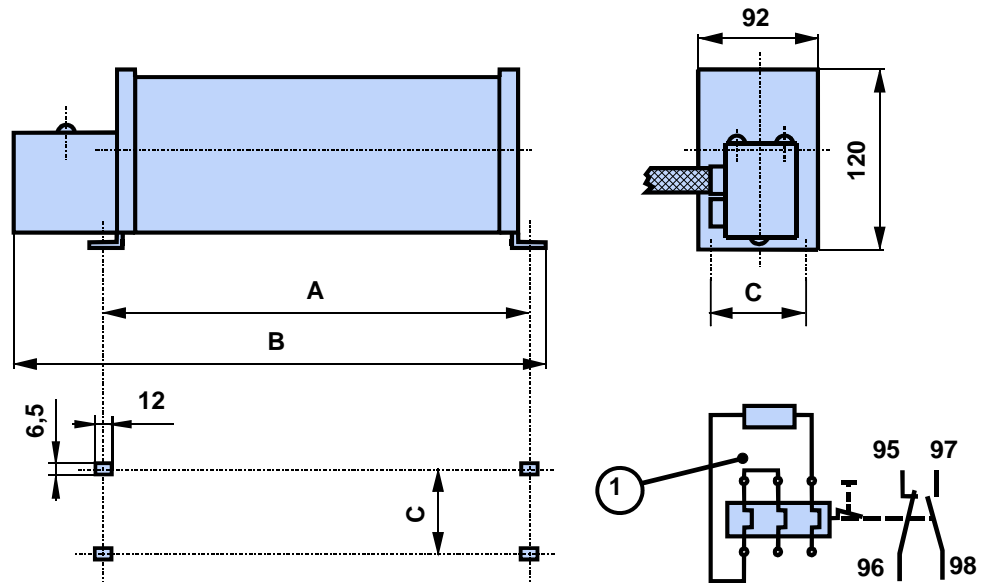
9.4.2.3 Braking resistor BRM5/02, BRM9/01 & BRM10/01

Dimensional drawing:



9.4.2.4 Braking resistor BRM4/0x

Dimensional drawing:



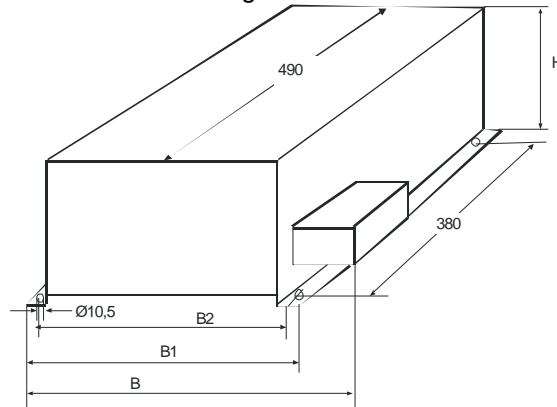
1: thermal current overload cut-off

Dimensions in mm:

Size:	BRM4/01	BRM4/02	BRM4/03
A	250	300	540
B	330	380	620
C	64	64	64

9.4.2.5 Braking resistor BRM11/01 & BRM12/01

Dimensional drawing:

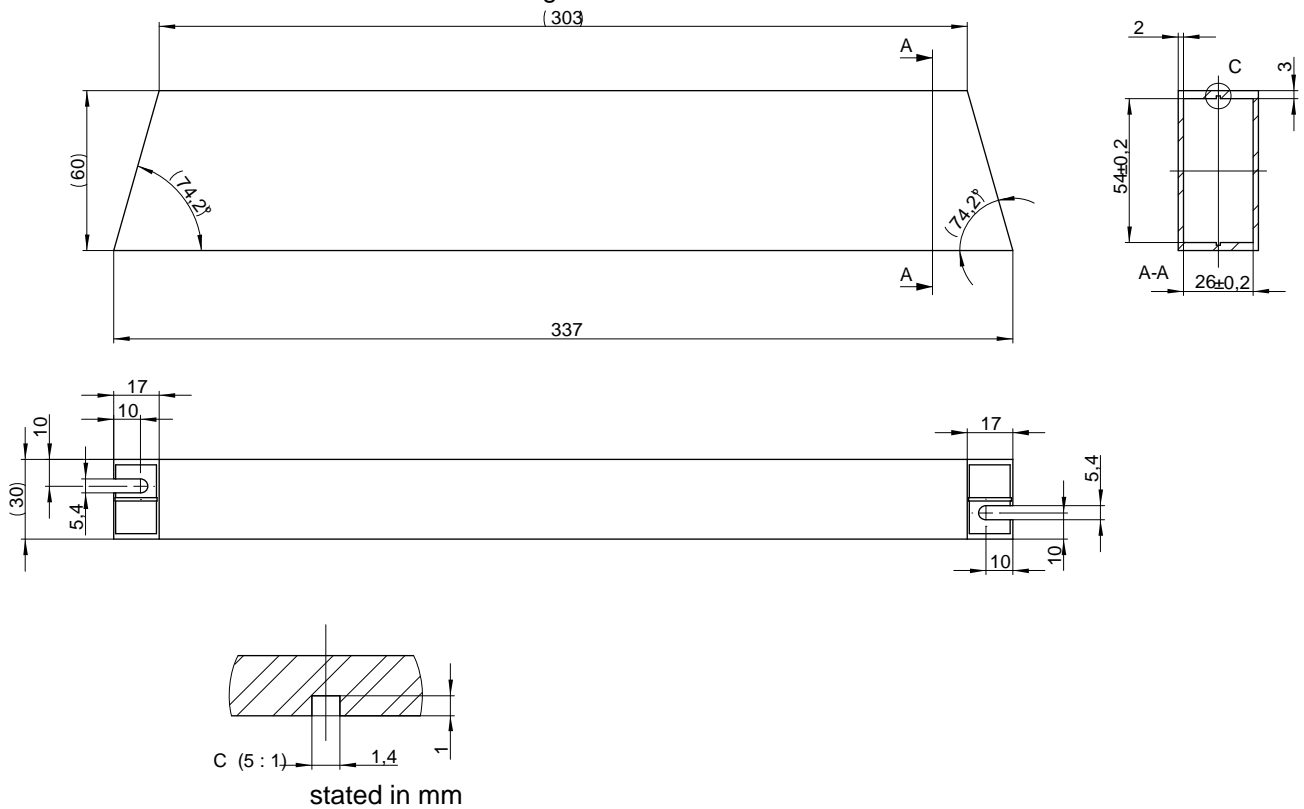


Dimensions in mm:

	BRM11/01	BRM12/02
B	330	
B1	295	
B2	270	
H	260	
Weight	6,0	7,0

9.4.2.6 Braking resistor BRM13/01 & BRM14/01

Dimensional drawing:



9.5 Connection set for Compax3S

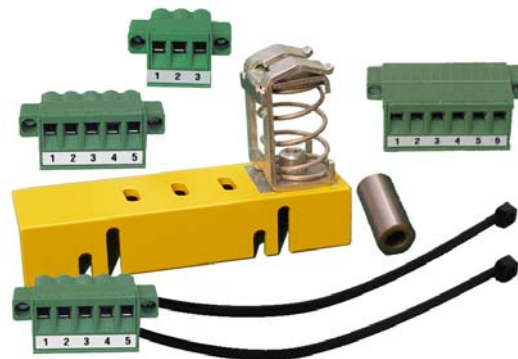
The connection set which is available as accessory comprises:

- ◆ a shield terminal with large contact area for the motor cable shield, and
- ◆ the mating plug connectors for the Compax3 plug connectors X1, X2, X3, and X4
- ◆ a toroidal core ferrite for a cable of the motor holding brake
- ◆ Lacing cord

Order Code connection set for Compax3S

for C3S0xxV2	ZBH 02/01	ZBH	0 2 / 0 1		
for C3S0xxV4 / S150V4 / S1xxV2	ZBH 02/02	ZBH	0 2 / 0 2		
for C3S300V4	ZBH 02/03	ZBH	0 2 / 0 3		

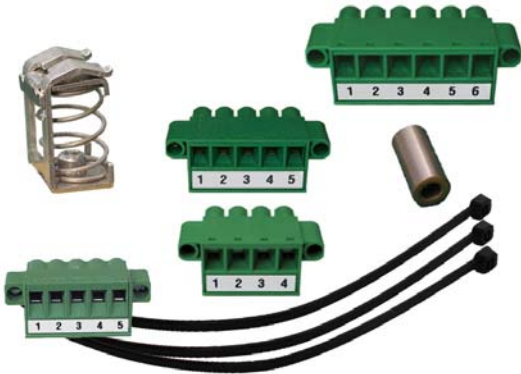
ZBH02/01: for Compax3 S0xx 1AC V2



ZBH02/02: for Compax3 S0xx 3AC V4, Compax3 S150 3AC V4 and Compax3 S1xx 3AC V2



ZBH02/03: for Compax3 S300 3AC V4



9.6 Connection set for Compax3MP/Compax3M

The connection set which is available as accessory comprises:

for Compax3M

- ◆ Cable clamps in different sizes for large area shielding of the motor cable, the screw for the cable clamp as well as
- ◆ the matching plug for the Compax3M connectors X14, X15, X43
- ◆ a toroidal core ferrite for a cable of the motor holding brake
- ◆ an interface cable (SSK28/23) for communication within the axis combination

for Compax3MP

- ◆ the matching plug for the Compax3MP connectors X9, X40, X41
- ◆ 2 bus terminal connectors (BUS07/01) for mains module and the last axis controller in the combination
- ◆

Order Code connection set for Compax3MP/Compax3M

for C3M050D6, C3M100D6, C3M150D6	ZBH 04/01	ZBH	0 4	/	0 1			
for C3MP10	ZBH 04/03	ZBH	0 4	/	0 3			

ZBH04/01: for Compax3M050-150D6

ZBH04/03: for Compax3MP10D6

9.7 Operator control module BDM

Order Code operating module

			/		
Operating module (for Compax3S)	BDM	0	1	/	0 1

Flexible service and maintenance



Functions:



- ◆ Mobile or stationary handling: can remain on the unit for display and diagnostic purposes, or can be plugged into any unit.
- ◆ Can be plugged in while in operation
- ◆ Power supply via Compax3 servo control
- ◆ Display with 2 times 16 places.
- ◆ Menu-driven operation using 4 keys.
- ◆ Displays and changing of values.
- ◆ Display of Compax3 messages.
- ◆ Duplication of device properties and IEC61131-3 program to another Compax3 with identical hardware.
- ◆ Additional information can be found in the BDM manual This can be found on the Compax3 CD or on our Homepage: **BDM-manual** (http://www.parker.com/euro_emd/EME/Literature_List/dokumentationen/BDM.pdf).

9.8 EAM06: Terminal block for inputs and outputs

Order Code terminal block

			/		
for I/Os without luminous indicator	for X11, X12, X22	EAM	0	6	/ 0 1
for I/Os with luminous indicator	for X12, X22	EAM	0	6	/ 0 2

The terminal block EAM06/.. can be used to route the Compax3 plug connector X11 or X12 for further wiring to a terminal strip and to a Sub-D plug connector.

Via a supporting rail (Design:  or ) the terminal block can be installed on a mounting rail in the control cabinet.

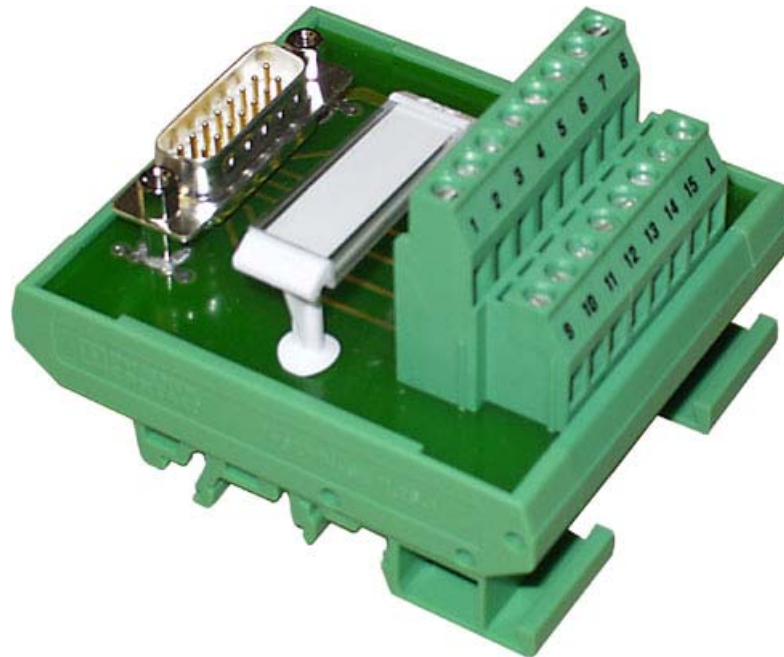
EAM06/ is available in 2 variants:

- ◆ EAM06/01: Terminal block for X11, X12, X22 without luminous indicator
- ◆ EAM06/02: Terminal block for X12, X22 with luminous indicator

Corresponding connecting cables EAM06 - Compax3 are available:

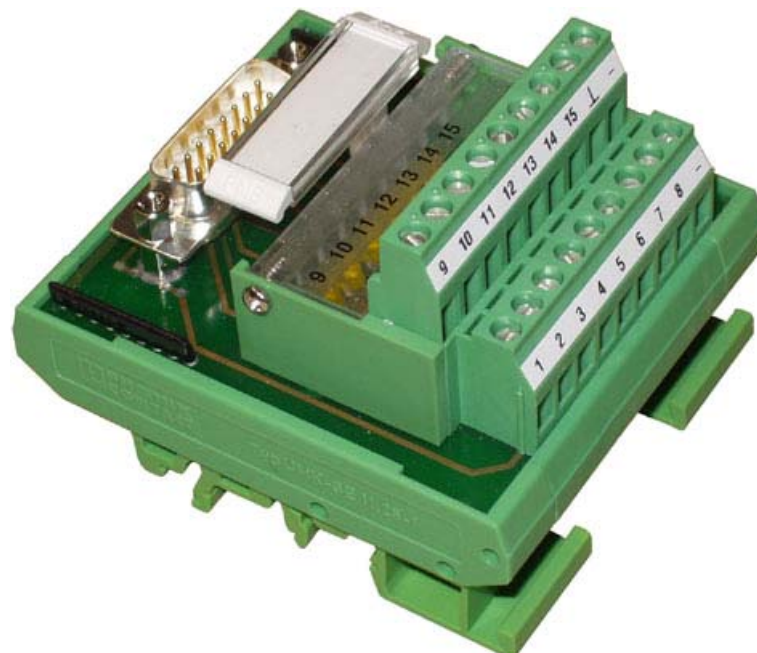
- ◆ from X11 - EAM06/01: SSK23/..
- ◆ from X12, X22 - EAM06/xx: SSK24/..

EAM06/01: Terminal block without luminous indicator for X11, X12 or X22



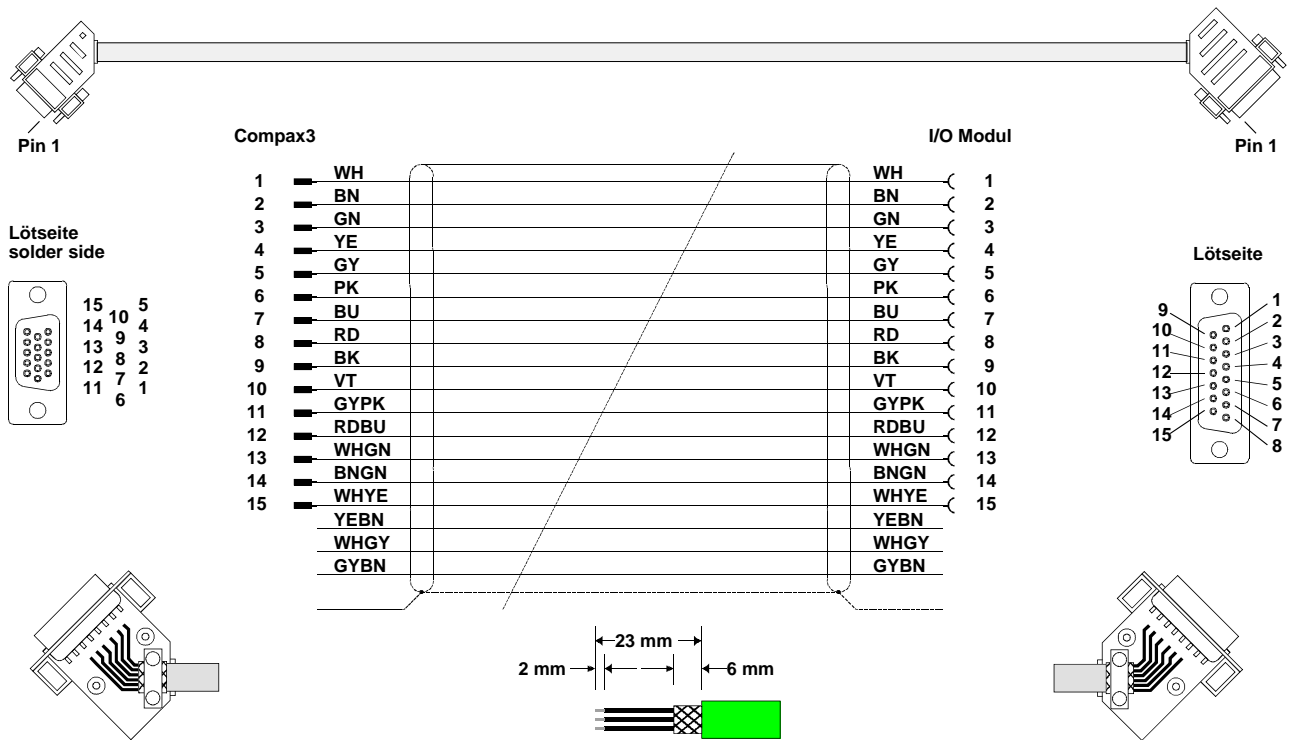
Width: 67.5mm

EAM06/02: Terminal block with luminous indicator for X12, X22

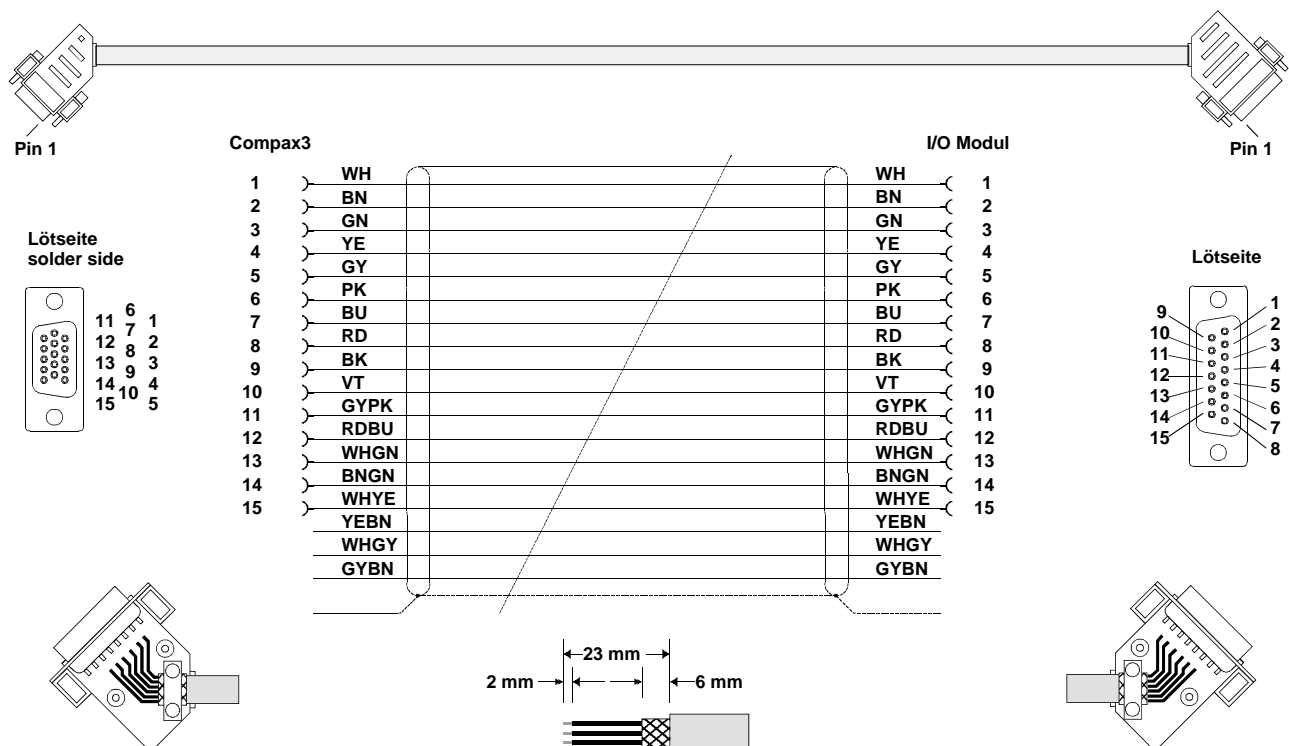


Width: 67.5mm

Cable plan SSK23/...: X11 to EAM 06/01



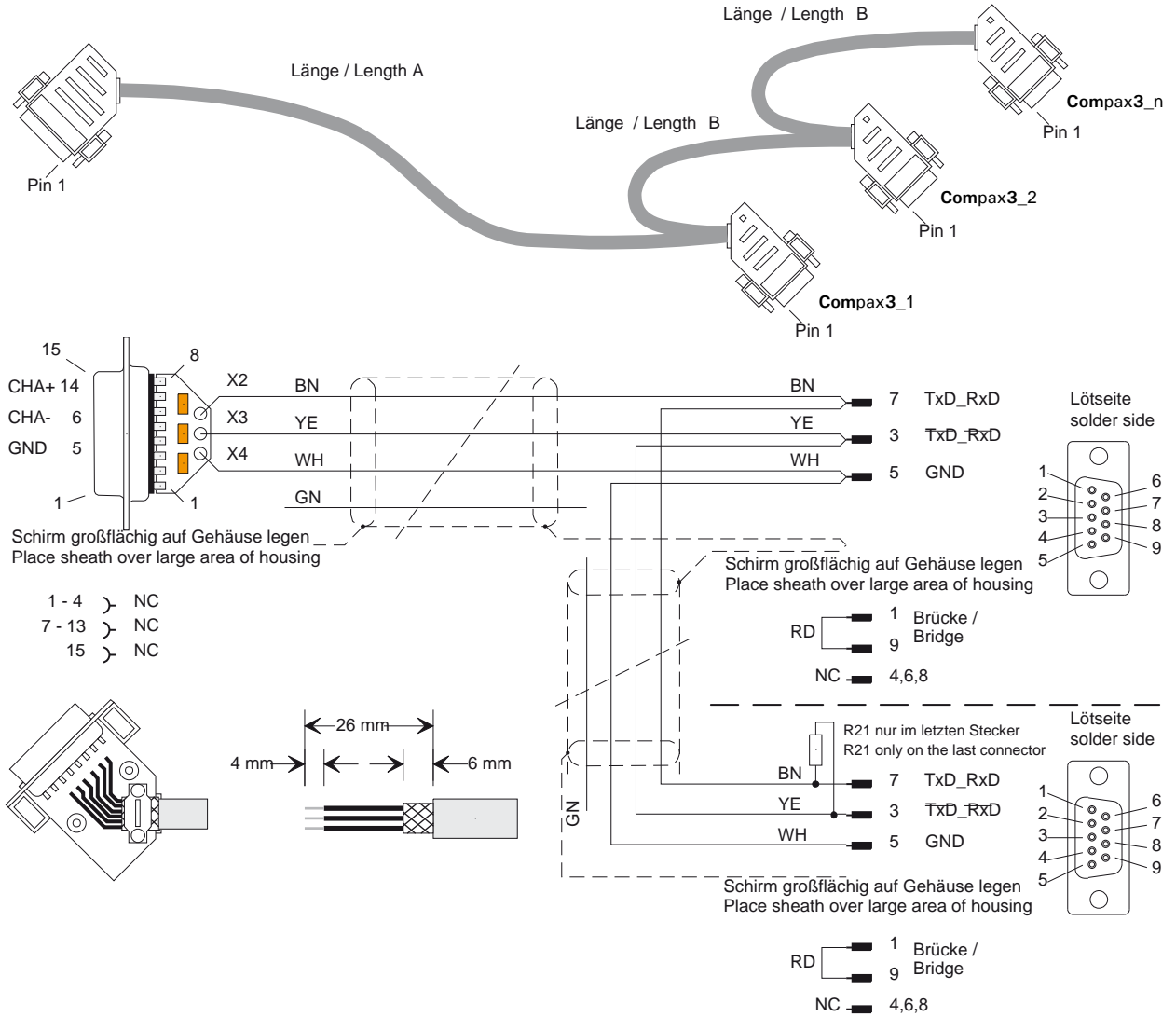
Cable plan SSK24/...: X12 to EAM 06/xx



You will find the length code in the **accessories order code** (see page 315).

9.9.2. RS485 cable to Pop

SSK27: Connection Pop - Compax3 - Compax3 - ...



⁶ Order code: SSK27/nn/..

Length A (Pop - 1. Compax3) variable (the last two numbers according to the length code for cable, for example SSK27/nn/01)

Length B (1. Compax3 - 2. Compax3 - ... - n. Compax3) fixed 50 cm (only if there is more than 1 Compax3, i.e. nn greater than 01)

Number n (the last two digits)

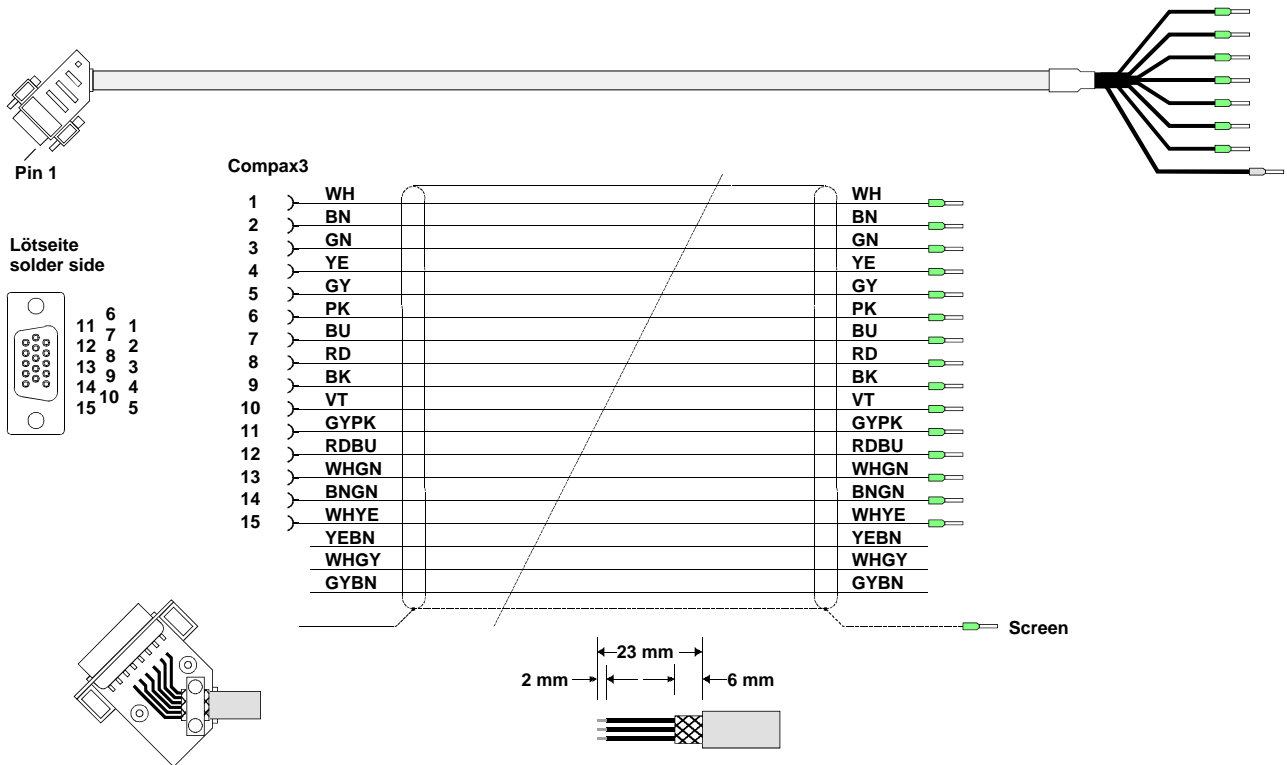
Examples:

SSK27/05/.. for connecting from Pop to 5 Compax3.

SSK27/01/.. for connection from Pop to one Compax3

9.9.3. I/O interface X12 / X22

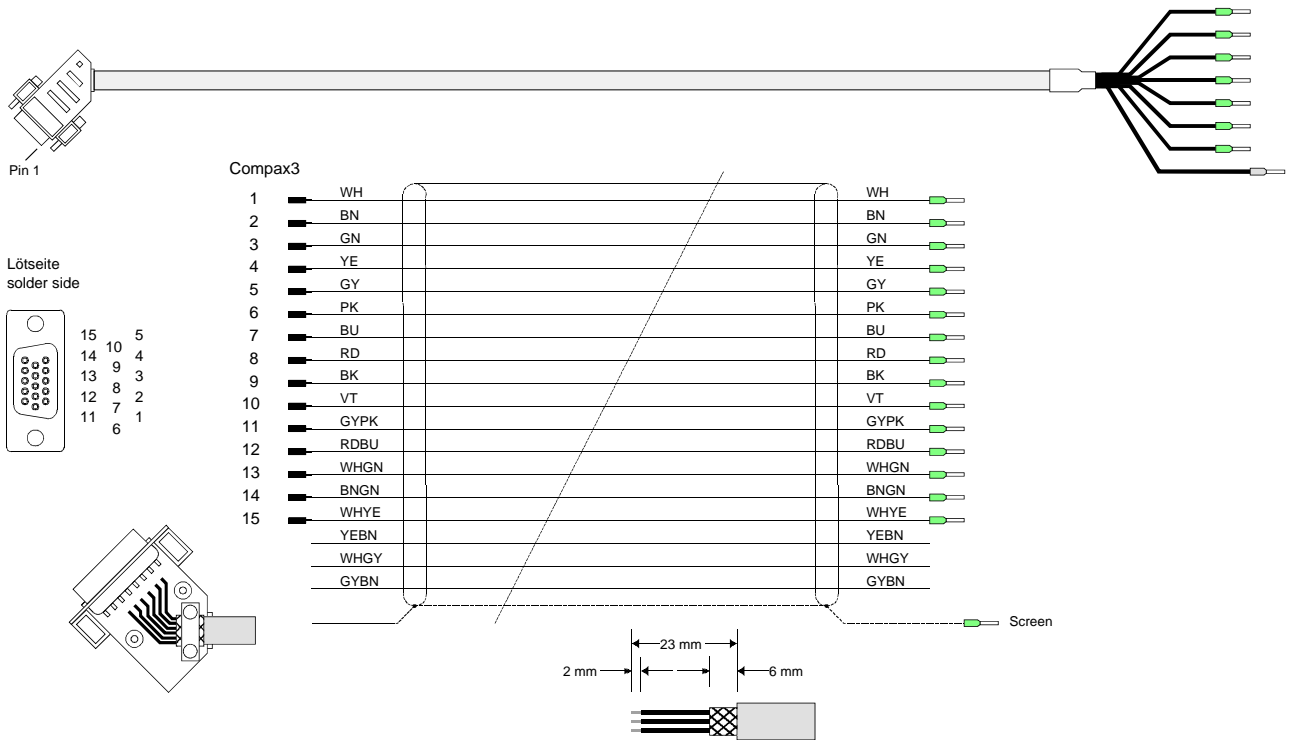
SSK22/...: Cable for X12 / X22 with flying leads



You will find the length code in the **accessories order code** (see page 315).

9.9.4. Ref X11

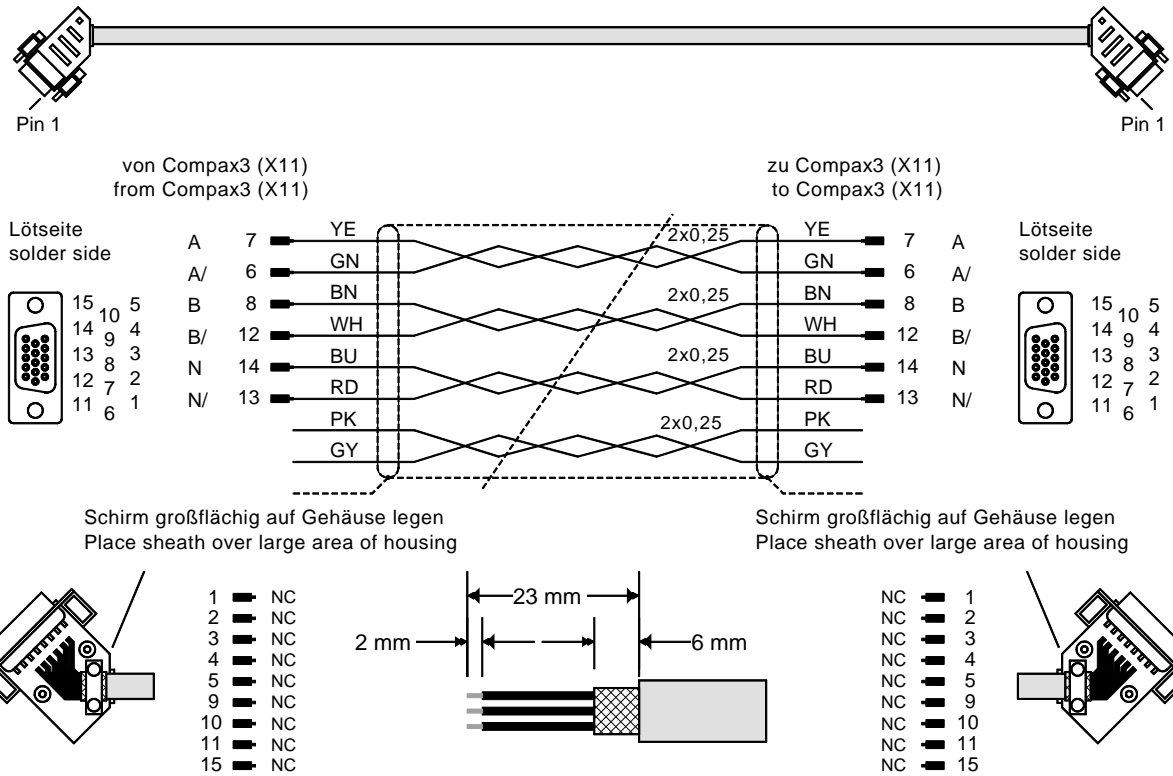
SSK21/...: Cable for X11 with flying leads



You will find the length code in the **accessories order code** (see page 315).

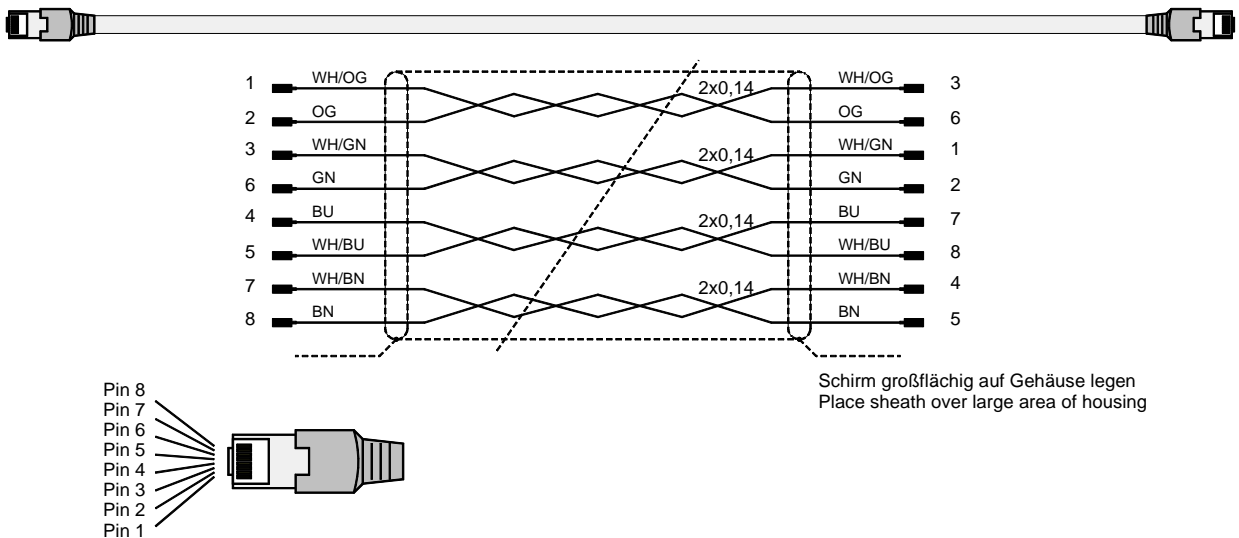
9.9.5. Encoder coupling of 2 Compax3 axes

SSK29/...: Cable from Compax3 X11 to Compax3 X11



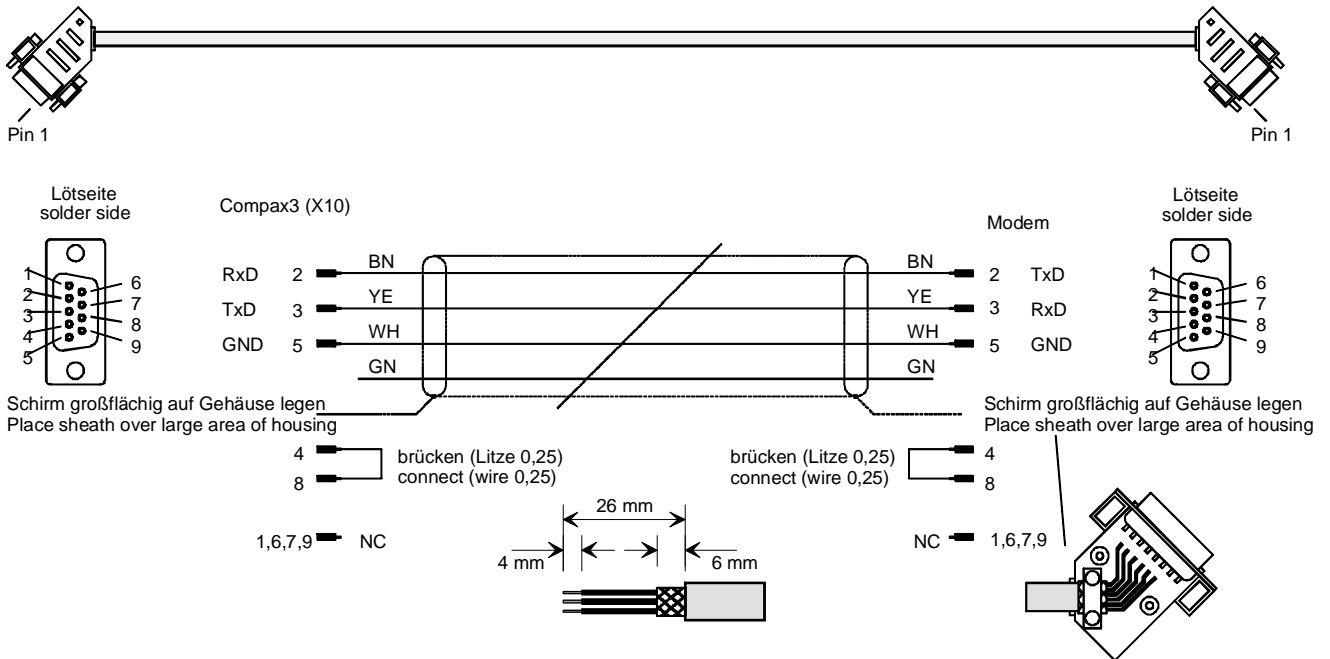
You will find the length code in the **accessories order code** (see page 315).

Layout of SSK28:



9.9.6. Modem cable SSK31

SSK31/..



You will find the length code in the **accessories order code** (see page 315).

9.10 Options M1x

In this chapter you can read about:

Input/output option M12362
 HEDA (motion bus) - Option M11364
 Option M10 = HEDA (M11) & I/Os (M12)365

9.10.1. Input/output option M12

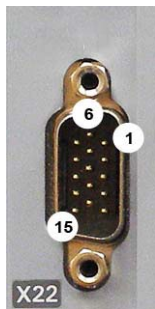
An optional input/output extension is available for Compax3. This option is named M12 and offers 12 digital 24V inputs/output (Ports) on X22.

The use of the option as inputs or outputs is programmable in groups of 4 (via the object 133.4).

The outputs are written via the object 133.3 "Output word for the I/O option"; this applies only for the ports defined as output.

The inputs are read via the object 121.2 "Input word for the I/O option"; all ports are being read, also the outputs.

9.10.1.1 Assignment of the X22 connector



PIN X22/	Input/output	I/O /X22 High density/Sub D	Access via IEC module:
1	n.c.	Reserved	
2	O0/I0	Output 0 / Input 0 - adjustable	C3_IOAddition_0
3	O1/I1	Output 1 / Input 1 - adjustable	
4	O2/I2	Output 2 / Input 2 - adjustable	
5	O3/I3	Output 3 / Input 3 - adjustable	
6	O4/I4	Output 4 / Input 4 - adjustable	C3_IOAddition_1
7	O5/I5	Output 5 / Input 5 - adjustable	
8	O6/I6	Output 6 / Input 6 - adjustable	
9	O7/I7	Output 7 / Input 7 - adjustable	
10	O8/I8	Output 8 / Input 8 - adjustable	C3_IOAddition_2 (not 24VDC)
11	E	24 VDC power supply	
12	O9/I9	Output 9 / Input 9 - adjustable	
13	O10/I10	Output 10 / Input 10 - adjustable	
14	O11/I11	Output 11 / Input 11 - adjustable	
15	E	Gnd 24 V	

The assignment can be adjusted.

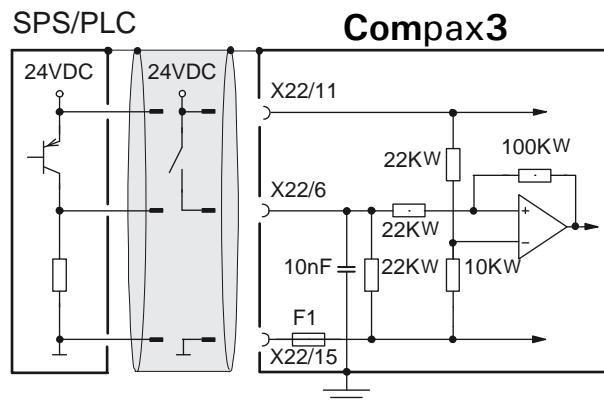
All inputs and outputs have 24V level.

Maximum load on an output: 100mA

Maximum capacitive load: 50nF (max. 4 Compax3 inputs)

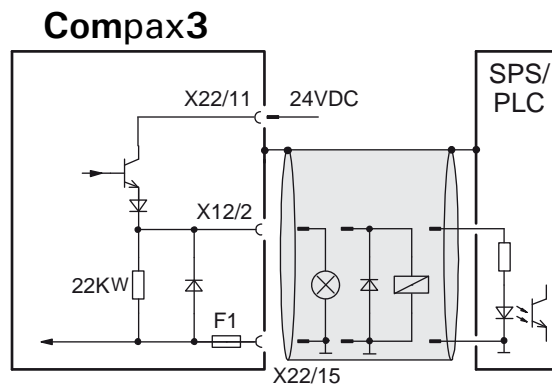
Caution! The 24VDC power supply (X22/11) must be supplied from an external source and must be protected by a 1.2A delayed fuse!

Input wiring of digital inputs



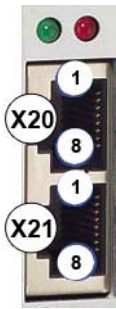
The circuit example is valid for all digital inputs!
 F1: quick action electronic fuse; can be reset by switching the 24VDC supply off and on again.

Output wiring of digital outputs



The circuit example is valid for all digital outputs!
 The outputs are short circuit proof; a short circuit generates an error.
 F1: quick action electronic fuse; can be reset by switching the 24VDC supply off and on again.

9.10.2. HEDA (motion bus) - Option M11



	RJ45 (X20)	RJ45 (X21)
PIN	HEDA in	HEDA out
1	Rx	Tx
2	Rx/	Tx/
3	Lx	Lx
4	-	Reserved
5	-	Reserved
6	Lx/	Lx/
7	-	Reserved
8	-	Reserved

Function of the HEDA LEDs

Green LED (left)

HEDA module energized

Red LED (right)

Error in the receive area

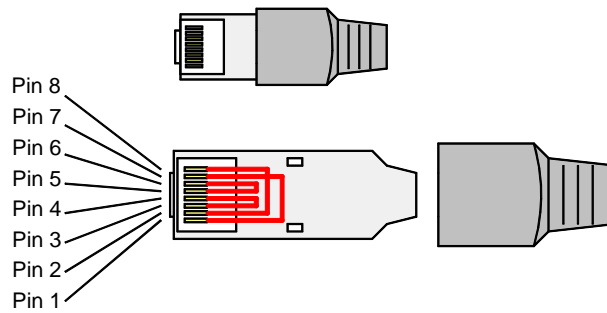
Possible causes:

- ◆ at the Master
 - ◆ no slave sending back
 - ◆ Wrong cabling
 - ◆ Terminal plug is missing
 - ◆ several masters are sending in the same slot
- ◆ at the slave
 - ◆ several masters in the system
 - ◆ no master active
 - ◆ Terminal plug is missing
 - ◆ no transmission from one or several receive slots (neither by the master nor by another slave)

HEDA-wiring:



Layout of SSK28 (see page 316, see page 360)

Design of the HEDA bus terminator BUS 07/01:

Jumpers: 1-7, 2-8, 3-4, 5-6

Function of the HEDA LEDs

Green LED (left)

HEDA module energized

Red LED (right)

Error in the receive area

Possible causes:

- ◆ at the Master
 - ◆ no slave sending back
 - ◆ Wrong cabling
 - ◆ Terminal plug is missing
 - ◆ several masters are sending in the same slot
- ◆ at the slave
 - ◆ several masters in the system
 - ◆ no master active
 - ◆ Terminal plug is missing
 - ◆ no transmission from one or several receive slots (neither by the master nor by another slave)

9.10.3. Option M10 = HEDA (M11) & I/Os (M12)

The M10 option includes the M12 input/output option and the HEDA M11 option.

10. Technical data

Mains connection Compax3S0xxV2 1AC

Controller type	S025V2	S063V2
Supply voltage	Single phase 230VAC/240VAC 80-253 VAC/50-60Hz	
Input current	6Aeff	13Aeff
Maximum fuse rating per device (=short circuit rating)	10 A (circuit breaker K)	16 A (circuit breaker K)

Mains connection Compax3S1xxV2 3AC

Controller type	S100V2	S150V2
Supply voltage	Three phase 3* 230VAC/240VAC 80-253 VAC/50-60Hz	
Input current	10Aeff	13Aeff
Maximum fuse rating per device (=short circuit rating)	16 A (circuit breaker K)	20 A (circuit breaker K)

Mains connection Compax3SxxxV4 3AC

Controller type	S015V4	S038V4	S075V4	S150V4	S300V4
Supply voltage	Three phase 3*400VAC/480VAC 80-528VAC / 50-60Hz				
Input current	3Aeff	6Aeff	10Aeff	16Aeff	22Aeff
Maximum fuse rating per device(=short circuit rating)	6A	10A	16A	20A	25A
	MTP miniature circuit breaker				D*

* for UL conform operation (see page 19): MTP miniature circuit breaker S273-K.

Mains connection Compax3MP10D6

Device type Compax3	MP10
Supply voltage	Rated voltage 3AC 400V 230-480VAC ±10% / 50-60Hz
Input current	22Aeff
Maximum fuse rating per device (=short circuit rating)	25A MTP miniature circuit breaker (ABB) Recommendation: S203-K25

Mains connection Compax3HxxxV4

Controller type	H050V4	H090V4	H125V4	H155V4
Supply voltage	Three phase 3*400VAC/480VAC 350-528VAC / 50-60Hz			
Input current	54Aeff	93Aeff	118Aeff	140Aeff
Maximum fuse rating per device(=short circuit rating)	60A	100A	125A	150A
	JDDZ class K5, JDRX class H	JDDZ class H5, JDRX class H		

Control voltage 24VDC Compax3S and Compax3H

Controller type	Compax3
Voltage range	21 - 27VDC
Mains module	with switch-on current limitation, due to capacitive load
Fuse	MTP miniature circuit breaker or "delayed action fuse", due to capacitive load
Current drain of the device	0.8A
Total current drain	0.8 A + Total load of the digital outputs + current for the motor holding brake
Ripple	0.5Vpp
Requirement according to safe extra low voltage (SELV)	yes
Short-circuit proof	conditional (internally protected with 3.15AT)

Control voltage 24VDC Compax3MP / Compax3M

Device type	Compax3MP / Compax3M
Voltage range	21 - 27VDC
Mains module	with switch-on current limitation, due to capacitive load
Fuse	MTP miniature circuit breaker or "delayed action fuse", due to capacitive load
Current drain of the device	C3MP10D6: 0.2A
Total current drain	C3M050D6: 0.85A C3M100D6: 0.85A C3M150D6: 0.85A + Total load of the digital outputs + current for the motor holding brake
Ripple	0.5Vpp
Requirement according to safe extra low voltage (SELV)	yes
Short-circuit proof	conditional (internally protected with 3.15AT)

Output data Compax3S0xx at 1*230VAC/240VAC

Controller type	S025V2	S063V2
Output voltage	3x 0-240V	3x 0-240V
Nominal output current	2.5Aeff	6.3Aeff
Pulse current for 5s	5.5Aeff	12.6Aeff
Power	1kVA	2.5kVA
Switching frequency	16kHz	16kHz
Power loss for In	30W	60W

Output data Compax3S1xx at 3*230VAC/240VAC

Controller type	S100V2	S150V2
Output voltage	3x 0-240V	3x 0-240V
Nominal output current	10Aeff	15Aeff
Pulse current for 5s	20Aeff	30Aeff
Power	4kVA	6kVA
Switching frequency	16kHz	8kHz
Power loss for In	80 W	130W

Output data Compax3Sxxx at 3*400VAC

Controller type	S015V4	S038V4	S075V4	S150V4	S300V4
Output voltage	3x 0-400V				
Nominal output current	1.5Aeff	3.8Aeff	7.5 Aeff	15Aeff	30Aeff
Pulse current for 5s	4.5Aeff	9.0Aeff	15Aeff	30Aeff	60Aeff
Power	1kVA	2.5kVA	5kVA	10kVA	20kVA
Switching frequency	16kHz	16kHz	16kHz	8kHz	8kHz
Power loss for In	60W	80 W	120W	160W	350W

Output data Compax3Sxxx at 3*480VAC

Controller type	S015V4	S038V4	S075V4	S150V4	S300V4
Output voltage	3x 0-480V				
Nominal output current	1.5Aeff	3.8Aeff	6.5Aeff	13.9Aeff	30Aeff
Pulse current for 5s	4.5Aeff	7.5 Aeff	15Aeff	30Aeff	60Aeff
Power	1.25kVA	3.1kVA	6.2kVA	11.5kVA	25kVA
Switching frequency	16kHz	16kHz	16kHz	8kHz	8kHz
Power loss for In	60W	80 W	120W	160W	350W

Output data Compax3Mxxx at 3*400VAC

Device type Compax3	M050D6	M100D6	M150D6
Output voltage	3x 0-400V		
Nominal output current	5Aeff	10Aeff	15Aeff
Pulse current for 5s *	10Aeff	20Aeff	30Aeff
Power	3.33kVA	6.66kVA	10kVA
Switching frequency	8 kHz	8 kHz	8 kHz
Power loss for In	60W+**	80W+**	110W+**

*Turning frequency for pulse current: $f > 5\text{Hz}$

** Losses microelectronics (24VDC): 10.3W without option card, 15W_{max} with option card.

Output data Compax3Mxxx at 3*480VAC

Device type Compax3	M050D6	M100D6	M150D6
Output voltage	3x 0-480V		
Nominal output current	4Aeff	8Aeff	12.5Aeff
Pulse current for 5s *	8Aeff	16Aeff	25Aeff
Power	3.33kVA	6.66kVA	10kVA
Switching frequency	8 kHz	8 kHz	8 kHz
Power loss for In	60W+**	80W+**	110W+**

*Turning frequency for pulse current: $f > 5\text{Hz}$

** Losses microelectronics (24VDC): 10.3W without option card, 15W_{max} with option card.

Output data Compax3Hxxx at 3*400VAC

Controller type	H050V4	H090V4	H125V4	H155V4
Output voltage	3x 0-400V			
Nominal output current	50Aeff	90Aeff	125Aeff	155Aeff
Pulse current for 5s *	75Aeff	135Aeff	187.5Aeff	232.5Aeff
Power	35kVA	62kVA	86kVA	107kVA
Switching frequency	8 kHz	8 kHz	8 kHz	8 kHz
Power loss for In	880W	900W	1690W	1970W

* during low speeds, the overload time is reduced to 1s. Limit:

< 2.5 electric rev/s (= actual revolutions/s * number of pole pairs) resp. > 2.5 Pitch/s

Output data Compax3Hxxx at 3*480VAC

Controller type	H050V4	H090V4	H125V4	H155V4
Output voltage	3x 0-480V			
Nominal output current	43Aeff	85Aeff	110Aeff	132Aeff
Pulse current for 5s *	64.5Aeff	127.5Aeff	165Aeff	198Aeff
Power	35kVA	70kVA	91kVA	109kVA
Switching frequency	8kHz	8kHz	8kHz	8kHz
Power loss for In	850W	1103W	1520W	1800W

* during low speeds, the overload time is reduced to 1s. Limit:

< 2.5 electric rev/s (= actual revolutions/s * number of pole pairs) resp. > 2.5 Pitch/s

Resulting nominal and peak currents depending on the switching frequency

Compax3S0xxV2 at 1*230VAC/240VAC

Switching frequency*		S025V2	S063V2
16kHz	$I_{nominal}$	2.5A _{eff}	6.3A _{eff}
	$I_{peak} (<5s)$	5.5A _{eff}	12.6A _{eff}
32kHz	$I_{nominal}$	2.5A _{eff}	5.5A _{eff}
	$I_{peak} (<5s)$	5.5A _{eff}	12.6A _{eff}

Compax3S1xxV2 at 3*230VAC/240VAC

Switching frequency*		S100V2	S150V2
8 kHz	$I_{nominal}$	-	15A _{eff}
	$I_{peak} (<5s)$	-	30A _{eff}
16kHz	$I_{nominal}$	10A _{eff}	12.5A _{eff}
	$I_{peak} (<5s)$	20A _{eff}	25A _{eff}
32kHz	$I_{nominal}$	8A _{eff}	10A _{eff}
	$I_{peak} (<5s)$	16A _{eff}	20A _{eff}

Compax3S0xxV4 at 3*400VAC

Switching frequency*		S015V4	S038V4	S075V4	S150V4	S300V4
8 kHz	$I_{nominal}$	-	-	-	15A _{eff}	30A _{eff}
	$I_{peak} (<5s)$	-	-	-	30A _{eff}	60A _{eff}
16kHz	$I_{nominal}$	1.5A _{eff}	3.8A _{eff}	7.5A _{eff}	10.0A _{eff}	26A _{eff}
	$I_{peak} (<5s)$	4.5A _{eff}	9.0A _{eff}	15.0A _{eff}	20.0A _{eff}	52A _{eff}
32kHz	$I_{nominal}$	1.5A _{eff}	2.5A _{eff}	3.7A _{eff}	5.0A _{eff}	14A _{eff}
	$I_{peak} (<5s)$	3.0A _{eff}	5.0A _{eff}	10.0A _{eff}	10.0A _{eff}	28A _{eff}

Compax3S0xxV4 at 3*480VAC

Switching frequency*		S015V4	S038V4	S075V4	S150V4	S300V4
8 kHz	$I_{nominal}$	-	-	-	13.9A _{eff}	30A _{eff}
	$I_{peak} (<5s)$	-	-	-	30A _{eff}	60A _{eff}
16kHz	$I_{nominal}$	1.5A _{eff}	3.8A _{eff}	6.5A _{eff}	8.0A _{eff}	21.5A _{eff}
	$I_{peak} (<5s)$	4.5A _{eff}	7.5A _{eff}	15.0A _{eff}	16.0A _{eff}	43A _{eff}
32kHz	$I_{nominal}$	1.0A _{eff}	2.0A _{eff}	2.7A _{eff}	3.5A _{eff}	10A _{eff}
	$I_{peak} (<5s)$	2.0A _{eff}	4.0A _{eff}	8.0A _{eff}	7.0A _{eff}	20A _{eff}

The values marked with grey are the pre-set values (standard values)!

*corresponds to the frequency of the motor current

Resulting nominal and peak currents depending on the switching frequency

Compax3MxxxD6 at 3*400VAC

Switching frequency*		M050D6	M100D6	M150D6
8 kHz	I_{nominal}	5A _{eff}	10A _{eff}	15A _{eff}
	$I_{\text{peak}} (<5s)$	10A _{eff}	20A _{eff}	30A _{eff}
16kHz	I_{nominal}	3.8A _{eff}	7.5A _{eff}	10A _{eff}
	$I_{\text{peak}} (<5s)$	7.5A _{eff}	15A _{eff}	20A _{eff}
32kHz	I_{nominal}	2.5A _{eff}	3.8A _{eff}	5A _{eff}
	$I_{\text{peak}} (<5s)$	5A _{eff}	7.5A _{eff}	10A _{eff}

Compax3MxxxD6 at 3*480VAC

Switching frequency*		M050D6	M100D6	M150D6
8 kHz	I_{nominal}	4A _{eff}	8A _{eff}	12.5A _{eff}
	$I_{\text{peak}} (<5s)$	8A _{eff}	16A _{eff}	25A _{eff}
16kHz	I_{nominal}	3A _{eff}	5.5A _{eff}	8A _{eff}
	$I_{\text{peak}} (<5s)$	6A _{eff}	11A _{eff}	16A _{eff}
32kHz	I_{nominal}	2A _{eff}	2.5A _{eff}	4A _{eff}
	$I_{\text{peak}} (<5s)$	4A _{eff}	5A _{eff}	8A _{eff}

The values marked with grey are the pre-set values (standard values)!
 *corresponds to the frequency of the motor current

Resulting nominal and peak currents depending on the switching frequency

Compax3HxxxV4 at 3*400VAC

Switching frequency*		H050V4	H090V4	H125V4	H155V4
8 kHz	I _{nominal}	50A _{eff}	90A _{eff}	125A _{eff}	155A _{eff}
	I _{peak} (<5s)	75A _{eff}	135A _{eff}	187.5A _{eff}	232.5A _{eff}
16kHz	I _{nominal}	33A _{eff}	75A _{eff}	82A _{eff}	100A _{eff}
	I _{peak} (<5s)	49.5A _{eff}	112.5A _{eff}	123A _{eff}	150A _{eff}
32kHz	I _{nominal}	19A _{eff}	45A _{eff}	49A _{eff}	59A _{eff}
	I _{peak} (<5s)	28.5A _{eff}	67.5A _{eff}	73.5A _{eff}	88.5A _{eff}

Compax3HxxxV4 at 3*480VAC

Switching frequency*		H050V4	H090V4	H125V4	H155V4
8 kHz	I _{nominal}	43A _{eff}	85A _{eff}	110A _{eff}	132A _{eff}
	I _{peak} (<5s)	64.5A _{eff}	127.5A _{eff}	165A _{eff}	198A _{eff}
16kHz	I _{nominal}	27A _{eff}	70A _{eff}	70A _{eff}	84A _{eff}
	I _{peak} (<5s)	40.5A _{eff}	105A _{eff}	105A _{eff}	126A _{eff}
32kHz	I _{nominal}	16A _{eff}	40A _{eff}	40A _{eff}	48A _{eff}
	I _{peak} (<5s)	24A _{eff}	60A _{eff}	60A _{eff}	72A _{eff}

The values marked with grey are the pre-set values (standard values)!
 *corresponds to the frequency of the motor current

Resolution of the motor position

For option F10: Resolver	<ul style="list-style-type: none"> ◆ Position resolution: 16Bit (= 0.005°) ◆ Absolute accuracy: ±0,167°
For option F11: SinCos®	<ul style="list-style-type: none"> ◆ Position resolution: 13.5Bit/Encoder sine period => 0.03107°/encoder resolution
For option F12:	<ul style="list-style-type: none"> ◆ Maximum position resolution <ul style="list-style-type: none"> ◆ Linear: 24 Bits per motor magnet spacing ◆ Rotary: 24 bits per motor revolution ◆ Resolution for analog hall sensors with 1V_{ss} signal (e.g. EnDat): 13.5 bits / graduation of the scale of the encoder ◆ For RS 422 encoders: 4x encoder resolution ◆ Accuracy of the feedback zero pulse acquisition = accuracy of the feedback resolution ◆ Resolution for analog hall sensors with 1V_{ss} signal: 13.5 bits / motor magnet spacing

Precision

The exactitude of the position signal is above all determined by the exactitude of the feedback system used.

Motors and feedback systems supported

<p>Motors Direct drives ◆ Linear motors ◆ Torque motors</p>	<ul style="list-style-type: none"> ◆ Sinusoidal commutated synchronous motors <ul style="list-style-type: none"> ◆ Maximum rotating field frequency: 1,000Hz ◆ Max. velocity at 8 pole motors: 15000min⁻¹. ◆ General max. speed: 60*1000/number of pole pairs in [min⁻¹]. ◆ Sinusoidal commutated asynchronous motors <ul style="list-style-type: none"> ◆ Maximum rotating field frequency: 1,000Hz ◆ Max. speed: 60*1000/number of pole pairs - slip in [min⁻¹]. ◆ Field suppression: typically up to triple (higher on request). ◆ Temperature sensor: KTY84-130 (insulated according to EN60664-1 or IEC60664-1) ◆ 3 phase synchronous direct drives
<p>Position encoder (Feedback)</p>	<p><u>Option F10: Resolver</u></p>
<p>LTN:</p>	<ul style="list-style-type: none"> ◆ JSSBH-15-E-5 ◆ JSSBH-21-P4 ◆ RE-21-1-A05 ◆ RE-15-1-B04
<p>Tamagawa:</p>	<ul style="list-style-type: none"> ◆ 2018N321 E64
<p>Siemens:</p>	<ul style="list-style-type: none"> ◆ 23401-T2509-C202
	<p><u>Option F11: SinCos®</u></p>
	<ul style="list-style-type: none"> ◆ Singleturn (SICK|Stegmann) ◆ Multiturn (SICK|Stegmann) Absolute position up to 4096 motor revolutions. ◆ Rotary feedback with HIPERFACE® interface: e.g.: SRS50, SRM50, SKS36, SKM36, SEK52

Special encoder systems for direct drives	Option F12
Analog hall sensors	<ul style="list-style-type: none"> ◆ Sine - cosine signal (max. 5V_{ss}⁴; typical 1V_{ss}) 90° offset ◆ U-V Signal (max. 5V_{ss}⁵; typical 1V_{ss}) 120° offset.
Encoder (linear or rotatory)	<ul style="list-style-type: none"> ◆ Sine-cosine (max. 5V_{ss}⁶; typical 1V_{ss}) (max. 400kHz) or ◆ TTL (RS422) (max. 5MHz) with the following modes of commutation: <ul style="list-style-type: none"> ◆ automatic commutation (see page 320) or ◆ Digital hall sensors (e.g. DiCoder®)
Digital, bidirectional interface	<ul style="list-style-type: none"> ◆ All EnDat 2.1 or EnDat 2.2 feedback systems with incremental track (sine-cosine track) ◆ linear or rotary ◆ max. 400kHz Sine-Cosine
Distance coded feedback systems	<ul style="list-style-type: none"> ◆ Distance coding with 1V_{SS} - Interface ◆ Distance coding with RS422 - Interface (Encoder)

Feedback error compensation

Feedback error compensation	<ul style="list-style-type: none"> ◆ Automatic feedback error compensation (offset & amplification) for analog hall sensors and sine-cosine encoder can be activated in the MotorManager.
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Motor holding brake output

Motor holding brake output	Compax3
Voltage range	21 – 27VDC
Maximum output current (short circuit proof)	1.6A
Minimum output current	150 mA
Securing of brake Compax3M	3.15A

Braking operation Compax3S0xxV2 1AC

Controller type	S025V2	S063V2
Capacitance / storable energy	560µF / 15Ws	1120µF / 30Ws
Minimum braking- resistance	100Ω	56Ω
Recommended nominal power rating	20 ... 60W	60 ... 180W
Maximum continuous current	8A	15A

⁴ Max. differential input between SIN- (X13/7) and SIN+ (X13/8).

⁵ Max. differential input between SIN- (X13/7) and SIN+ (X13/8).

⁶ Max. differential input between SIN- (X13/7) and SIN+ (X13/8).

Braking operation Compax3S1xxV2 3AC

Controller type	S100V2	S150V2
Capacitance / storable energy	780 μ F / 21Ws	1170 μ F / 31Ws
Minimum braking- resistance	22 Ω	15 Ω
Recommended nominal power rating	60 ... 450W	60 ... 600W
Maximum continuous current	20A	20A

Braking operation Compax3SxxxV4 3AC

Controller type	S015V4	S038V4	S075V4	S150V4	S300V4
Capacitance / storable energy	235 μ F / 37Ws	235 μ F / 37Ws	470 μ F / 75Ws	690 μ F / 110Ws	1100 μ F / 176Ws
Minimum braking- resistance	100 Ω	100 Ω	56 Ω	33 Ω	15 Ω
Recommended nominal power rating	60 ... 100W	60 ... 250W	60 ... 500 W	60 ... 1000 W	60 ... 1000 W
Maximum continuous current	10A	10A	15A	20A	30A

Braking operation Compax3MxxxD6 (axis controller)

Device type Compax3	M050	M100	M150
Capacitance / storable energy	110 μ F / 18Ws at 400V 10Ws at 480V	220 μ F / 37Ws at 400V 21Ws at 480V	220 μ F / 37Ws at 400V 21Ws at 480V

Braking operation of Compax3HxxxV4

Controller type	H050V4	H090V4	H125V4	H155V4
Capacitance / storable energy	2600 μ F / 602Ws	3150 μ F / 729Ws	5000 μ F / 1158Ws	5000 μ F / 1158Ws
Minimum braking- resistance	24 Ω	15 Ω	8 Ω	8 Ω
Maximum continuous current	30A	45A	83A	83A

Braking resistors for Compax3

Braking Resistor (see page 337)	Device	Rated Power
BRM08/01 (100 Ω)	Compax3S025V2 Compax3S015V4 Compax3S038V4	60W
BRM05/01 (56 Ω)	Compax3S063V2 Compax3S075V4	180W
BRM05/02 (56 Ω)	Compax3S075V4	570W
BRM10/01 (47 Ω)	Compax3S150V4	570W
BRM04/01 (15 Ω)	Compax3S300V4 Compax3S150V2	570W
BRM04/02 (15 Ω)	Compax3S300V4 Compax3S150V2	740W
BRM04/03 (15 Ω)	Compax3S300V4	1500W
BRM09/01 (22 Ω)	Compax3S100V2	570W
BRM11/01 (27 Ω)	Compax3H0xxV4	3500W
BRM13/01 (30 Ω)	Compax3MP10D6	500 W
BRM14/01 (15 Ω)	Compax3MP10D6*	500 W
BRM12/01 (18 Ω)	Compax3H1xxV4	4500W

*for Compax3MP10D6 2x15 Ω in series

Size / weight of Compax3S

Controller type	Dimensions HxWxD [mm]	Weight [kg]
Compax3S025V2	191 x 84 x 172	2.0
Compax3S063V2	191 x 100 x 172	2.5
Compax3S015V4	248 x 84 x 172	3.1
Compax3S100V2	248 x 115 x 172	4.3
Compax3S150V2	248 x 158 x 172	6.8
Compax3S038V4	248 x 100 x 172	3.5
Compax3S075V4	248 x 115 x 172	4.3
Compax3S150V4	248 x 158 x 172	6.8
Compax3S300V4	380 x 175 x 172	10.9

Minimum mounting distance: 15mm at the sides, above & below 100mm

Protection type IP20

Drawings, Mounting (see page 64)

Size / weight of Compax3MP/Compax3M

Device type	Dimensions HxWxD [mm]	Weight [kg]
Compax3MP010D6	360 x 50 x 263	3,95
Compax3M050D6	360 x 50 x 263	3,5
Compax3M100D6	360 x 50 x 263	3,6
Compax3M150D6	360 x 50 x 263	3,6

Protection type IP20

Size / weight of Compax3H

Controller type	Dimensions HxWxD [mm]	Weight [kg]
Compax3H050V4	453 x 252 x 245	17,4
Compax3H090V4	668.6 x 257 x 312	32,5
Compax3H125V4	720 x 257 x 355	41
Compax3H155V4	720 x 257 x 355	41

Protection class IP20 when mounted in a control cabinet (not for Compax3H1xxxV4)

Drawings, Mounting (see page 64)

Safety technology Compax3S

Safe torque-off as per EN954-1, category 3 Certified: (BG-PRÜFZERT certification number: 0403005)	<ul style="list-style-type: none"> ◆ For implementation of the "protection against unexpected start-up" function described in EN1037. ◆ Note the circuit examples circuit examples (see page 72).
--	--

Safety technology Compax3MP / Compax3M

Safety technology as an option State-of-the-art safety technology EN ISO 13849	◆ Please respect the stated safety technology on the type designation plate (see page 11) and the circuitry examples
--	---

UL certification for Compax3S

conform to UL:	◆ according to UL508C
Certified	◆ E-File_No.: E235 342

The UL certification is documented by a "UL" logo on the device (type specification plate).



"UL" logo

Insulation requirements

Protection class	Protection class I according to EN60664-1
Protection against human contact with dangerous voltages	According to En 61800-5-1
Overvoltage category	Voltage class III according to EN 60664-1
Degree of contamination	Degree of contamination 2 according to EN 60664-1 and EN 61800-5-1

Environmental conditions Compax3S and Compax3H

General ambient conditions	According to EN 60 721-3-1 to 3-3 Climate (temperature/humidity/barometric pressure): Class 3K3	
Permissible ambient temperature:		
Operation	0 to +45 C	Class 3K3
Storage	-25 to +70 C	Class 2K3
Transport	-25 to +70 C	Class 2K3
Tolerated humidity:	No condensation	
Operation	<= 85% class 3K3	(Relative humidity)
Storage	<= 95% class 2K3	
Transport	<= 95% class 2K3	
Elevation of operating site	<=1000m above sea level for 100% load ratings <=2000m above sea level for 1% / 100m power reduction Please inquire for greater elevations	
Mechanic resonances:	EN 60068-2-6 (sinusoidal excitation)	
Sealing	IP20 protection class according to EN 60 529	

Cooling Compax3S and Compax3H

Cooling mode:	C3S025V2 ... S150V4: Convection C3S300V4 & C3H: Forced air ventilation with fan in the heat dissipator Air flow rate: 459m ³ /h (C3H)
Supply:	C3S300V4, C3H050, C3H090 internal C3H125, C3H155 external 220/240VAC: 140W, 2.5μF, Stator - 62Ω Optionally on request: 110/120VAC: 130W, 10μF, Stator - 16Ω Circuit breaker: 3A

EMC limit values Compax3S and Compax3H

EMC interference emission	Limit values according to EN 61 800-3, Limit value class C3/C4 without additional mains filter: Information on C2 limit value classes (see page 16)
EMC disturbance immunity	Industrial area limit values in accordance with EN 61 800-3

Environmental conditions Compax3MP / Compax3M

General ambient conditions	According to EN 60 721-3-1 to 3-3 Climate (temperature/humidity/barometric pressure): Class 3K3	
Permissible ambient temperature:		
Operation Storage Transport	0 to +40 C -25 to +70 C -25 to +70 C	Class 3K3
Tolerated humidity:	No condensation	
Operation Storage Transport	<= 85% class 3K3 <= 95% <= 95%	(Relative humidity)
Elevation of operating site	<=1000m above sea level for 100% load ratings <=2000m above sea level for 1% / 100m power reduction Please inquire for greater elevations	
Sealing	IP20 protection class according to EN 60 529	
Mechanic resonances:	Class 2M3, 20m/s ² ;8-200Hz	

Cooling Compax3MP / Compax3M

Cooling mode:	Forced air ventilation with fan in the heat dissipator
----------------------	---

EMC limit values Compax3MP/Compax3M

EMC interference emission	Limit values according to EN 61 800-3, Limit value class C3 with mains filter.
EMC disturbance immunity	Industrial area limit values in accordance with EN 61 800-3

EC directives and harmonised EC norms

Low voltage directive 2006/95/EC	EN 61800-5-1, Standard for electric power drives with settable speed; requirements to electric safety EN 60664-1, isolation coordinates for electricale equipment in low-voltage systems EN 60 204-1, machinery standard partly applied
EC-EMC-directive 2004/108/EC	EN 61 800-3, EMC norm Product standard for variable speed drives

COM ports

RS232	<ul style="list-style-type: none"> ◆ 115200 baud ◆ Word length: 8 bits, 1 start bit, 1 stop bit ◆ Hardware handshake XON, XOFF
RS485 (2 or 4-wire)	<ul style="list-style-type: none"> ◆ 9600, 19200, 38400, 57600 or 115200 baud ◆ Word length 7/8 bit, 1 start bit, 1 stop bit ◆ Parity (can be switched off) even/odd ◆ 2 or 4-wire
USB (Compax3M)	<ul style="list-style-type: none"> ◆ USB 2.0 Full Speed compatible

Load position control

Dual Loop Option	<ul style="list-style-type: none"> ◆ 2. Feedback system for the control of the load position (see page 139) is possible.
------------------	--

Signal interfaces

Signal inputs / signal sources	<ul style="list-style-type: none"> ◆ Encoder – input track A/B (RS422) <ul style="list-style-type: none"> ◆ up to max. 10MHz ◆ internal quadrature of the resolution ◆ Step / direction input (24V-level) Max. 300kHz at $\geq 50\Omega$ source impedance and minimum pulse width of 1,6μs. ◆ +/-10V analog input 14Bit; 62.5μs scanning rate. ◆ SSI Feedback
Signal outputs	<ul style="list-style-type: none"> ◆ Encoder simulation <ul style="list-style-type: none"> ◆ 1...16384 increments/revolution or pitch ◆ Limit frequency 620kHz ◆ Bypass function with encoder feedback with feedback module F12.(Limit frequency 5MHz).
Signal transmission	<p>HEDA (option M10 or M11) Exchange of process values:</p> <ul style="list-style-type: none"> ◆ from Slave to Master ◆ from Slave to Master and ◆ from Slave to Slave.

Ethernet Powerlink - characteristics

Profile	◆ Motion Control CiADS402
Baud rate	◆ 100Mbits (FastEthernet)
EDS file	◆ C3_EPL_cn.EDS
Service data object	◆ SDO
Cycle time	◆ <200µs, up to 240 nodes
Synchronicity precision of the SYNC telegram	◆ maximum jitter: +/-25µs ◆ Typical cycle times: >= 1ms
Typical cycle times	◆ >= 1ms
Deviations from the Device Profile DSP402	◆ For the velocity mode profile the setpoint acceleration is also applicable when braking. ◆ Only one rotation speed is possible for machine zero run start (objects 0x6099.1 and .2 are the same).

Functions

Operating modes:	◆ Speed control ◆ Direct positioning (position control) ◆ Positioning with set selection
Speed control	◆ Cyclic predefined Setpoint value ◆ Up to 2 cyclic actual values
Direct positioning	◆ Cyclic predefined Setpoint value ◆ Cyclic actual values ◆ Different motion functions
Positioning with set selection	◆ up to 31 motion sets possible. ◆ Different motion functions
Motion functions	◆ Absolute positioning ◆ Relative positioning ◆ Electronic Gearbox (Gearing) ◆ Reg-related positioning (precision < 1µs) ◆ Speed control ◆ Stop - Set ◆ Defining status bits for the sequence control ◆ Specification of speed, acceleration, deceleration and jerk ◆ Different machine zero modes ◆ Absolute / continuous operation
Actual position	◆ Encoder Simulation ◆ Resolution: 1 - 16384 increments / revolution
Signal monitor	◆ 2 channels ±10 V analog ◆ Resolution: 8 Bit

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