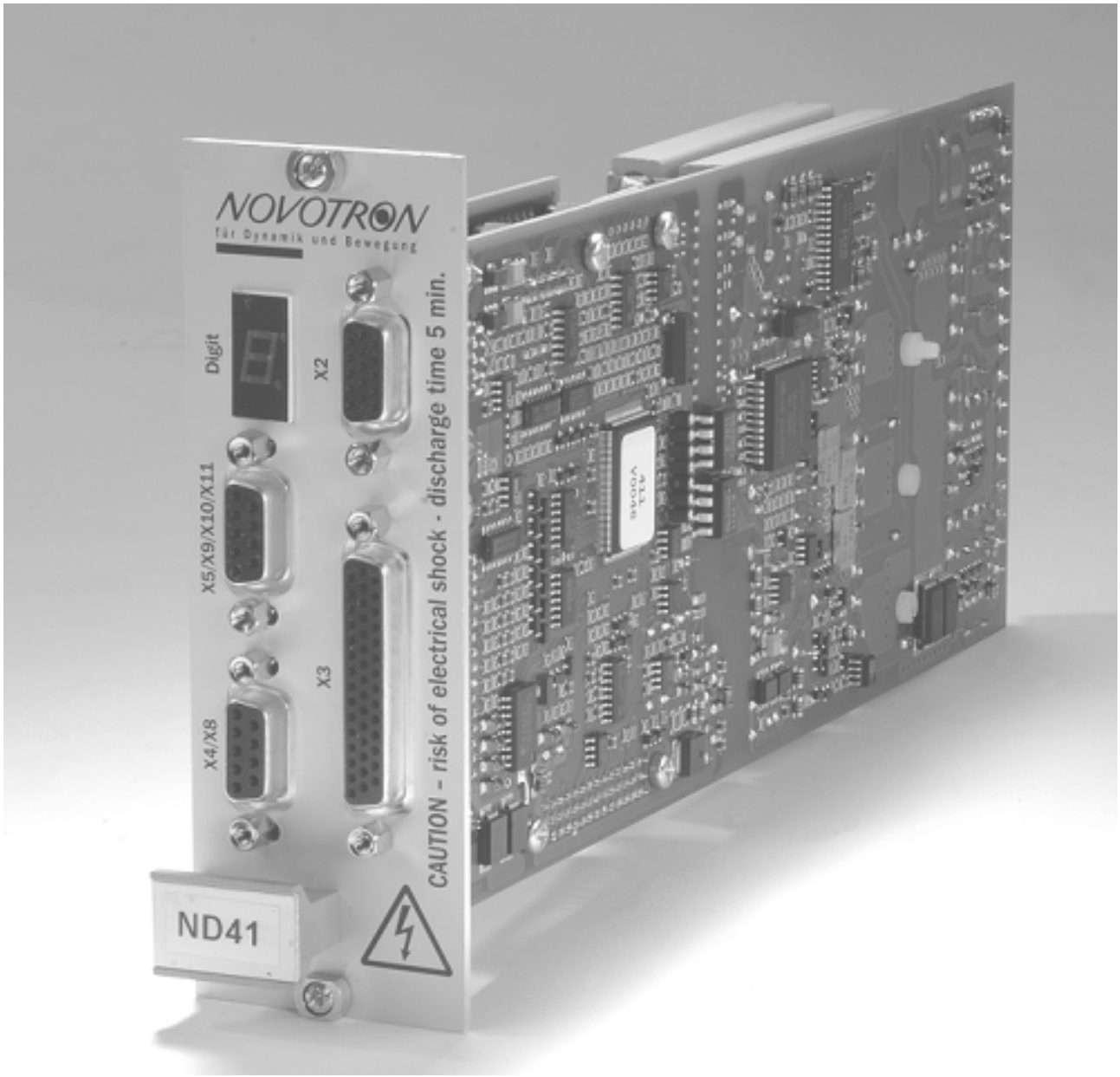
NOVOTRON
Future in Drives

Manual For Servo Amplifier

NOVODRIVE ND40

Software Reference



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2 General Information

2.1 Customer Service

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2.2 List of Abbreviations

Abbreviation	Meaning	Abbreviation	Meaning
VAC	AC voltage	VDC	DC voltage
RO	Read Only	RW	Readable and Writeable
WO	Write Only	BCD	binary coded decimal

2.3 Symbols

Warning or important information.

Noncompliance may lead to trouble in operation or to property damage.

Hazard that may lead to

- damage of life or health of user or other persons, or
- major property damage.

2.4 Trademarks

"EnDat" is a registered trademark of DR. JOHANNES HEIDENHAIN GmbH.

"Windows" is a registered trademark of Microsoft Corporation.

"COMBICON", "MICRO COMBICON" and "POWER COMBICON" are product names of Phoenix Contact.

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2.5 User Manual Structure

Volume 1 Basic Device

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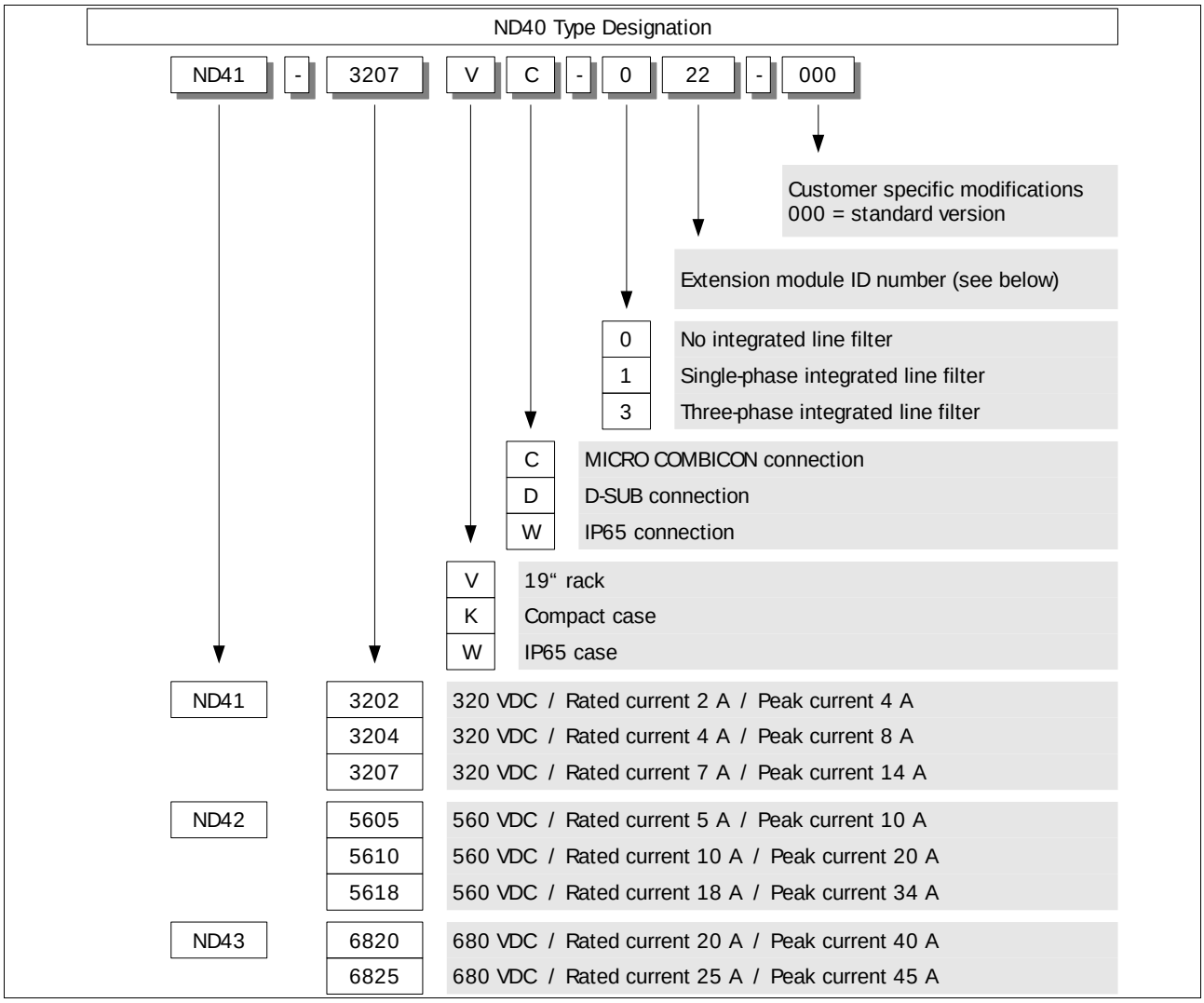
2.6 Ordering Designations

2.6.1 Type Designation



2.6.2 Extension Modules Designations

ID number	Meaning
11	NOVOBUS + CAN-NOVOTRON
12	NOVOBUS + CAN-NOVOTRON galvanically isolated
21	NOVOBUS + PROFIBUS (obsolete)
22	NOVOBUS + EnDat 2.2 (obsolete)
23	NOVOBUS + PROFIBUS + EnDat 2.2 (obsolete)
31	NOVOBUS + PROFIBUS
32	NOVOBUS + EnDat 2.2
33	NOVOBUS + PROFIBUS + EnDat 2.2
34	NOVOBUS + CANopen
35	NOVOBUS + CANopen + EnDat 2.2

2.6.3 Software Bus Options

For customer specific modification NOVODRIVE can be delivered with preset bus system parameters. Regardless of the parameter set loaded, this allows a control unit to build up communication with NOVODRIVE and do the configuration without needing to set the bus address over a PC before.

Bus Option = 0 (standard option)

Customer specific parameters are not changed upon reset.

Bus Options = 1...4

Bus options for CAN-NOVOTRON. The data rate is preset to 1 MBit/s. All CAN Identifiers are defined by the states of the digital inputs GPIn9...14. The four options differ regarding their numbers of process data identifiers activated.

Bus Option = 5

Bus option for extension modules featuring PROFIBUS or CANopen. For PROFIBUS, the bus address is defined by the states of the digital inputs GPIn9...14. For CANopen, all CAN Identifiers are set according to the CANopen standard, with the Node-ID defined by the states of the digital inputs GPIn9...14.

Bus-Option = 7

Bus option for the connection of an external controller of the EPIS company.

	Value	**Example**
GPIn9	1	1
GPIn10	2	0
GPIn11	4	0
GPIn12	8	1
GPIn13	16	1
GPIn14	32	1
Bus address		= 57 (1 + 8 + 16 + 32)

States of digital inputs GPIn9...14:

24 V → 0

0 V → 1

2.6.4 Scope of Delivery for standard NOVODRIVE

Compact case version

- Connector set 'Power Connection ND41/42/43' with Power connector, Connector for motor temperature sensor (for ND42 only) and Ring core
- Shield connection clamp SK14 (ND41) or SK20 (ND42) by Phoenix Contact
- Integrated line filter single-phase (ND41) or three-phase (ND42-5605, ND42-5610 and ND43)
- Integrated forced ventilation
- Connector set 'MICRO COMBICON ND40' or 'D-SUB ND40'

19“ version1

- Connector set 'Power Connection NDxx' with Power connector, Connector for motor temperature sensor (for ND42 only) and Ring core
- Connector set 'MICRO COMBICON ND40' or 'D-SUB ND40'

No line filter integrated. Please provide for an external line filter.

Accessories

You may order additional connector sets and ring cores for assembly and installation of the devices.

Order number	Product	Scope of delivery / Characteristics
105212	Connector set 'MICRO COMBICON ND40'	1 x HD D-SUB, 15-pole, male (incl. hood) 1 x D-SUB, 9-pole, male (incl. hood) 1 x D-SUB, 9-pole, female (incl. hood) 1 x MICRO COMBICON, 8-pole female 1 x MICRO COMBICON, 12-pole female 1 x connector 'bus termination'
105213	Connector set 'D-SUB ND40'	1 x HD D-SUB, 44-pole, male (incl. hood) 1 x HD D-SUB, 15-pole, male (incl. hood) 1 x D-SUB, 9-pole, male (incl. hood) 1 x D-SUB, 9-pole, female (incl. hood) 1 x connector 'bus termination'
105214	Connector set 'Power Connection ND41'	1 x COMBICON, 16-pole female 1 x ring core (order number 100950)
105215	Connector set 'Power Connection ND42' (ND42-5605 and ND42-5610)	1 x COMBICON, 12-pole, female 1 x COMBICON, 2-pole, male 1 x ring core (order number 100950)
105468	Connector set 'Power Connection ND42-5618'	1 x POWER COMBICON, 12-pole, female 1 x COMBICON, 2-pole, male 1 x ring core (order number 100950)
105216	Connector set 'Power Connection ND43'	1 x POWER Connector, 6-pole, female 1 x POWER Connector, 3-pole, female 1 x ring core (order number 100950)
100950	Ring core	Ring core Material:N30 Version: R25/10 AL: 4600 nH
102719	serial cable for “NOVOBUS” to the computer	1 x serial cable 9poles 2m

3 NOVOBUS

All NOVODRIVEs of the ND40 series come with a NOVOBUS interface. Usually this interface is used for connecting NOVODRIVE with the serial interface of a PC or laptop in order to be able to do the parameterization of NOVODRIVE via the setup software.

> We recommend not to connect a control unit to the NOVOBUS interface, as this makes it impossible to conduct an error search via the setup software.

3.1 Modifications Compared to ND30 Series

For a description of the NOVOBUS protocol please see the 'Bus Functions ND31 and ND32' user manual. Modifications compared to the ND30 series are the following:

- Addressing the registers is now done directly and not by bytes anymore. As a consequence, access to a register must now be done in the right bit size. Access to individual bytes of a register is not possible anymore. Apart from that, it is now possible that 16-bit or 32-bit registers have odd addresses.
- Some registers are read-only registers now.
- In Section 4.6.2 of the 'Bus Functions ND31 and ND32' user manual, commands for bit manipulation are described. The 'AND' and the 'OR' command are not relevant anymore, as bitwise access in not required anymore and these two commands cannot be translated into the new form of addressing registers.
- Unlike with ND21/ND31/ND32, the only baud rate supported is 38400.

3.2 Description

See 'Bus Functions ND31 and ND32' user manual.

4 CAN-NOVOTRON

All NOVODRIVEs of the ND40 series come with a CAN-NOVOTRON interface. This interface will be deactivated if an extension module with a different bus system (e.g. PROFIBUS, CANopen) is used.

4.1 Modifications Compared to ND30 Series

For a description of the NOVOBUS protocol please see the 'Bus Functions ND31 and ND32' user manual. Modifications compared to the ND30 series are the following:

- Addressing the registers is now done directly and not by bytes anymore. As a consequence, access to a register must now be done in the right bit size. Access to individual bytes of a register is not possible anymore. Apart from that, it is now possible that 16-bit or 32-bit registers have odd addresses.
- Some registers are read-only registers now.
- The parameterization of CAN Identifiers is now done in compliance with CANopen as a 32-bit value. The default values for the different data transmission channels are CANopen compliant.
- The definition of the CAN Identifiers over digital inputs was changed.
- In Section 4.6.2 of the 'Bus Functions ND31 and ND32' user manual, commands for bit manipulation are described. The 'AND' and the 'OR' command are not relevant anymore, as bitwise access in not required anymore and these two commands cannot be translated into the new form of addressing registers.
- In Section 6.2.3 of the 'Bus Functions ND31 and ND32' user manual, commands for reading and writing the X-RAM are described. The 'ReadLongX' and the 'WriteLongX' command are not relevant anymore.
- For efficient access to the interpolation buffer, a new protocol has been implemented.

4.2 Bus Options

You may select one of four bus options determining the value of the CAN Identifiers after power-on or reset. The digital inputs GPIn9...14 determine Parameter 'CanNodeId'.

The baud rate is set to 1 Mbit/s. Other bus options are available on request.

Register	Bus option 1	Bus option 2	Bus option 3	Bus option 4
CanNodeId	GPIN 9...14	GPIN 9...14	GPIN 9...14	GPIN 9...14
CanSyncId	0x0000 0080	0x0000 0080	0x0000 0080	0x0000 0080
CanSdoRxId	0x0000 0600 + CanNodeId	0x0000 0600 + CanNodeId	0x0000 0600 + CanNodeId	0x0000 0600 + CanNodeId
CanSdoTxId	0x0000 0580 + CanNodeId	0x0000 0580 + CanNodeId	0x0000 0580 + CanNodeId	0x0000 0580 + CanNodeId
CanPdo1RxId	0x0000 0200 + CanNodeId	0x0000 0200 + CanNodeId	0x0000 0200 + CanNodeId	0x0000 0200 + CanNodeId
CanPdo1TxId	0x0000 0180 + CanNodeId	0x0000 0180 + CanNodeId	0x0000 0180 + CanNodeId	0x0000 0180 + CanNodeId
CanPdo2RxId	0x0000 0300 + CanNodeId	0x8000 0000 (inactive)	0x8000 0000 (inactive)	0x0000 0300 + CanNodeId
CanPdo2TxId	0x0000 0280 + CanNodeId	0x8000 0000 (inactive)	0x0000 0280 + CanNodeId	0x8000 0000 (inactive)
CanNmtErrControlId	0x0000 0700 + CanNodeId	0x0000 0700 + CanNodeId	0x0000 0700 + CanNodeId	0x0000 0700 + CanNodeId

Relation between Register „CanNodeId“ and the digital inputs:

	Value	Example	
GPIn 9	1	1	0 V
GPIn 10	2	0	24 V
GPIn 11	4	0	24 V
GPIn 12	8	1	0 V
GPIn 13	16	1	0 V
GPIn 14	32	1	0 V
CanNodeId		= 57 (1 + 8 + 16 + 32)	

States of digital inputs GPIn9...14:

24 V → 0

0 V → 1

4.3 CAN Identifiers

Registers

Address	Name	Function
372	CanNodeId	Network address (for control of states of GPIns for bus options 1...4)
373	CanNmtId	No function
374	CanSyncId	Sync message from control unit to NOVODRIVE
375	CanTimeStamp	No function
376	CanEmergencyId	No function
377	CanPdo1TxId	Process data 1 from NOVODRIVE to control unit
378	CanPdo1RxId	Process data 1 from control unit to NOVODRIVE
379	CanPdo2TxId	Process data 2 from NOVODRIVE to control unit
380	CanPdo2RxId	Process data 2 from control unit to NOVODRIVE
381	CanSdoTxId	Service channel reply from NOVODRIVE to control unit
382	CanSdoRxId	Service channel command from control unit to NOVODRIVE
383	CanNmtErrControlId	Boot-up message from NOVODRIVE to control unit

Parameter assignment

Only 11-bit standard identifiers without remote transfer will be supported.

Bit	31	30	29	28	...	11	10	...	0
Function	Active = 0 Inactive = 1	Reserved = 0	Reserved = 0	Extended identifiers 28...11 = 0			Standard identifiers 10...0		

4.4 Data Transmission Rate

The data transmission rate can be set in Register 'CanBcr'. Any alteration of the value of this register does not become effective until a software reset.

Register

Address	Name	Function
371	CanBcr	Data transmission rate of CAN-NOVOTRON

Examples

Data transmission rate	Value in Register 'CanBcr'
1 MBit/s	0x4025
500 kBit/s	0x404D

4.5 Abbreviations

A0	LSB of register address
A1	MSB of register address
D0	LSB of data (8-bit, 16-bit and 32-bit values)
D1	...
D2	...
D3	MSB of data (32-bit values)
CS	Check sum calculated by bytewise summation of all user data
NCS	Two's complement of check sum from user data
X	Byte will be ignored
-	Byte is not part of the message. message length is reduced accordingly.

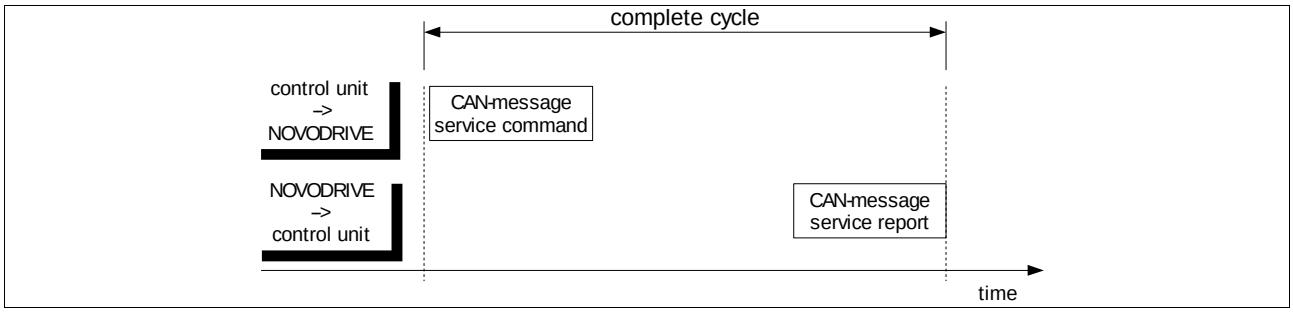
4.6 Boot-Up Message

Upon power-on or software reset a boot-up message is sent from NOVODRIVE to the control unit (when the 'Feedback system ready' state is reached) in order to inform the control unit about the reset.

Byte	0	1	2	3	4	5	6	7
Boot-up message NOVODRIVE → control unit	0x00	-	-	-	-	-	-	-

4.7 Service Channel

Process



The following message definitions are taken from Section 6.2 of the 'Bus Functions ND31 and ND32' user manual.

Read Byte – Reading of an 8-bit value

Byte	0	1	2	3	4	5	6	7
Command (control unit → NOVODRIVE)	0xC0	A0	A1	CS	-	-	-	-
Reply (NOVODRIVE → control unit)	0xC0	A0	D0	NCS	-	-	-	-

Read Word - Reading of a 16-bit value

Byte	0	1	2	3	4	5	6	7
Command (control unit → NOVODRIVE)	0xC1	A0	A1	0x3F	CS	-	-	-

Byte	0	1	2	3	4	5	6	7
Reply (NOVODRIVE → control unit)	0xC1	A0	D0	D1	NCS	-	-	-

Read Long - Reading of a 32-bit value

Byte	0	1	2	3	4	5	6	7
Command (control unit → NOVODRIVE)	0xC7	A0	A1	0x3F	0x3F	0x3F	CS	-
Reply (NOVODRIVE → control unit)	0xC7	A0	D0	D1	D2	D3	NCS	-

Write Byte - Writing of an 8-bit value

Byte	0	1	2	3	4	5	6	7
Command (control unit → NOVODRIVE)	0x82	D0	A0	A1	CS	-	-	-
Reply (NOVODRIVE → control unit)	0x82	D0	A0	A1	NCS	-	-	-

Write Word - Writing of a 16-bit value

Byte	0	1	2	3	4	5	6	7
Command (control unit → NOVODRIVE)	0x63	D0	D1	A0	A1	CS	-	-
Reply (NOVODRIVE → control unit)	0x63	D0	D1	A0	A1	NCS	-	-

Write Long - Writing of a 32-bit value

Byte	0	1	2	3	4	5	6	7
Command (control unit → NOVODRIVE)	0xC8	D0	D1	D2	D3	A0	A1	CS
Reply (NOVODRIVE → control unit)	0xC8	D0	D1	D2	D3	A0	A1	NCS

Read Word X – Reading of a 16-bit value from the X-RAM

Byte	0	1	2	3	4	5	6	7
Command (control unit → NOVODRIVE)	0xC9	A0	A1	0x3F	CS	-	-	-
Reply (NOVODRIVE → control unit)	0xC9	A0	D0	D1	NCS	-	-	-

Write Word X - Writing of a 16-bit value into the X-RAM

Byte	0	1	2	3	4	5	6	7
Command (control unit → NOVODRIVE)	0x6A	D0	D1	A0	A1	CS	-	-
Reply (NOVODRIVE → control unit)	0x6A	D0	D1	A0	A1	NCS	-	-

Reset – Software reset of NOVODRIVE

Byte	0	1	2	3	4	5	6	7
Command (control unit → NOVODRIVE)	0xDD	0x21	CS	-	-	-	-	-
Reply (NOVODRIVE → control unit)	No reply or boot-up message upon reset							

Error handling

If an error occurs, the command message will be returned unchanged and an error of class 1 (warning) generated. The cause of an error may be:

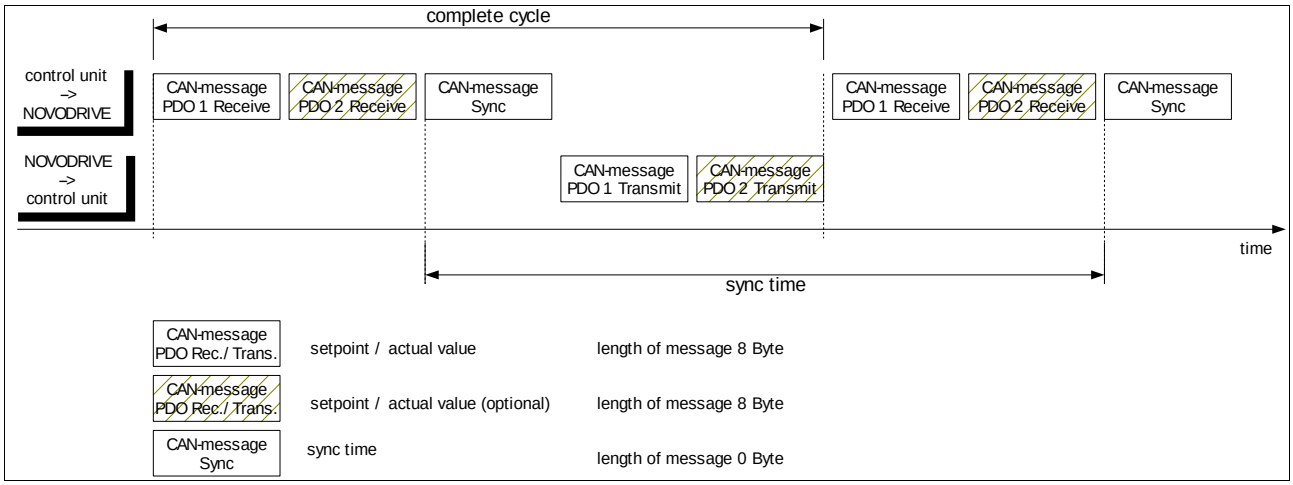
- invalid command code,
- invalid data length of message,
- invalid check sum,
- invalid register size,
- invalid register address.

4.8 Process Data Exchange With Sync Message

Activation

Process data exchange with sync message is activated by setting Register 'PdoHandler' to '32'.

Process



Within each sync time interval up to two process data messages can be sent and received.

NOVODRIVE is able to process a full cycle within 1 ms.

Registers (see above for CAN Identifiers)

Address	Name	Function
387	BusCycleTimeMin	Lower time limit for receiving the next sync message (in ms)
388	BusCycleTimeMax	Upper time limit for receiving the next sync message (in ms). Value must be at least '1' and larger than value in 'BusCycleTimeMin'.
400	PdoTByte[0]	Mapping of registers in Bytes 0...7 of the CAN message 'PDO 1 Transmit' to be sent.
...	...	
407	PdoTByte[7]	
408	PdoTByte[8]	Mapping of registers in Bytes 0...7 of the CAN message 'PDO 2 Transmit' to be sent.
...	...	
415	PdoTByte[15]	
416	PdoRByte[0]	Mapping of registers in Bytes 0...7 of the CAN message 'PDO 1 Receive' to be received.
...	...	
423	PdoRByte[7]	
424	PdoRByte[8]	Mapping of registers in Bytes 0...7 of the CAN message 'PDO 2 Receive' to be received.
...	...	
431	PdoRByte[15]	
150	ParamControl	Activation of mapping parameters.

Mapping of messages

Bytes 0...7 in CAN messages can be related individually to single registers. To do so, write the register's name and the selected byte into Register 'PdoRByte[0...15]' and 'PdoTByte[0...15]', respectively.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	Byte No.		0	0	0	Register address 100 ... 829 dec										

If register is set to 0, then this byte will not be mapped.

Depending on the register's size, for 'Byte-No.' the following options are possible:

Register size	Selected byte			
	MSB Byte 3	Byte 2	Byte 1	LSB Byte 0
INT8	-	-	-	Byte-No.= 00 (binary)
INT16	-	-	Byte-No.= 00 (binary)	Byte-No.= 01 (binary)
INT32	Byte-No.= 00 (binary)	Byte-No.= 01 (binary)	Byte-No.= 10 (binary)	Byte-No.= 11 (binary)

Activate settings via Register 'ParamControl'. By writing the value 'PMAP' (0x504D 4150) the setting from 'PdoRByte[]' and 'PdoTByte[]' will be internally adopted. This is done automatically after reset (make sure to save all settings in the EEPROM before reset!). When the value changes to 'DONE' (0x444F 4E45), the message mapping is ready.

Time window

The time window for receiving the sync message is determined by two time values. The time window starts with receiving of the first sync message upon reset. If the time values set are exceeded, an error (Class 2) will be generated and the motor will be stopped.

If the PdoData exchange is to be terminated with sync message without the error E519 occurs, the "PdoHandler" must first be set to a value not equal to 32 (e.g. 0).

Errors

Error code	Description
E 5 1 8	Next sync message has been received before the time set in Register 'BusCycleTimeMin'
E 5 1 9	Next sync message has not been received before the time set in Register 'BusCycleTimeMax'. The error can not for safety reasons be deleted when the "PdoHandler" is set to a value not equal to 32 (e.g. 0).
E 5 2 0	Sync channel is activated but the value in Register 'BusCycleTimeMax' is '0'
E 5 2 2	Invalid variable for process data exchange. Example 1: A read-only variable is mapped into a receive message. Example 2: From a 16-bit variable the third byte is mapped.

4.9 Process Data Exchange With Interpolation Buffer

Activation

Process data exchange between a control unit and the interpolation buffer (Operating Mode #48) is activated by setting Register 'PdoHandler' to '4'.

Process

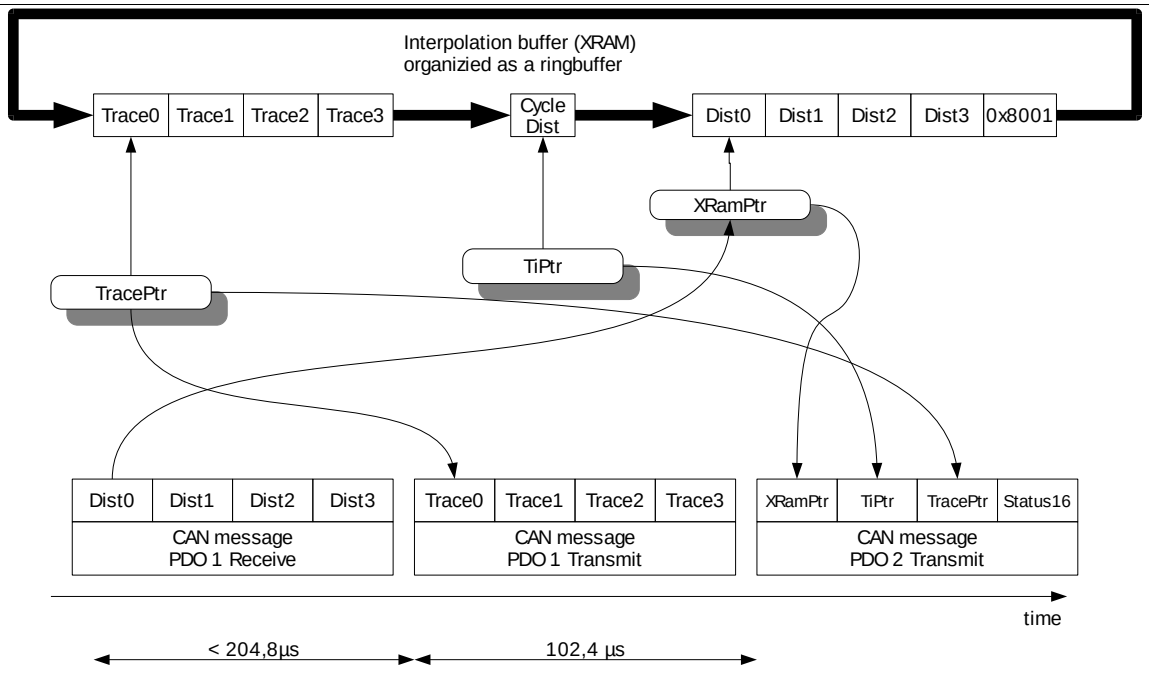
Within each cycle, data will be transmitted by means of three messages. This will be done in four steps:

1. Via channel 'PDO 1 Receive', the control unit sends four words containing new interpolation data to NOVODRIVE. Alternatively, a message of zero length can be sent to read only the trace data.
2. Via channel 'PDO 1 Transmit', NOVODRIVE sends four words from the ring buffer to the control unit and increases pointer 'TracePtr' by 4. By this, the control unit receives the recorded tracking error from the ring buffer for evaluation.
3. Via pointer 'XramPtr', NOVODRIVE adds the data from the first message to the ring buffer and increases the pointer by the number of words added. The new end of the interpolation data is marked with 0x8001.
4. Via channel 'PDO 2 Transmit', NOVODRIVE sends the values of Registers 'XRamPtr', 'TiPtr', 'TracePtr' and 'Status16'.

All pointers must be set prior to data transmission. Make sure there is always enough space between the write and the read sections in the ring buffer. During a request cycle the pointers may not be accessed via the service channel. Before you start any cycle wait for an outstanding reply from the service channel.

Registers

Address	Name	Function
573	TiPtr	Pointer on actual target position in ring buffer (→ Operating Modes #48 and #50)
574	XRamPtr	Pointer on interpolation data in the ring buffer to be entered next
578	TracePtr	Pointer on trace data in the ring buffer to be sent next



messages of CAN-Bus in time order.

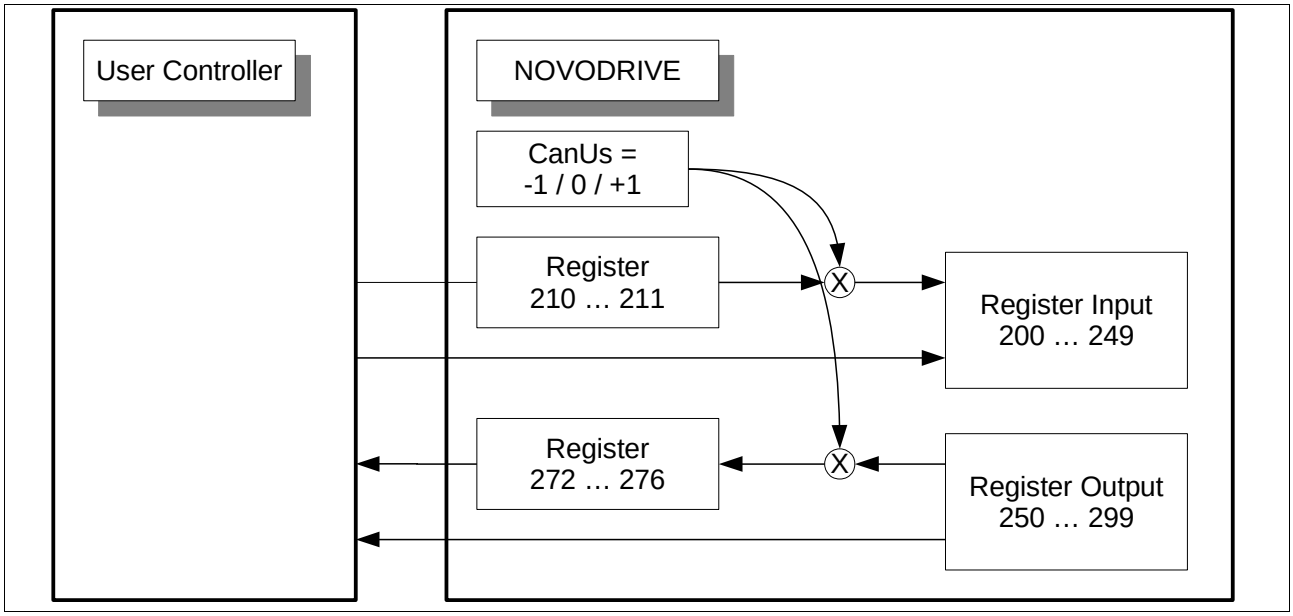
All 16 Bit data of a message in Little Endian order (LSB, MSB).

4.10 Adaptation of Direction for NOVOBUS and CAN-NOVOTRON

This Function is available as of software version V02.14.

Description

In some applications, an adaptation of the direction of movement of the drive to the external control is required. For the nominal and actual values of position, speed and torque / current additional registers exist with the addresses 210 ... 211 and 272 ... 276. They contain the adjusted value in the direction of the original register of the addresses 202, 205, 256, 270, 267 and 254.
All other job parameters or state values are not dependent on direction and can be used unchanged.



To activate the direction of adaptation, the Parameter "CanUs" must be set to +1 or -1.

Job Parameter

Address	Name	Function
210	UsDigitalSetpoint	Copy to register "DigitalSetpoint" address 202 with the direction of adaptation, INT16, RW
211	UsTargetPosition	Copy to register "TargetPosition" address 205 with the direction of adaptation, INT32, RW

Status Parameter / Actual Value

Address	Name	Function
272	UsSpeedSetpoint	Copy to register "SpeedSetpoint1" address 256 with the direction of adaptation, INT16, RO
273	UsSpeedActual	Copy to register "SpeedActual" address 258 with the direction of adaptation, INT16, RO
274	UsCurrentSetpoint	Copy to register "CurrentSetpoint" address 260 with the direction of adaptation, INT16, RO

Address	Name	Function
275	UsMeasuredTorqueCurrent	Copy to register "MeasuredTorqueCurrent" address 270 with the direction of adaptation, INT16, RO
276	UsPositionSetpoint	Copy to register "PositionSetpoint" address 267 with the direction of adaptation, INT32, RO
277	UsPositionAcutal	Copy to register "PositionActual1" address 254 with the direction of adaptation, INT32, RO

Additional Parameter

Address	Name	Function
389	CanUs	Parameter for enabling and configuring the function (INT16, RW). Possible value, see table.

Possible Values of Register „CanUs“

Value	Function	Job Parameter	Status Parameter / Actual Value
0	Off	DigitalSetpoint = RW TargetPosition = RW Both registers can be written	UsSpeedSetpoint = + SpeedSetpoint1 UsSpeedActual = + SpeedActual UsCurrentSetpoint = + CurrentSetpoint UsMeasuredTorqueCurrent = + MeasuredTorqueCurrent UsPositionActual1 = + PositionActual1 UsPositionSetpoint = + PositionSetpoint
-1	On	DigitalSetpoint = - DigitalSetpointUs TargetPosition = - TargetPositionUs Die Register DigitalSetpoint und TargetPosition dürfen nicht beschrieben werden. The registers DigitalSetpoint and TargetPosition are not allowed to be written.	UsSpeedSetpoint = - SpeedSetpoint1 UsSpeedActual = - SpeedActual UsCurrentSetpoint = - CurrentSetpoint UsMeasuredTorqueCurrent = - MeasuredTorqueCurrent UsPositionActual1 = - PositionActual1 UsPositionSetpoint = - PositionSetpoint
+1	On	DigitalSetpoint = + DigitalSetpointUs TargetPosition = + TargetPositionUs The registers DigitalSetpoint and TargetPosition are not allowed to be written	UsSpeedSetpoint = + SpeedSetpoint1 UsSpeedActual = + SpeedActual UsCurrentSetpoint = + CurrentSetpoint UsMeasuredTorqueCurrent = + MeasuredTorqueCurrent UsPositionActual1 = + PositionActual1 UsPositionSetpoint = + PositionSetpoint
Other values are not allowed and may cause incompatibilities in future software releases.			

5 Operating Modes

5.1 Basic Information

Interface

NOVODRIVE is capable of performing a number of tasks, which the user can specify as jobs. A job is determined by selecting an Operating Mode and certain parameters, e.g. for speed and position. To do so, NOVODRIVE offers an interface which is used for all Operating Modes.

Job parameters			**Actual values**		
Address	**Name**	**Function**	**Address**	**Name**	**Function**
200	Control	Control register; software interface for controlling NOVODRIVE's basic functions	251	Status16	Status indication; accommodates the complete spectrum of NOVODRIVE's switching states
201	OperationMode	Operating mode selection	252	ErrorCode	Error code in BCD
202	DigitalSetpoint	Speed setpoint setting	254	Position1Actual	Actual position
203	CurrentPeakLimit1	Application dependent current limitation	258	SpeedActual	Actual speed
205	TargetPosition	Target position setting	260	CurrentSetpoint	Actual current setpoint
206	AccelerateLimit	Acceleration ramp	265	ActualOperation Mode	Selected operating mode
207	DecelerateLimit	Deceleration ramp			
248	DataInput16	General input variables			

Selection and enabling of Operating Modes

Proceed as follows:

1. Select Operating Mode by means of the 'OperationMode' Register.
2. Enable Operating Mode by setting a 0→1 edge in Bit 5 of the 'Control' register.

The position controller will be activated or deactivated automatically, depending on the Operating Mode selected. If a position tracking error has occurred, this will be cleared automatically upon switching from speed control to position control.

The Operating Mode selected is shown in Register 'ActualOperationMode'.

Independent from activation by user, there will be an automatic activation in case of:

- after end of reset in state ready to use
- after inverter enable
- after starting a new job in job control

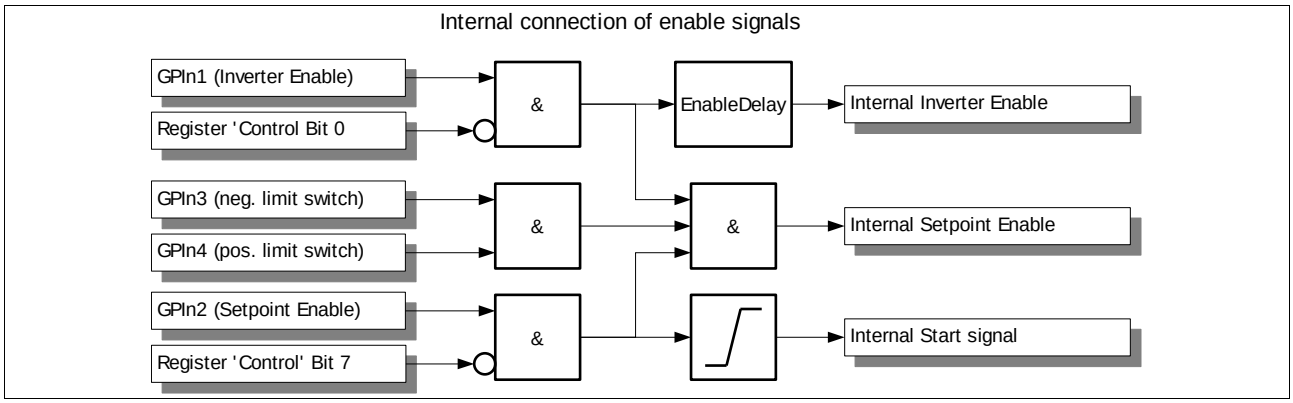
Job start

Most Operating Modes need a start signal for starting a job. The start signal is generated by setting a 0→1 edge for Setpoint Enable. Depending on the configuration chosen, Setpoint Enable is done via the digital input GPIn1 and/or via Bit 7 of the 'Control' register, or internally by the Technology

Function activated. A small number of Operating Modes, for which no prior Setpoint Disable is reasonable, initiate job start immediately after Operating Mode enable (0→1 edge in Bit 5 of the 'Control' register).

Operating Modes explicitly requiring a start signal for job start (e.g. relative positioning) should be enabled only if the motor stands still.

If prior to job completion you provide for Setpoint Disable, the motor gets decelerated until it stops according to the linear deceleration ramp set in register 'StopRamp'



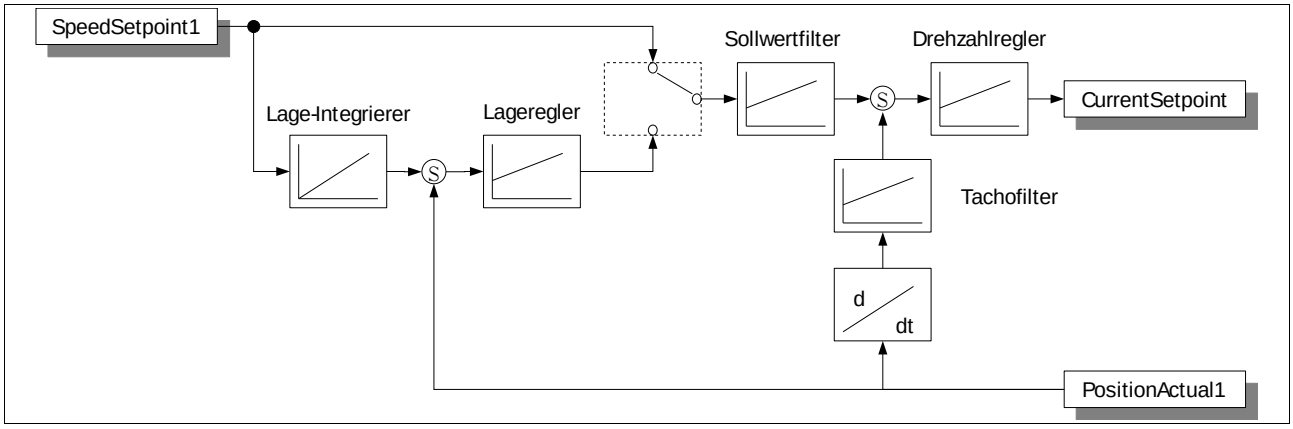
Job completion

If a job is started, Bit 0 of register 'Status16' is reset to '0'. Upon full completion of a job, Bit 0 of register 'Status16' is set to '1'. What job completion means depends on the type of Operating Mode selected. If the job is about speed setpoint setting, full completion is achieved if a certain speed limit value has not been exceeded ('In Speed'). In case of positioning jobs, full completion is achieved if a certain position tolerance range is kept ('In Position').

Errors

Some errors can occur for certain Operating Modes only. In such cases, the Operating Mode's description contains a list of error codes plus an error description.

Speed and position control



Modifications compared to ND30 series

- An Operating Mode is selected by setting a register, i.e. there is no need to set various pointers.

- Whether the position controller is activated or deactivated is selected automatically upon selection of an Operating Mode. This can happen also while motor is moving.
- One interface is used for all Operating Modes.

5.2 Examples

The following examples refer to NOVODRIVE's control via NOVOBUS or CAN-NOVOTRON. For examples referring to NOVODRIVE's control via the PROFIBUS or CANopen extension modules, please see the respective description.

Please note: The following examples use a simplified pseudo code in order to be able to focus on the most essential steps.

5.2.1 Example 1: Move at constant speed

```
/* Select Operating Mode #21 while motor is not running */
NB_write(Control, 0x80);
NB_write(OperationMode, 21);
/* Enable Operating Mode by setting a L-H edge in Bit 5.
 * Register 'OperationModeActual' will change to '21'.
 */
NB_write(Control, 0xC0);
/* Set speed setpoint and ramps (take into account the scaling
 * of the values)
 */
NB_write(DigitalSetpoint, 0x2078);
NB_write(AccelerationLimit, 0x0157);
NB_write(DecelerationLimit, 0x0023);
/* Start job by Setpoint Enable (reset Bit 5) */
NB_write(Control, 0x00);
/* Check register 'Status 16' for successful completion of job */
do {
    success = NB_read(Status16) & Mask_Bit0;
} while (success == 0);
/* Desired speed has been reached */
```

5.2.2 Example 2: Alter value for speed

```
/* Set new speed setpoint. */
NB_write(DigitalSetpoint, 0x5278);
/* Check register 'Status 16' for successful completion of job */
do {
    success = NB_read(Status16) & Mask_Bit0;
} while (success == 0);
/* Desired speed has been reached */
```

5.2.3 Example 3: Stop during movement to a 360 degree angle

```
/* Select Operating Mode #45 without prior stop of motor
 * (register 'Control' shows 0x00)
 */
NB_write(OperationMode, 45);
/* Set target position (lower 16 bits only!) (take into account
 * the scaling of the values).
 */
NB_write(TargetPosition, 12567);
/* Enable Operating Mode by setting a L-H edge in Bit 5.
 * Register 'OperationModeActual' will change to '45' and
 * deceleration process begins.
 */
NB_write(Control, 0x40);
/* Check Register 'Status 16' for successful completion of job */
do {
    success = NB_read(Status16) & Mask_Bit0;
} while (success == 0);
/* Upon stop the setpoint can be disabled.
 */
NB_write(Control, 0x80);
```

5.2.4 Example 4: Positioning to an absolute position setpoint

```
/* Select Operating Mode #42 while motor is not running */
NB_write(Control, 0x80);
NB_write(OperationMode, 42);
/* Enable Operating Mode by setting a L-H edge in Bit 5.
 * Register 'OperationModeActual' will change to '42'.
 */
NB_write(Control, 0xC0);
/* Set target position, target speed and ramps (take into account
 * the scaling of the values).
 */
NB_write(TargetPosition, 1234567);
NB_write(DigitalSetpoint, 0x2078);
NB_write(AccelerationLimit, 0x0157);
NB_write(DeccelerationLimit, 0x0023);
/* Start job by Setpoint Enable (reset Bit 5) */
NB_write(Control, 0x00);
/* Check register 'Status 16' for successful completion of job */
do {
    success = NB_read(Status16) & Mask_Bit0;
} while (success == 0);
/* The desired position has been reached */
```

5.2.5 Example 5: Positioning to another absolute position setpoint

```
/* Stop by Setpoint Disable */
NB_write(Control, 0x80);
/* Set target position, target speed and ramps (take into account
 * the scaling of the values).
 */
NB_write(TargetPosition, 1234567);
/* Start job by Setpoint Enable */
NB_write(Control, 0x00);
/* Check Register 'Status 16' for successful completion of job */
do {
    success = NB_read(Status16) & Mask_Bit0;
} while (success == 0);
/* The desired position has been reached */
```

5.3 Overview

5.4 Operation Modes for Setup

5.4.1 Operating Mode #1 and #2 – Reversing

These Operating Modes are available as of software version V00.46.

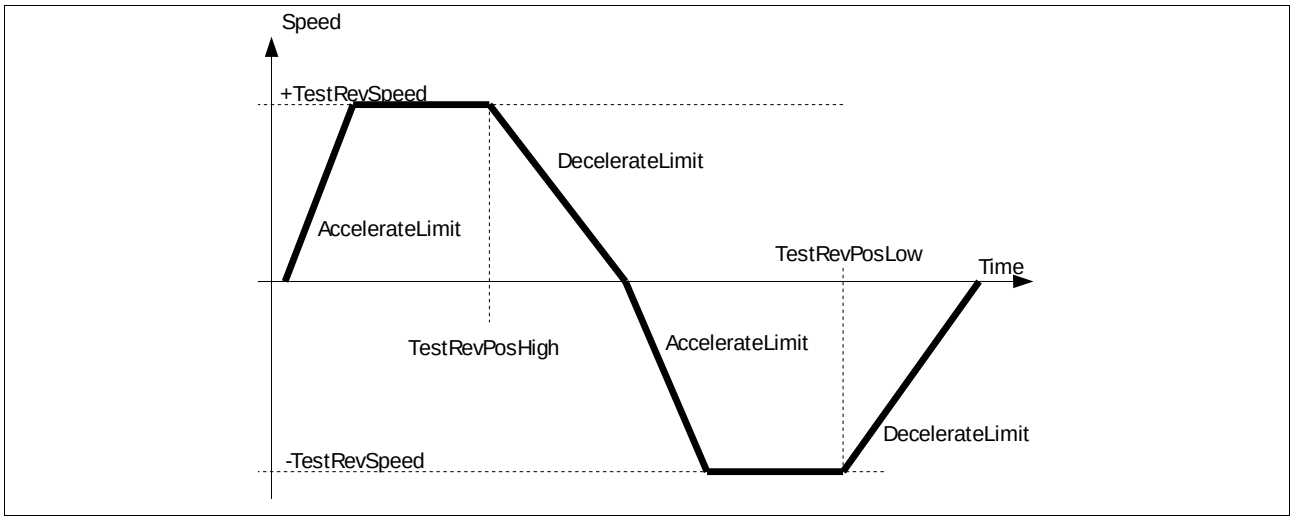
Variant

Operation mode	position control
#1	without position control
#2	with position control

General description

Use these Operating Modes to adjust controllers for current, speed, and position, and for test runs. The motor will move between two positions. You may determine values for speed as well as acceleration and deceleration ramps.

The motor will move only if you provided for Setpoint Enable. As these Operating Modes do not lead to a certain result, Bit 0 of Register 'Status16' will never be set to '1'.



Job parameters

Address	Name	Function
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

These Operating Modes use no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
358	TestRevSpeed	Absolute value for speed
359	TestRevPosHigh	Upper limit where speed setpoint is reversed
360	TestRevPosLow	Lower limit where speed setpoint is reversed

Errors

These Operating Modes generate no errors.

Additional information

- The motor will move over both limiting points. The maximum achieved position is made up of limiting point + deceleration distance.

5.4.2 Operating Mode #3 – Auto adjustment of commutation angle

This Operating Mode is available as of software version V00.46.

General description

Use this Operating Mode to determine the offset for commutation of the motor. During the procedure, the motor must be flanged off and freely movable.

Caution! Danger of getting hurt!

During the process of using this Operating Mode, the motor may move jerkily.

Upon enabling of this Operating Mode, first provide for Inverter Enable, then provide for Setpoint Enable. Current will slowly increase and the motor will move slowly and jerkily until it is in its preferred position.

The whole process will take about 20 seconds. Upon full completion of the job, Bit 0 of Register 'Status16' is set to '1'. Finally provide for Setpoint Disable in order to switch off power again.

Job parameters

This Operating Mode uses no job parameters.

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
203	CurrentPeakLimit1	Peak current limitation for controllable torque limitation
322	McAngleOffset	Value for optimum commutation of motor
335	I2tLimit	Max. permissible r.m.s. current of motor; if this value is exceeded, peak current will be limited to this value

Errors

This Operating Mode generates no errors.

Additional information

- Any new value for register 'McAngleOffset' must be saved in the EEPROM, otherwise it is no more available after power-off or reset.
- Peak current is determined either by the peak current limitation ('CurrentPeakLimit1') or by the I^2t limitation ('I2tLimit').

5.4.3 Operating Mode #4 – Adjustment of commutation angle (Autokomm algorithm)

This Operating Mode is available as of software version V00.46.

General description

Use this Operating Mode to determine the offset for optimum commutation of the motor. During the procedure, the motor will move minimally. Unlike Operating Mode #3, this Operating Mode can be used also when the motor is installed in the machine.

Upon enabling of this Operating Mode, first provide for Inverter Enable, then provide for Setpoint Enable. In the first phase current will slowly increase until the motor overcome the sticking friction and get moving. In the second phase the motor will move minimally back and forth (depending on the value set in Register 'AkSpeed'). The whole process will take about 20 seconds. After that, the motor will be stopped in speed controlled state. Upon full completion of the job, Bit 0 of register 'Status16' is set to '1'.

Job parameters

This Operating Mode uses no job parameters.

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
203	CurrentPeakLimit1	Peak current limitation for controllable torque limitation
322	McAngleOffset	The result value of the function for optimal commutation of the motor.
335	I2tLimit	Max. permissible r.m.s. current of motor; if this value is exceeded, peak current will be limited to this value
484	AkPhiPoGain	Amplification factor in first phase. Recommended value range = 20 … 64 Inc. (possible value range 1...128)
485	AkCurrentGain	Step size for rise of current in first phase recommended value range ~ 8 Inc.(possible value range 1...128)
486	AkSpeed	Speed setpoint in second phase. Recommended value range = 10 … 250 Inc.(possible value range 1...32767)

Errors

This Operating Mode generates no errors.

Additional information

- Any new value for register 'McAngleOffset' must be saved in the EEPROM, otherwise it is no more available after power-off or reset.
- Peak current is determined either by the peak current limitation ('CurrentPeakLimit1') or by the I²t limitation ('I2tLimit').

- Parameters 'Ak...' must be adapted to motor and resolution of feedback system. A higher value of “AkSpeed” enlarges the back and forth movement (optimum speed ~10 mm/s).
- For initial start-up, the speed controller should be set quite low to avoid that the motor starts oscillating after adjustment.

5.4.4 Operating Mode #5 – Analog input offset calibration

This Operating Mode is available as of software version V01.00.

General description

Use this Operating Mode to determine the offset of the analog input.

Inverter Enable or line voltage is not required.

> To use this Operating Mode, the analog input must be on 0 V.

Start the job by setting a 0→1 edge of Setpoint Enable in register “Control”.

Upon full completion of the job, Bit 0 of register 'Status16' is set to '1'.

Job parameters

This Operating Mode uses no job parameters.

Hardware I/O

This Operating Mode uses the analog input on Connector X3, Pin 35 (AnalogInput+) and Pin 36 (AnalogInput-).

Additional parameters

Address	Name	Function
353	AnalogInputOffset	Newly determined offset value for analog input

Errors

This Operating Mode generates no errors.

Additional information

- Any new value for register 'AnalogInputOffset' must be saved in the EEPROM, otherwise it is no more available after power-off or reset.
- These operation mode stops motor with deceleration ramp.

5.5 Operation Modes for Setting Position and Homing

5.5.1 Operating Mode #8 – Move actual position

This Operating Mode is available as of software version V02.08.

General description

With this Operating Mode the actual position shifted of a positive or negative value. The position control is not affected. It is not necessary that the power enable, or mains voltage is applied.

When setting the position of a bit mask is taken into account (→ Appendix A).

The job is started by a 0 → 1 transition of the enable setpoint. After the job completes, the bit 0 is set in the "Status16" to 1 and bit 3 deleted.

Job parameters

Address	Name	Function
205	TargetPosition	Distance by which the actual position can be shifted.

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
366	HomePositionMask	Bitmask to set the position
368	PositionOffset	Parameters for shifting the zero position; the parameter is changed by this operation mode.

Errors

Error code	Description
E 6 5 0	After activation operation mode only one of the 0 → 1 transition of the enable setpoint are allowed. A repeat of the edge, an error E650 is generated, in order to prevent accidental displacement of the zero point.

Additional information

- The new value of register "position offset" must be stored in the EEPROM, otherwise it is lost after turning off or resetting.
- The controller structure (position controller on / off) is not altered by the activation of the operation mode.
- This operation mode gives speed setpoint from 0. If the motor has moved before, so it is stopped with the decelaration ramp of the register "DecelerateLimit".
- After use of this operation mode, the operation mode should be deactivated immediately to prevent further accidental displacement of the zero point.
- When this mode is active, then the inverter is enabled, the current of the motor is set to 0A. That means that the motor is not hold in position.

5.5.2 Operating Mode #9 – Set actual position value

This Operating Mode is available as of software version V01.00.

General description

Use this Operating Mode to set the actual position to a new value.

Inverter Enable or line voltage is not required.

This Operating Mode uses a bit mask (→ Annex A).

Start the job by setting a 0→1 edge for Setpoint Enable.

Upon full completion of the job, Bit 0 of register 'Status16' is set to '1' and Bit 3 is set to '0'.

Job parameters

Address	Name	Function
205	TargetPosition	New value for actual position

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
366	HomePositionMask	Bit mask for setting actual position
368	PositionOffset	Parameter for zero point offset; this parameter will be changed by the Operating Mode

Errors

This Operating Mode generates no errors.

Additional information

- Any new value for register 'PositionOffset' must be saved in the EEPROM, otherwise it is no more available after power-off or reset.
- The controller configuration (position controller on/off) is not affected by this Operating Mode.
- This Operating Mode sets the setpoint for speed to '0'. If the motor has moved prior to enabling of the Operating Mode, it will be stopped by means of the deceleration ramp according to register 'DecelerateLimit'.
- Upon full completion of the job, the Operating Mode should be disabled right away in order to prevent any further, accidental zero point offset.
- If this Operating Mode is enabled and then you provide for Inverter Enable, the setpoint for current of the motor will be set to 0 A. That means: The motor will not be held in position.

5.5.3 Operating Mode #10 – ND30 Set position value (obsolete)

This Operating Mode is available as of software version V00.46.

> This Operating Mode is available only for reasons of compatibility with ND30.
> We recommend not to use it for new applications.

General description

Use this Operating Mode to to set the actual position to a new value.

This Operating Mode differs from Operating Mode #9 with regard to the following aspects:

- Any new actual position will not be determined by the 'TargetPosition' job parameter but by Parameter 'HomePosition'.
- Upon full completion of the job, there will be an automatic change from this Operating Mode to Operating Mode #66 (no function) in order to prevent any further, accidental zero point offset.

Job parameters

This Operating Mode uses no job parameters.

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
365	HomePosition	New value for actual position
366	HomePositionMask	Bit mask for setting actual position (→ Annex A)
368	PositionOffset	Parameter for zero point offset; this parameter will be changed by the Operating Mode

Errors

Error code	Description
E 6 5 0	Upon enabling of this Operating Mode, the 0→1 edge for Setpoint Enable may be set only one time. If Setpoint Enable is done more than one time, Error 650 is generated to prevent any further, accidental zero point offset.

Additional information

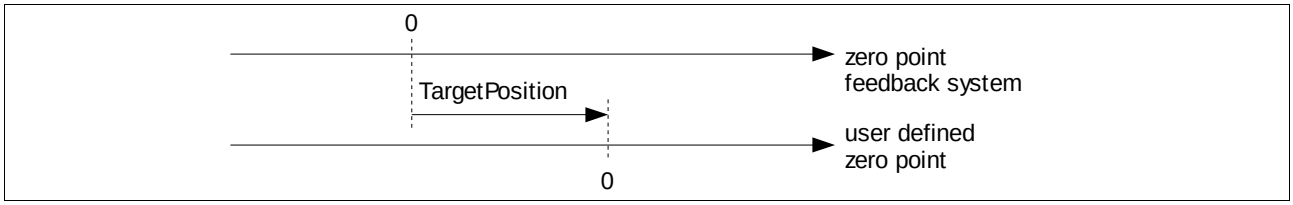
- Any new value for Register 'PositionOffset' must be saved in the EEPROM, otherwise it is no more available after power-off or reset.
- The controller configuration (position controller on/off) is not affected by this Operating Mode.
- This Operating Mode sets the setpoint for speed to '0'. If the motor has moved prior to enabling of the Operating Mode, it will be stopped by means of the deceleration ramp according to register 'DecelerateLimit'.
- If this Operating Mode is enabled and then you provide for Inverter Enable, the setpoint for current of the motor will be set to 0 A. That means: The motor will not be held in position.

5.5.4 Operating Mode #11 – Set position offset

This Operating Mode is available as of software version V00.46.

General description

Use this Operating Mode to shift the zero point of the feedback system to the zero point defined by user.



The controller configuration (position controller on/off) is not affected by this Operating Mode.

Inverter Enable or line voltage is not required.

Start the job by setting a 0→1 edge for Setpoint Enable.

Upon full completion of the job, Bit 0 of register 'Status16' is set to '1' and Bit 3 is set to '0'.

Job parameters

Address	Name	Function
205	TargetPosition	New position offset

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
368	PositionOffset	Parameter for zero point offset; this parameter will be changed by the Operating Mode

Errors

This Operating Mode generates no errors.

Additional information

- Any new value for Register 'PositionOffset' must be saved in the EEPROM, otherwise it is no more available after power-off or reset.
- The controller configuration(position controller on/off) is not affected by this Operating Mode.
- This Operating Mode sets the setpoint for speed to '0'. If the motor has moved prior to enabling of the Operating Mode, it will be stopped by means of the deceleration ramp according to Register 'DecelerateLimit'.
- Using this Operating Mode makes sense only if you are working with an absolute feedback system.
- If this Operating Mode is enabled and then you provide for Inverter Enable, the setpoint for current of the motor will be set to 0 A. That means: The motor will not be held in position.

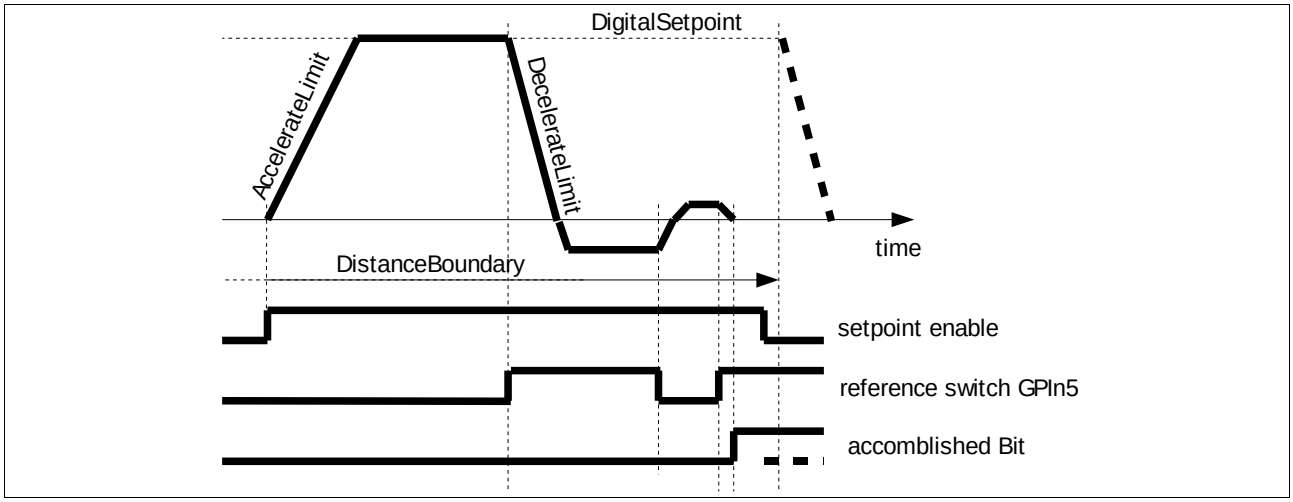
5.5.5 Operating Mode #12 – Homing with switch

This Operating Mode is available as of software version V00.46.

General description

Use this Operating Mode to search for a homing switch.

Start the job by setting a 0→1 edge for Setpoint Enable. If the homing switch has been found, the actual position is set to the value set. Upon full completion of the job, Bit 0 of register 'Status16' is set to '1' and Bit 3 is set to '0'.



Speed and moving direction are determined by the value set in Register 'DigitalSetpoint'. By several changes in direction the switching point will be approached optimally. The homing switch must be hold until the motor moves backwards. Therefore the actuator of the homing switch must be at least two times as long as the braking distance. Otherwise NOVODRIVE is not able to to recognize the homing switch, and the search process leads to no result.

Alternatively, the braking distance can be reduced by Register 'DecelerationLimit' (provided this is possible with the motor and machine used).

If the homing switch is not found within the distance set in Register 'DistanceBoundary, Error 600 is generated.

This Operating Mode uses a bit mask (→ Annex A).

Job parameters

Address	Name	Function
202	DigitalSetpoint	Setpoint for speed and direction
205	TargetPosition	New position value at reference switch
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

The homing switch input is the digital input GPIn5 on Connector X3 (Pin 24). 24 V = homing switch is active.

Additional parameters

Address	Name	Function
361	DistanceBoundary	Maximum distance (positive value) to be covered before the search is abandoned
366	HomePositionMask	Bit mask for setting actual position (→ Annex A)
368	PositionOffset	Parameter for zero point offset; this parameter will be changed by the Operating Mode

Errors

Error code	Description
E 6 0 0	Maximum distance has been exceeded

Additional information

None.

5.5.6 Operating Mode #14 – Homing with encoder zero marker

This Operating Mode is available as of software version V01.00.

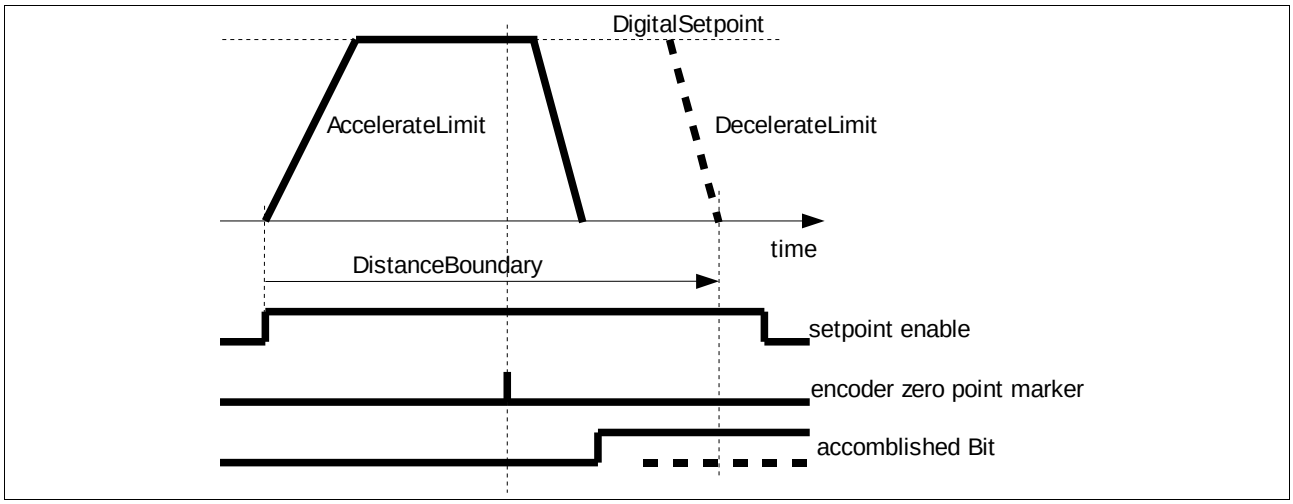
General description

Use this Operating Mode to search for the encoder zero marker. Using this Operating Mode makes sense only if you are working with a sine wave encoder or an incremental feedback system.

Start the job by setting a 0→1 edge for Setpoint Enable.

If the zero marker became overrun the direction of movement changes. The zero marker will be overrunned backward with a slower speed and the actual position will be set to the desired value automatically.

Upon full completion of the job, Bit 0 of register 'Status16' is set to '1'.



If the zero marker is not found within the distance set in Register 'DistanceBoundary, Error 600 is generated.

This Operating Mode uses a bit mask (→ Annex A).

Job parameters

Address	Name	Function
202	DigitalSetpoint	Setpoint for speed and direction
205	TargetPosition	New position value at reference switch
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
361	DistanceBoundary	Maximum distance (positive value) to be covered before the search is abandoned
366	HomePositionMask	Bit mask for setting actual position (→ Annex A)

Address	Name	Function
368	PositionOffset	Parameter for zero point offset; this parameter will be changed by the Operating Mode

Errors

Error code	Description
E 6 0 0	Maximum distance has been exceeded
E 6 0 1	No sine wave encoder is used for position feedback

Additional information

- After successful execution the motor will not stand on the zero point marker. The position setting is done during movement. After that the motor is stopped.
- It is not guaranteed by different measuring system manufacturers that the zero-marker is indicated on the identical position when starting from both side. Therefore the search should always take place into the same direction! In this case the deceleration ramp should be chosen very small to overrun the zero-marker by a great distance.

5.5.7 Operating Mode #15 – Homing with blocked method

This Operating Mode is available as of software version V01.00.

General description

Use this Operating Mode to let the motor move to a fixed stopper. Start the job by setting a 0→1 edge for Setpoint Enable. If the motor gets blocked for a certain time, the actual position is set to the value set. Upon full completion of the job, Bit 0 of register 'Status16' is set to '1' and Bit 3 is set to '0'.

The blocking of the motor is recognized if either

- the motor I²t current exceeds the value set in register 'BlockCurrent', or
- the actual speed exceeds 75 % of the value set in register 'SpeedTrackingBoundary'.

If the marker is not found within the distance set in register 'DistanceBoundary, Error 600 is generated.

This Operating Mode uses a bit mask (→ Annex A).

Job parameters

Address	Name	Function
202	DigitalSetpoint	Setpoint for speed and direction
205	TargetPosition	New position value at reference switch
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
316	SpeedTrackingBoundary	Max. permissible deviation of actual speed and speed setpoint
361	DistanceBoundary	Maximum distance to be covered before the search is abandoned (value must be positive)
364	BlockedCurrent	Current limit value to recognize that the motor is blocked
366	HomePositionMask	Bit mask for setting actual position (→ Annex A)
368	PositionOffset	Parameter for zero point offset; this parameter will be changed by the Operating Mode

Errors

Error code	Description
E 6 0 0	Maximum distance has been exceeded

Additional information

- When determining the value for speed, make sure to take into account the physical forces occurring when the motor hits the stopper.
- When starting the job and the motor is always blocked, the the job end immediately with success.

- After this job a position tracking error exists. Therefore the motor must be driven backwards away from the stropper, before changing to another operation mode with position control.

5.6 Operation Modes for Speed Setting

5.6.1 Operating Mode #16 and #17 – Digital speed setpoint

These Operating Modes are available as of software version V00.46.

Variant

Operation mode	position control
#16	without position control
#17	with position control

General description

While setpoint is enabled, speed and direction of motor is determined by register “DigitalSetpoint”. If the contents of register “DigitalSetpoint” will we changed, the speed of motor will changed also in respect of the acceleration and deceleration ramps.

Bit 0 of register 'Status16' is set to '1', as long as the motor's actual speed lies within the tolerance range determined by 'DigitalSetpoint' ± 'SpeedWindow' (→ Annex C).

Job parameters

Address	Name	Function
202	DigitalSetpoint	Setpoint for speed and direction
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
370	SpeedWindow	Max. permissible deviation of actual speed and speed setpoint for receiving 'In Speed' message (→ Annex C)

Errors

These Operating Modes generate no errors.

Additional information

- Linear acceleration / deceleration ramps are active.

5.6.2 Operating Mode #18,#19 and #20 – Analog speed setpoint

These Operating Modes are available as of software version V01.00.

Variant

Operation mode	position control	direction control
#18	without position control	by analog input
#19	with position control	by analog input
#20	without position control	GPIn6

General description

Use these Operating Modes to set the setpoint for the motor's speed and moving direction via the analog input. Start the job by setting a 0→1 edge for Setpoint Enable. The motor will accelerate until it reaches the speed value set under consideration of register 'AccelerateLimit'. If the analog value is altered, the motor's actual speed will be adjusted under consideration of the ramps.

Bit 0 of register 'Status16' is set to '1', as long as the motor's actual speed lies within the tolerance range determined by 'SpeedSetpoint1' ± 'SpeedWindow' (→ Annex C).

The speed setpoint can be scaled by the value set in Register 'AnalogInputScale':

$$SpeedSetpoint1 = \frac{AnalogInputScale}{256} \cdot \frac{Voltage}{0{,}35273mV}$$
$$with\ AnalogInputscale = -32768 \ldots +32767$$

This Operating Mode differs from Operating Mode #18 with regard to the following aspects:

- The speed setpoint is determined by the absolute value of the input voltage and the absolute value of parameter “AnalogInputScale”. Please note: Negative voltage does not mean negative speed!
- If GPIn6 is on 0 V, the motor will move in the positive direction ('SpeedSetpoint1' > 0). If GPIn6 is on 24 V, the motor will move in the negative direction ('SpeedSetpoint1' < 0).

Job parameters

Address	Name	Function
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

These Operating Modes use the analog input on Connector X3, Pin 35 (+) and Pin 36 (-).

Additional parameters

Address	Name	Function
352	AnalogInputScale	Scaling factor of speed setpoint via analog input
370	SpeedWindow	Max. permissible deviation of actual speed and speed setpoint for receiving 'In Speed' message (→ Annex C)

Errors

These Operating Modes generate no errors.

Additional information

- If setpoint is disabled, then “SpeedSetpoint1” is always zero, independent from analog input.
- Linear acceleration / deceleration ramps are active.

5.6.3 Operating Mode #21 and #22– Digital speed setpoint setting with S-ramp

These Operating Modes are available as of software version V01.02.

Variant

Operation mode	position control
#21	without position control
#22	with position control

General description

Use these Operating Modes to set the setpoint for the motor's speed and moving direction via register 'DigitalSetpoint'.

These Operating Modes differ from Operating Modes #16 and #17 with regard to the following aspects:

- Acceleration and deceleration is done by S-ramps.
- Ramps are symmetric.
- Any new value for speed is not accepted until the acceleration / deceleration process is complete.

Job parameters

Address	Name	Function
202	DigitalSetpoint	Setpoint for speed and direction
206	AccelerateLimit	Max. value of acceleration / deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
370	SpeedWindow	Max. permissible deviation of actual speed and speed setpoint for receiving 'In Speed' message (→ Annex C)

Errors

These Operating Modes generate no errors.

Additional information

- Acceleration / deceleration ramps are active.
- Setpoint Disable leads to deceleration by means of the linear deceleration ramp.

5.6.4 Operating Mode #23 and #24 – Digital speed setpoint setting with marker output

These Operating Modes are available as of software version V01.00.

Variant

Operation mode	position control
#23	without position control
#24	with position control

General description

Use these Operating Modes to set the setpoint for the motor's speed and moving direction via Register 'DigitalSetpoint'.

These Operating Modes differ from Operating Modes #16 and #17 with regard to the following aspect:

– When the motor crosses the marker position set in register 'TargetPosition', Bit 0 of register 'Status16' is set to '1'.

$$Status16.Bit0 = \begin{array}{l}((DigitalSetpoint > 0)\ \mathrm{AND}\ (PositionActual1 > TargetPosition)) \\ \mathrm{OR} \\ ((DigitalSetpoint < 0)\ \mathrm{AND}\ (PositionActual1 < TargetPosition))\end{array}$$

Job parameters

Address	Name	Function
202	DigitalSetpoint	Setpoint for speed and direction
205	TargetPosition	Marker position
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

These Operating Modes use no hardware inputs and/or outputs.

Additional parameters

These Operating Modes use no additional parameters.

Errors

These Operating Modes generate no errors.

Additional information

- Linear acceleration / deceleration ramps are active.

5.6.5 Operating Mode #25 and #26 – Encoder speed setpoint

These Operating Modes are available as of software version V01.00.

Variant

Operation mode	position control
#25	without position control
#26	with position control

General description

Use these Operating Modes to set the setpoint for the motor's speed via the counting input. As long as Setpoint Enable is provided, the motor is moving forward or backward by the counter steps. The counting input can be configured as a quadrature counter (encoder signals) or as a step/direction counter (step motor emulation). The step size can be adjusted via a parameter (electronic gear).

$$Positions\,inkrements\,of\,feedback\,system = \frac{Multiplier}{Divisor} \cdot counter\,steps$$

To compensate for the dead time when the steps are being evaluated, the target position can be pre-controlled depending on the speed. Bit 0 of register 'Status16' is set to '1', as long as the motor's actual speed lies within the tolerance range determined by 'SpeedSetpoint1' ± 'SpeedWindow' (→ Annex C).

Job parameters

These Operating Modes use no job parameters.

Hardware I/O

These Operating Modes use the counting input on Connector X3, Pins 1 (A--), 2 (B--), 16 (A+) and 17 (B+). The pins comply with RS-422 (5 V differential inputs).

If the counting input is used as a step/direction counter, input A is used for direction and input B is used for steps.

→ User Manual 'ND40 Basic Device', Section 10.5 Counting Input

Additional parameters

Address	Name	Function
263	EncInputCounter	Count (read only)
354	EncInputControl	Parameter for configuration of counting input Bit 0: 0 = quadrature counter (A/B signals) 1 = step/direction counter
355	EncInputPreControl	Pre-control factor
356	EncInputFactor	High Word = Multiplier Low Word = Divisor

Errors

Error code	Description
E 9 7 7	Counting frequency too high

Additional information

- Any new value for Parameter 'EncInputControl' is not effective until reset.
- Depending on the resolution, the setpoint filter in the speed controller should be set relatively high, as otherwise the motor will move jerkily.
- Acceleration and deceleration ramps must be generated by the master. As long as Setpoint Enable is provided, no ramp generator is active.

5.6.6 Operating Mode #27...#30 – Digital speed setpoint setting with time limitation

These Operating Modes are available as of software version V01.00.

Variant

Operation mode	position control	time base	Maximum time
#27	without position control	1,024 ms	67,1 s
#28	with position control	1,024 ms	67,1 s
#29	without position control	1 s	18,21 h
#30	with position control	1 s	18,21 h

General description

Use these Operating Modes to set the setpoint for the motor's speed and moving direction via Register 'DigitalSetpoint'.

These Operating Modes differ from Operating Modes #16 and #17 with regard to the following aspect:

– Upon starting the job by setting a 0→1 edge for Setpoint Enable a timer is started. Upon expiry of the time interval set in register 'DigitalInput16', Bit 0 of register 'Status16' is set to '1'. If Setpoint Enable is provided already when the Operating Mode is enabled, the timer is started immediately.

Job parameters

Address	Name	Function
202	DigitalSetpoint	Setpoint for speed and direction
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp
248	DigitalInput16	Time limitation in [ms]

Hardware I/O

These Operating Modes use no hardware inputs and outputs.

Additional parameters

These Operating Modes use no additional parameters.

Errors

These Operating Modes generate no errors.

Additional information

- Linear acceleration / deceleration ramps are active.

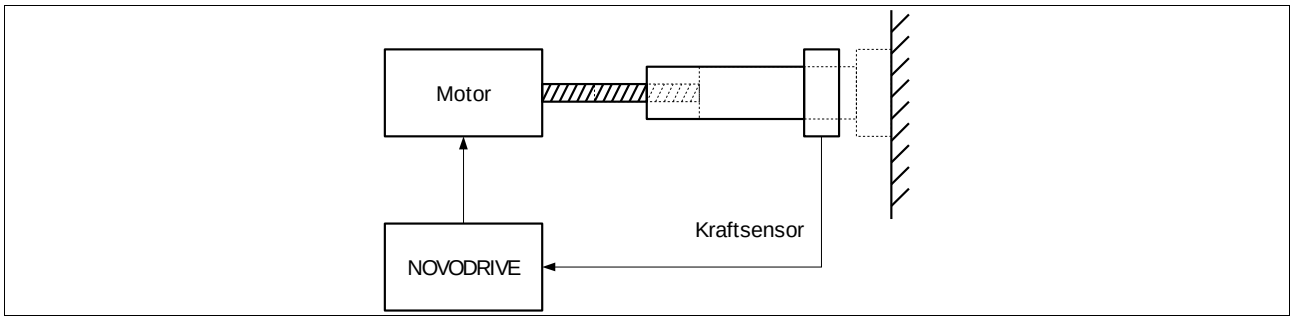
5.7 Operation Mode of Force Control

5.7.1 Operation Mode #31 – Force Control F ~ x

These Operating Modes are available as of software version V02.04.

General description

These Operating Mode can create a controlled linear force. The control algorithm is adapted to the force proportional to the way.



The output voltage of the force sensor can be adjusted to a user defined force scaling

$$DataOutput16 = \frac{AnalogInputScale}{256} \cdot \frac{Voltage}{0,35273\,mV}$$
$$with\ AnalogInputscale = -32768 \ldots +32767$$

There will be distinguished two states:

(1) If the measured force is smaller than limit value “ForceLimit”, then motor is moving with speed and direction of register “DigitalSetpoint”. This case should be used to get a fast contact to the obstacle.

(2) If the measured force is larger than limit value, force control is active. Speed and direction of motor is calculated from factor “ForceKp” and the difference of actual value and setpoint of force. The movement can be depending on the force ratio in both directions.

While the measured force “DataOuput16” is inside the limits of „DataInput16“ ± “ForceWindow“, bit 0 of register 'Status16' is set to '1'.

Job parameters

Address	Name	Function
202	DigitalSetpoint	Setpoint for speed and direction
203	CurrentPeakLimit1	Peak current limitation for controllable torque limitation
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp
248	DataInput16	Force setpoint in increments, value range 0....+32767, scaling see above.
298	DataOutput16	Measured force in increments, value range 0....+32767, scaling see above.

Hardware I/O

This operation mode uses analog input at connector X1 Pin35 (+) and 36 (-) for measuring the force by a force sensor. The polarity can be changed by a positive or negative value of parameter “AnalogInputScale”. The offset can be adjusted by parameter “AnalogInputOffset”.

Additional parameters

Address	Name	Function
352	AnalogInputScale	Scaling factor for conversion of the output voltage from force sensor in a force value (see above).
353	AnalogInputOffset	Adjustment of offset voltage from force sensor.
503	ForceFilter	Low pass filter for noise reduction from force sensor, value range 0...255, recommended value 0 (no noise reduction).
504	ForceKp	P-Gain of force control If the direction of the force, and a positive speed is equal, the value must be within the range of +1 .... +32767. Otherwise, the value in the range must be chosen from -1 ...-32767. Recommended value range 10...100.
505	ForceWindow	Max. permissible deviation of actual force and force setpoint for receiving 'In Force' message at register “Status16” bit 0.
506	ForceLimit	Force limit for switching between state “moving” and “force control” Hint: If “ForceLimit” is set to -32767, then the drive is trapped in state “force control”.

Errors

This Operating Mode generates no errors.

Additional information

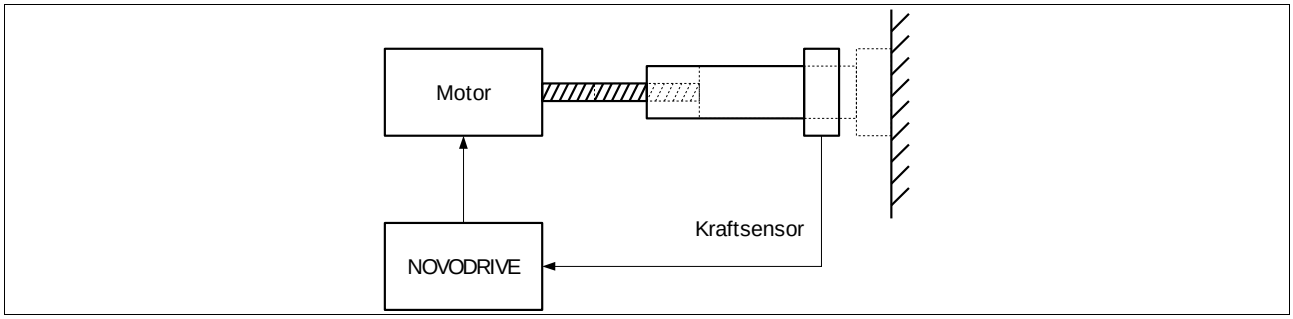
- Linear acceleration / deceleration ramps are active.
- Position control and checking for position tracking error is active. By choosing the limit value of position tracking error keep in mind, that the impact creates for a short time a high tracking error.
- The current limitation is also affected by parameter “CurrentPeakLimit2”, the internal temperature dependent current limitation and i^2t limitation.
- The parameter “ForceKp” must be chosen small in a stiff mechanical construction. Other case the force control is oscillating. As disadvantage the moving speed gets very small.
- The acceleration and deceleration ramps must be chosen as large as possible and physically allowed. Other case the settling time gets very long.
- The parameter “DigitalSetpoint” must be chosen not to high. Other case the impact on obstacle is high and the saturation of the force control extends the settling time.
- The parameter “ForceLimit” must be chosen clearly above or below the idle level of the force sensor. Other case the force control switches always between the two states.

5.7.2 Operation Mode #33 – Force Control F ~ v

These Operating Modes are available as of software version V02.08.

General description

With this operation mode can be controlled via the analog input a controlled force. The control algorithm is designed for the physical connection force proportional to the speed.



The output voltage of the force sensor can be adjusted using the "Analog Input Scale" to the selectable scaling of the force. The force value must be positive:

$$DataOutput16 = \frac{AnalogInputScale}{256} \cdot \frac{Voltage}{0{,}35273\,mV}$$

$$with\ AnalogInputscale = -32768 ... +32767$$

The movement is limited to the speed range 0 ... DigitalSetpoint. That means there is only one movement instead of in the selected direction.

As long as the actual force "DataOutput16" within the limits "DataInput16" ± "Force Window" is, the bit is set to 0 in the "Status16" to 1, otherwise it is cleared.

Job parameters

Address	Name	Function
202	DigitalSetpoint	Setpoint of maximum speed and direction
203	CurrentPeakLimit1	application depended current and torque limitation (→notes)
206	AccelerateLimit	Acceleration ramp (→ notes)
207	DecelerateLimit	Deceleration ramp (→ notes)
248	DataInput16	Target force in increments, value 0....+32767, Scaling see above.
298	DataOutput16	Actual force in increments, value 0....+32767, Scaling see above.

Hardware I/O

This operation mode uses the analog input on terminal X3 pin 35 (+) 36 and (-) for measuring the actual force with a force sensor. The polarity can be adjusted by a positive or negative value of the parameter "Analog Input Scale". The offset value can be compensated by this parameters.

Additional parameters

Address	Name	Function
352	AnalogInputScale	Scaling factor for converting the output voltage of the force sensor into a force value (see above).
353	AnalogInputOffset	Correction value for adjustment of the offset of the force sensor.
503	ForceFilter	Low-pass filter for noise suppression of the actual force value, range 0 .. 255, recommended value 0 (no filtering).
504	ForceKp	The value must be in the range of +1 .... +32767. The direction of movement is given by the parameter "DigitalSetpoint". Recommended value range 10 .. 500.
505	ForceWindow	Max. permissible deviation of actual force and force setpoint for receiving 'In Force' message at register “Status16” bit 0.

Errors

This Operating Mode generates no errors.

Additional information

- The linear acceleration and deceleration ramps are active.
- The current limit is also influenced by the motor parameters 'CurrentPeakLimit2', the internal temperature-dependent current limitation and the I^2t monitoring.
- The acceleration and deceleration ramps must be chosen as large as possible and physically allowed. Other case the settling time gets very long.

5.8 Position Control NM41-40 NOVOMERIK

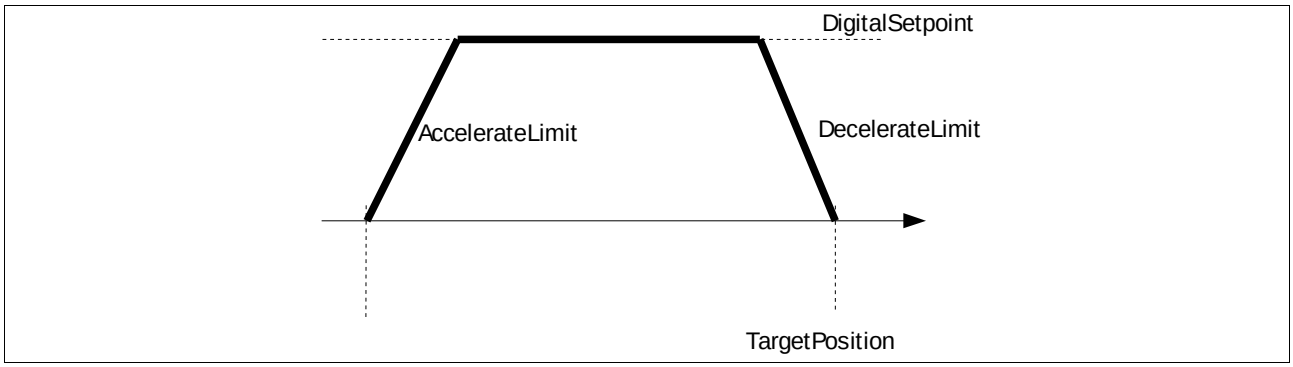
5.8.1 Operating Mode #32 – ND30 absolute positioning online (obsolete)

This Operating Mode is available as of software version V00.46.

> This Operating Mode is available only for reasons of compatibility with ND30.
> We recommend not to use it for new applications.

General description

As long as Inverter Enable and Setpoint Enable are provided, the motor is moving to a target position set.



Any values for target position, maximum positioning speed, and ramps can be altered any time and become effective immediately.

Bit 0 of register 'Status16' is set to '1' when the motor is 'In Position'. This is the case if the difference between actual position and target position is smaller than set in register 'PositioningWindow' (→ Annex B).

Job parameters

Address	Name	Function
205	TargetPosition	Absolute target position
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

Address	Name	Function
204	PositioningSpeed	Max. positioning speed
369	PositioningWindow	Max. permissible deviation of actual position and target position for receiving 'In Position' message (→ Annex B)
488	InPosTimeConst	Minimum time interval in [ms] the motor must be 'In Position' for Bit 0 in Register 'Status16' to be set to '1' (→ Annex B)

Errors

This Operating Mode generates no errors.

Additional information

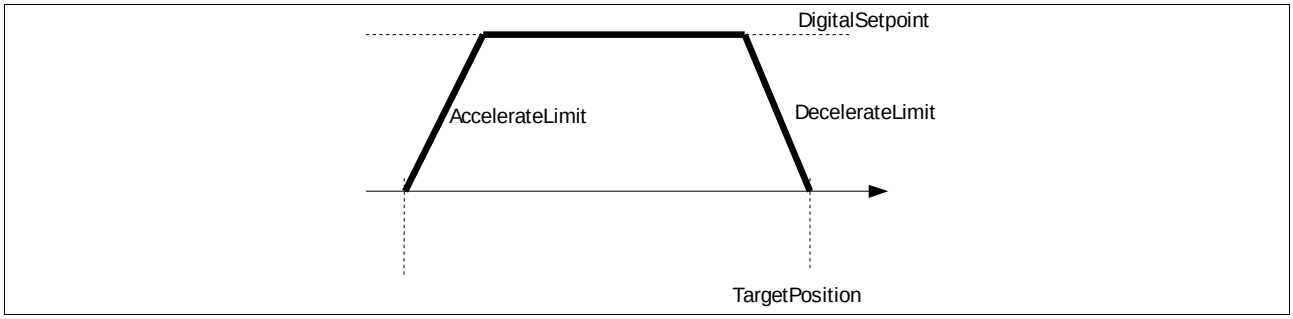
- Upon altering the value for target position, Bit 0 of register 'Status16' remains set to '1' until the new value has been accepted. Therefore, wait a moment until you check register 'Status16'.

5.8.2 Operating Mode #37 – Absolute positioning with linear ramp

This Operating Mode is available as of software version V00.46.

General description

Use this Operating Mode to move the motor to an absolute position. Upon starting the job by setting a 0→1 edge for Setpoint Enable the target position will be internally adopted.



Any values for maximum positioning speed and ramps can be altered any time and become effective immediately.

Bit 0 of register 'Status16' is set to '1' when the motor is 'In Position'. This is the case if the difference between actual position and target position is smaller than set in register 'PositioningWindow' (→ Annex B).

Job parameters

Address	Name	Function
202	DigitalSetpoint	Max. positioning speed (positive value)
205	TargetPosition	Absolute target position
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and outputs.

Additional parameters

Address	Name	Function
369	PositioningWindow	Max. permissible deviation of actual position and target position for receiving 'In Position' message (→ Annex B)
488	InPosTimeConst	Minimum time interval in [ms] the motor must be 'In Position' for Bit 0 in register 'Status16' to be set to '1' (→ Annex B)

Errors

This Operating Mode generates no errors.

Additional information

None.

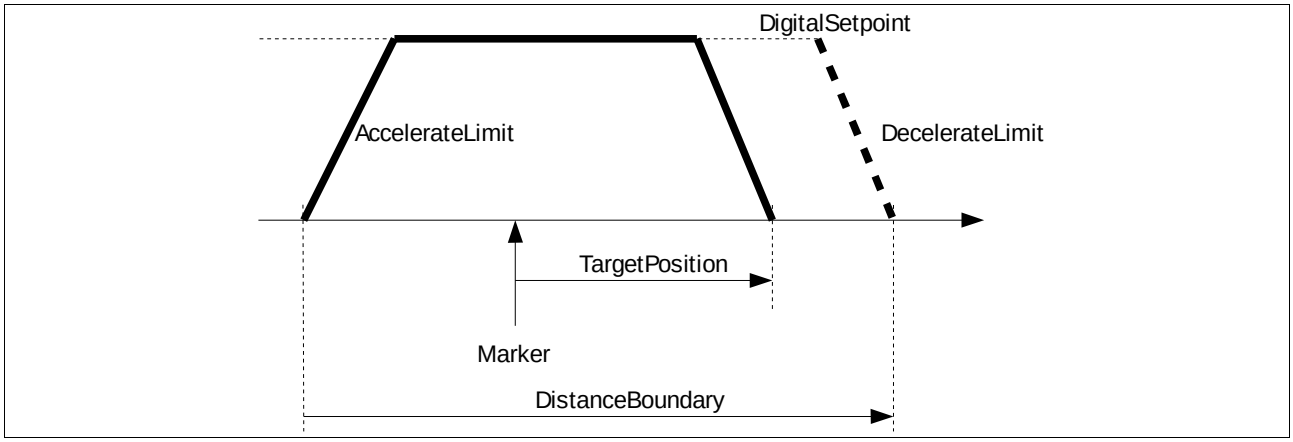
5.8.3 Operating Mode #39 – Relative positioning to a marker signal

This Operating Mode is available as of software version V01.00.

General description

Use this Operating Mode to move the motor to a position relative to a marker signal. Upon starting the job by setting a 0→1 edge for Setpoint Enable the target position will be internally adopted. The motor moves at the speed and in the direction set. It is not until the marker signal is active that the target position is calculated from:

$$new\ target\ position = actual\ position + target\ position$$



Any values for maximum positioning speed and ramps can be altered any time and become effective immediately.

Bit 0 of register 'Status16' is set to '1' when the motor is 'In Position'. This is the case if the difference between actual position and target position is smaller than set in register 'PositioningWindow' (→ Annex B).

If the marker is not found within the distance set in register 'DistanceBoundary, Error 600 is generated.

Job parameters

Address	Name	Function
202	DigitalSetpoint	Max. positioning speed; positive value: marker is searched for in positive direction; negative value: marker is searched for in negative direction.
205	TargetPosition	Relative target position
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

This Operating Mode uses the digital input GPIn6 on Connector X3, Pin 9. 24 V = marker is active.

Additional parameters

Address	Name	Function
361	DistanceBoundary	Maximum distance to be covered before the search is abandoned (value must be positive)
369	PositioningWindow	Max. permissible deviation of actual position and target position for receiving 'In Position' message (→ Annex B)
488	InPosTimeConst	Minimum time interval in [ms] the motor must be 'In Position' for Bit 0 in register 'Status16' to be set to '1' (→ Annex B)

Errors

Error code	Description
E 6 0 0	Maximum distance has been exceeded

Additional information

- The target position may lie before the marker. If this is the case, the motor gets stopped after crossing the marker and moves back.

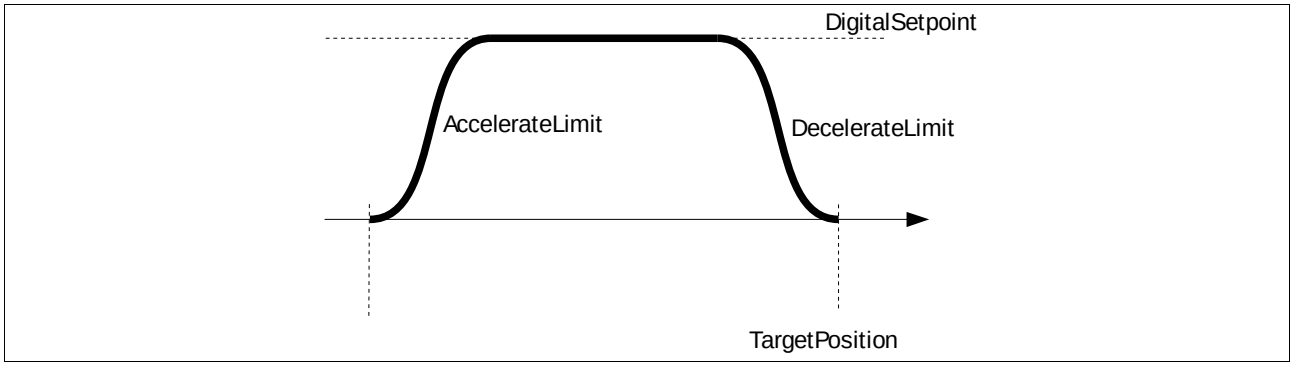
5.8.4 Operating Mode #40 – Absolute positioning with S-ramp

This Operating Mode is available as of software version V00.46.

General description

Use this Operating Mode to move the motor to an absolute position. Upon starting the job by setting a 0→1 edge for Setpoint Enable, the target position, the maximum positioning speed, and the ramps will be internally adopted.

In contrast to Operating Mode #37, this Operating Mode uses a jerk reduced S-ramp.



Bit 0 of register 'Status16' is set to '1' when the motor is 'In Position'. This is the case if the difference between actual position and target position is smaller than set in register 'PositioningWindow' (→ Annex B).

Job parameters

Address	Name	Function
202	DigitalSetpoint	Max. positioning speed (positive value)
205	TargetPosition	Absolute target position
206	AccelerateLimit	Max. value of acceleration / deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and outputs.

Additional parameters

Address	Name	Function
369	PositioningWindow	Max. permissible deviation of actual position and target position for receiving 'In Position' message (→ Annex B)
488	InPosTimeConst	Minimum time interval in [ms] the motor must be 'In Position' for Bit 0 in register 'Status16' to be set to '1' (→ Annex B)

Errors

Error code	Description
E 6 0 4	Value for acceleration too low. Positioning job will be executed with an appropriate value.

Additional information

- Ramps are symmetric.

- Setpoint Disable leads to linear deceleration by means of the stop ramp.

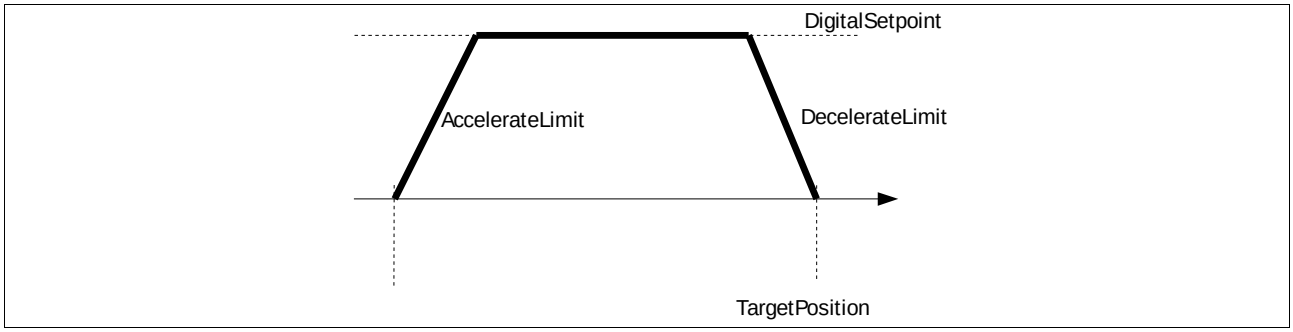
5.8.5 Operating Mode #42 – Absolute positioning online with linear ramp

This Operating Mode is available as of software version V00.46.

General description

Use this Operating Mode to move the motor to an absolute position.

As long as Inverter Enable and Setpoint Enable are provided, the motor is moving to a target position set.



Any values for target position, maximum positioning speed, and ramps can be altered any time and become effective immediately.

Bit 0 of register 'Status16' is set to '1' when the motor is 'In Position'. This is the case if the difference between actual position and target position is smaller than set in register 'PositioningWindow' (→ Annex B).

Job parameters

Address	Name	Function
202	DigitalSetpoint	Max. positioning speed (positive value)
205	TargetPosition	Absolute target position
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and outputs.

Additional parameters

Address	Name	Function
369	PositioningWindow	Max. permissible deviation of actual position and target position for receiving 'In Position' message (→ Annex B)
488	InPosTimeConst	Minimum time interval in [ms] the motor must be 'In Position' for Bit 0 in register 'Status16' to be set to '1' (→ Annex B)

Errors

This Operating Mode generates no errors.

Additional information

- Upon altering the value for target position, Bit 0 of Register 'Status16' remains set to '1' until the new value has been accepted. Therefore, wait some 10 ms until you check register 'Status16'.

5.8.6 Operating Mode #43 and #45 – Positioning within a 16-bit revolution

These Operating Modes are available as of software version V01.02.

Variant

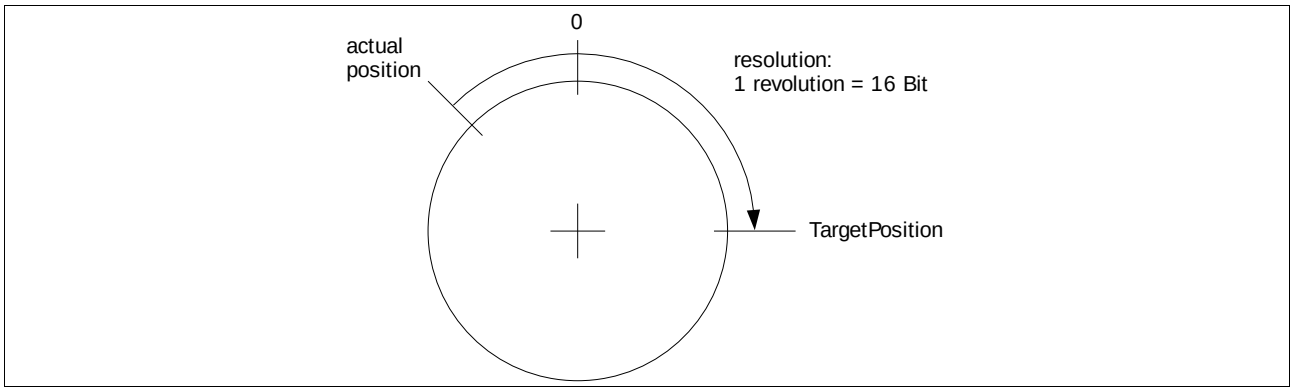
Operation mode	acceleration and deceleration
#43	with linear ramps
#45	with S-ramps

General description

Use these Operating Modes to move the motor to an absolute position.

These Operating Modes differ from Operating Modes #37 and #40, respectively, with regard to the following aspects:

- These Operating Modes can be used only when working with rotary motors and when using a feedback system with a resolution of 16 bits/revolution (e.g. resolver).
- The target position refers only to the angular position within one revolution.
- The shortest way to the desired angle position is always used.



Bit 0 of register 'Status16' is set to '1' when the motor is 'In Position'. This is the case if the difference between actual position and target position is smaller than set in register 'PositioningWindow' (→ Annex B).

Job parameters

Address	Name	Function
202	DigitalSetpoint	Max. positioning speed (positive value)
205	TargetPosition	Low Word: absolute target position 0...360 degree High Word: = 0
206	AccelerateLimit	Acceleration ramp
207	DecelerateLimit	Deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and outputs.

Additional parameters

Address	Name	Function
369	PositioningWindow	Max. permissible deviation of actual position and target position for receiving 'In Position' message (→ Annex B)
488	InPosTimeConst	Minimum time interval in [ms] the motor must be 'In Position' for Bit 0 in register 'Status16' to be set to '1' (→ Annex B)

Errors

This Operating Mode generates no errors.

Additional information

None.

5.8.7 Operating Mode #46 and #47 – Target braking within a 16-bit revolution

These Operating Modes are available as of software version V01.02.

Variant

Operation mode	acceleration and deceleration
#46	with linear ramps
#47	with S-ramps

General description

Use these Operating Modes to stop a motor turning at constant speed in a certain angular position. The deceleration process is initiated upon enabling of the Operating Modes. Upon enabling of the Operating Modes, the target position is 'frozen', i.e. its value cannot be altered afterwards. Bit 0 of register 'Status16' is set to '1' when the motor is 'In Position'. This is the case if the difference between actual position and target position is smaller than set in register 'PositioningWindow' (→ Annex B).

Job parameters

Address	Name	Function
205	TargetPosition	Low Word: absolute target position 0...360 degree High Word: = 0
207	DecelerateLimit	Max. value of deceleration ramp

Hardware I/O

This Operating Mode uses no hardware inputs and outputs.

Additional parameters

Address	Name	Function
369	PositioningWindow	Max. permissible deviation of actual position and target position for receiving 'In Position' message (→ Annex B)
488	InPosTimeConst	Minimum time interval in [ms] the motor must be 'In Position' for Bit 0 in register 'Status16' to be set to '1' (→ Annex B)

Errors

Error code	Description
E 6 0 1	Operating Mode enabled while motor was stopped
E 6 0 5	Value for deceleration too low.

Additional information

- Setpoint Disable leads to deceleration by means of the linear deceleration ramp.
- At decelerating of a speed near maximum speed a post-pulse oscillation can appear. For optimal deceleration we suggest to reduce the speed to approx. 10% of maximum speed and to start then the operation mode.

5.9 Interpolated Operation Modes

5.9.1 Operating Mode #48...#50 – Buffered interpolated position mode

These Operating Modes are available as of software version V00.46.

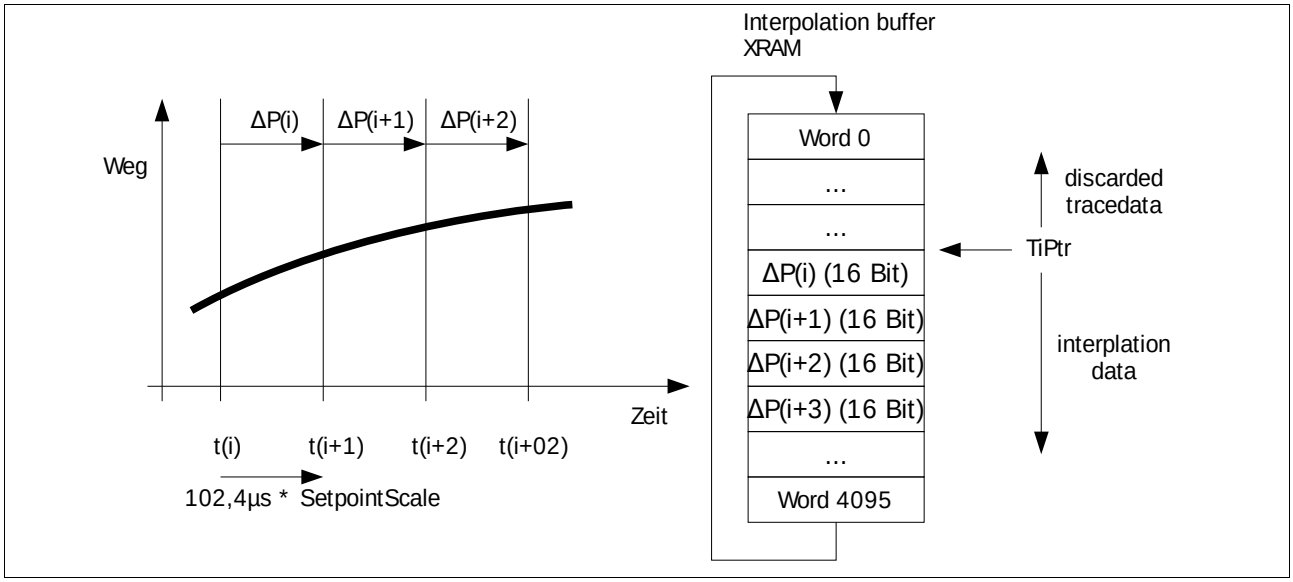
Variant

Operation mode	Interpolation	Override	Trace
#48	Linear	Yes	Yes
#49	Spline	Yes	Yes
#50	Linear	Yes	No

General description

Use this Operating Mode to drive the motor by a numeric control unit over CAN-NOVOTRON.

Prior to job execution the motor's movement must be calculated externally and the data must be loaded to the interpolation buffer of the X-RAM. When calculating interpolation data make sure to take into account acceleration and deceleration ramps in compliance with physical rules and restrictions.



The interpolation buffer contains a maximum of 4096 words, which can be addressed by the X-RAM words addresses 0...4095. It works as a ring buffer. Every word entry indicates the relative distance which must be moved within the time value from Register 'SetpointScale'. Several distance values have a special function:

0x8000 Marker for end of movement,

0x8001 Marker for end of data.

Prior to Setpoint Enable, the 'TiPtr' pointer must be set to the first entry of the trajectory. Start the job by setting a 0→1 edge for Setpoint Enable. The time will be split into equidistant intervals according to register 'SetpointScale'. Within each time interval the motor must move the distance of the corresponding entry in the interpolation buffer. At the end of each interval every entry will be

overwritten by the largest position tracking error that has occurred within this interval (trace data). By reading and analyzing the trace data the quality of moving can be checked.

Whereas in Operating Mode #48 the values for speed are determined by means of linear interpolation, in Operating Mode #49 the values for speed are determined by means of 2nd-order spline interpolation.

If the number of 4096 entries is not sufficient, data can be reloaded by special CAN-NOVOTRON telegrams. To do so, Parameter 'PdoHandler' must be set to '4' (→ 'Process data exchange with interpolation buffer').

When the marker indicating the end of movement is reached, the motor stops and Bit 0 in register 'Status16' is set to '1'. When the marker indicating the end of data is reached, the motor stops and Error 610 is generated.

Job parameters

These Operating Modes use no job parameters.

Hardware I/O

These Operating Modes use no hardware inputs and outputs.

Additional parameters

Address	Name	Function
350	SetpointScale	Interval length of in units of 102,4 µs. Negative values are not valid. Value '0' stops the movement.
573	TiPtr	Pointer to the actual entry in the X-RAM to move
574	XRamDataPtr	Pointer to the next entry in the X-RAM to write by CAN-NOVOTRON
578	TracePtr	Pointer to the next trace value in the X-RAM to read by CAN-NOVOTRON

Errors

Error code	Description
E 6 1 0	Marker indicating the end of data is reached (i.e. drive move faster than data was downloaded)
E 9 7 7	Overflow in calculation of speed setpoint (Register 'SpeedSetpoint1')

Additional information

- During the time of Setpoint Enable, no ramp generator is active.
- All trajectory data entries are cleared upon processing of the data, upon power-off and upon reset. They must be reloaded for each new movement.
- These Operating Modes cannot by used by the Job Control.
- Upon Setpoint Disable the motor gets decelerated by means of the linear deceleration ramp until it stops. The position setpoint gets lost.
- If the marker indicating the end of movement is reached and the setpoint is not disabled, the movement is continued if the value in Register 'TiPtr' is altered or if the value for the marker indicating the end of movement is overwritten.
- At activating operation mode setpoint must be disabled!

- At activating operation mode, parameter „SetpointScale“ must be larger than zero!

5.9.2 Operating Mode #57 – CAN-NOVOTRON interpolated position mode

This Operating Mode is available as of software version V01.00.

General description

Use this Operating Mode to drive the motor by a numeric control unit by CAN-NOVOTRON.

To use this Operating Mode, activate the CAN-NOVOTRON process data exchange with synchronization (→ Parameter 'PdoHandler' = '32').

Sync telegrams must be sent in equidistant time intervals according to Parameter 'FiCycle'.

The Operating Mode calculates the speed setpoint in such a way that the target position is reached at the time of the next sync telegram.

In this Operating Mode Bit 0 in register 'Status16' is never set to '1'.

Job parameters

Address	Name	Function
205	TargetPosition	Absolute target position for next cycle

Hardware I/O

This Operating Mode uses the connector for CAN-NOVOTRON.

Additional parameters

Address	Name	Function
390	FiCycle	Cycle time for interpolation in [µs] = time interval of sync telegrams Value range +500...+6553 µs

Errors

Error code	Description
E 9 7 7	Target position is changing too fast

Additional information

- Prior to starting the job by setting a 0→1 edge for Setpoint Enable the master must match its setpoint with the actual position, as otherwise a position difference occurs leading to an error.
- Acceleration and deceleration ramps must be generated by the master. During the time of Setpoint Enable, no ramp generator is active.

5.10 Other Operation Modes

5.10.1 Operating Mode #64 – Open motor brake

This Operating Mode is available as of software version V00.46.

General description

Use this Operating Mode to release the motor brake without Inverter Enable and line voltage.

Upon enabling of the Operating Mode the motor brake can be released/activated manually by setting/resetting Bit 3 in register 'Control'.

The superordinate position control is not affected by this Operating Mode. The setpoint value for speed is '0'.

Job parameters

Address	Name	Function
200	Control	Control register

Hardware I/O

This Operating Mode changes the status of output MB1/MB2 on Connector X3 (motor brake).

Additional parameters

This Operating Mode uses no additional parameters.

Errors

This Operating Mode generates no errors.

Additional information

- The controller configuration (position controller on/off) is not affected by this Operating Mode.
- If this Operating Mode is enabled and then you provide for Inverter Enable, the setpoint for current of the motor will be set to 0 A. That means: The motor will not be held in position.

5.10.2 Operating Mode #66 – Void operating mode

This Operating Mode is available as of software version V00.46.

General description

Use this Operation Mode, which has no effect on NOVODRIVE's state, to set Bit 0 in register 'Status16' to '1'. This Operating Mode has a filling function when working with the Job Control.

The controller structure and the speed setpoint set last are maintained. Upon Setpoint Disable the motor gets decelerated by means of the deceleration ramp until it stops.

Job parameters

Address	Name	Function
200	Control	Control register

Hardware I/O

This Operating Mode uses no hardware inputs and/or outputs.

Additional parameters

This Operating Mode uses no additional parameters.

Errors

This Operating Mode generates no errors.

Additional information

- The operation mode hold the last speed setpoint.
- The controller configuration (position controller on/off) is not affected by this Operating Mode.
- If this Operating Mode is enabled and then you provide for Inverter Enable, the setpoint for current of the motor will be set to 0 A. That means: The motor will not be held in position.

5.10.3 Operating Mode #70 – Choose control parameter set X

This Operating Mode is available as of software version V01.00.

General description

Besides the active parameter sets for the speed controller and the position controller there are four more controller parameter sets to choose from. Using this Operating Mode you may easily change controller parameters during operation.

Use this Operating Mode to copy one of the four alternative controller parameter sets into the active parameter set for the speed controller and the position controller.

The job will be started as soon as the setpoint is enabled by register “Control” and the operation mode is activated.

Upon full completion of the job, Bit 0 of register 'Status16' is set to '1'.

Job parameters

Address	Name	Function
248	DataInput16	Parameter set No. (0...3)

Hardware I/O

This Operating Mode uses no hardware inputs and outputs.

Additional parameters

Address	Name	Function
450...455	CsScKp0; CsScKi0; CsScKd0; CsScKf0; CsPcKp0; CsPcKd0	Alternative parameter set 0 for speed controller and position controller
456...461	CsScKp1; CsScKi1; CsScKd1; CsScKf1; CsPcKp1; CsPcKd1	Alternative parameter set 1 for speed controller and position controller
462...467	CsScKp2; CsScKi2; CsScKd2; CsScKf2; CsPcKp2; CsPcKd2	Alternative parameter set 2 for speed controller and position controller
468...473	CsScKp3; CsScKi3; CsScKd3; CsScKf3; CsPcKp3; CsPcKd3	Alternative parameter set 3 for speed controller and position controller

Errors

Error code	Description
E 1 0 4	Value in register 'DataInput16' is not within tolerable range (0...3)

Additional information

- The operation mode hold the last speed setpoint.
- The controller configuration (position controller on/off) is not affected by this Operating Mode.
- If this Operating Mode is enabled and then you provide for Inverter Enable, the setpoint for current of the motor will be set to 0 A. That means: The motor will not be held in position.

5.10.4 Operating Mode #71 – Choose current control parameter set X

This Operating Mode is available as of software version V01.04.

General description

Beside the active current controller parameter set there are two alternative current controller parameter sets. Thus is possible to change the parameter sets during the operation. With this operation mode one of the two alternative parameter sets can be copied in the active parameter set.

The job will be started as soon as the setpoint is enabled by register “Control” and the operation mode is activated.

After full completion of the job, Bit 0 of register 'Status16' is set to '1'.

Job parameters

Address	Name	Function
248	DataInput16	Parameter set No. (0...1)

Hardware I/O

This Operating Mode uses no hardware inputs and outputs.

Additional parameters

Address	Name	Function
474...476	CsCcEmk0; CsCcKi0; CsCcKp0;	Alternative parameter set 0 for current controller
477...479	CsCcEmk1; CsCcKi1; CsCcKp1;	Alternative parameter set 1 for current controller

Errors

Error code	Description
E 1 0 4	Value in register 'DataInput16' is not within tolerable range (0...1)

Additional information

- A change of the current control parameters during the operation only makes sense, when mains voltage is switched over during operation.
- The operation mode hold the last speed setpoint.
- The controller configuration (position controller on/off) is not affected by this Operating Mode.
- If this Operating Mode is enabled and then you provide for Inverter Enable, the setpoint for current of the motor will be set to 0 A. That means: The motor will not be held in position.

5.11 Extensions

This section is reserved for future extensions.

5.12 Reserved Operation Modes

5.12.1 Operating Mode #100...#125 – Reserved

Operating Modes #100...125 are used internally by NOVODRIVE for testing and calibration.

Enabling these Operating Modes may destroy calibration data.

If one of these Operating Modes has been enabled accidentally, reset NOVODRIVE in order to get the calibration data from the EEPROM again.

5.12.2 Operating Mode #126 and #127 – Invalid operating mode

This Operating Mode is available as of software version V01.00.

Variant

Operation mode	Function
#126	The job in job control control is deleted.
#127	The job in job control is a part of a graph and can't be used directly.

General description

Use this Operating Mode when working with the Job Control to mark deleted jobs. Upon enabling, this Operating Mode generates Error 108.

Job parameters

This Operating Mode uses no job parameters.

Hardware I/O

This Operating Mode uses no hardware inputs and outputs.

Additional parameters

This Operating Mode uses no additional parameters.

Errors

Error code	Description
E 1 0 8	An invalid Operating Mode was enabled

Additional information

None.

5.13 Annex

5.13.1 Annex A – Position setting with Bit mask

Operating Modes #9, #12 #13, #14 and #15 set the actual position to a new value using a bit mask. The default value of the bit mask is 0x0000 0000. By setting bits in the bit mask it is possible to maintain parts of the position information.

Example: Resolver - Alter value of revolution counter

Function	Register	Value
Actual position	PositionActual1	0x UUUU UUUU DDDD DDDD
Target position	TargetPosition	0x WWWW WWWW PPPP PPPP
Bit mask	HomePositionMask	0x 0000 0000 FFFF FFFF
New actual position	PositionActual1	0x WWWW WWWW DDDD DDDD

With:

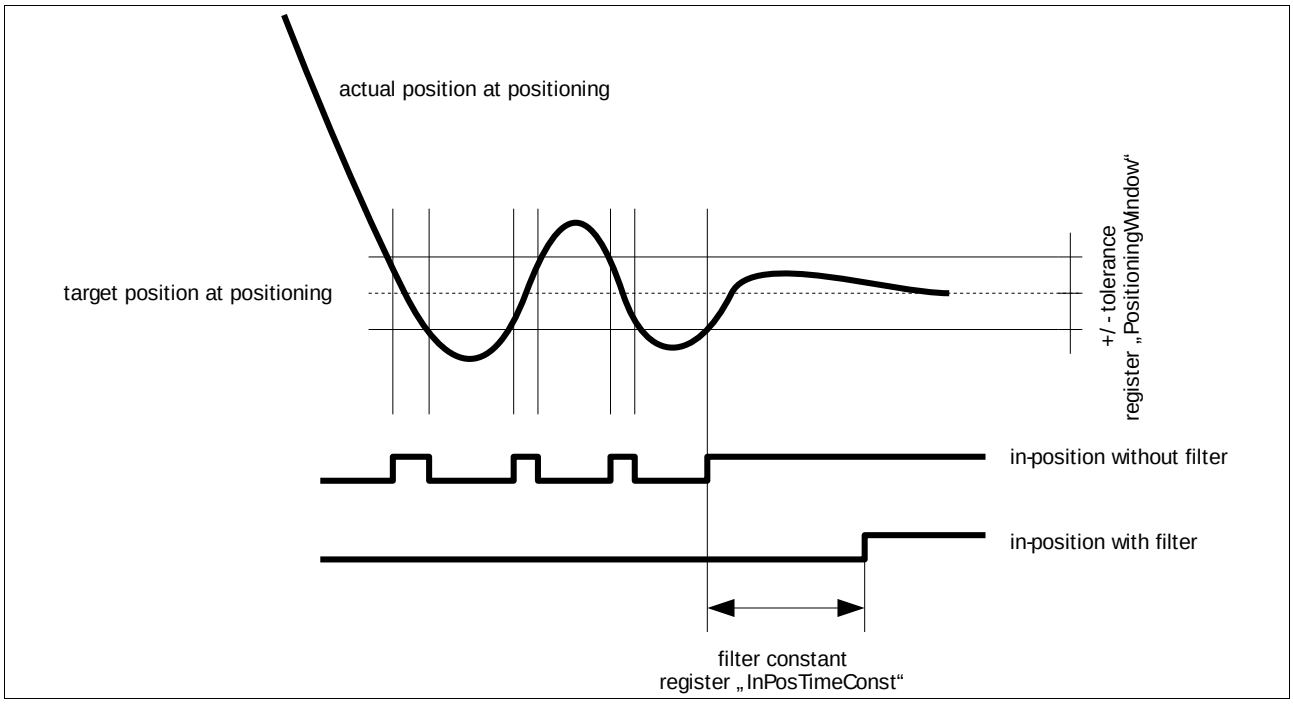
UUUU UUUU	Revolution counter
DDDD DDDD	Angular position
WWW WWW	Setpoint for revolutions
PPPP PPPP	Setpoint for angular position

Upon setting of the bits the value of the revolution counter has changed from 'UUUU UUUU' to 'WWWW WWWW', whereas the angular position remains 'DDDD DDDD'.

> This example is based on the assumption that you work with a standard resolution of 16 bits per revolution. If you work with other feedback systems, you may adapt the mask accordingly.

5.13.2 Annex B – 'In Position'

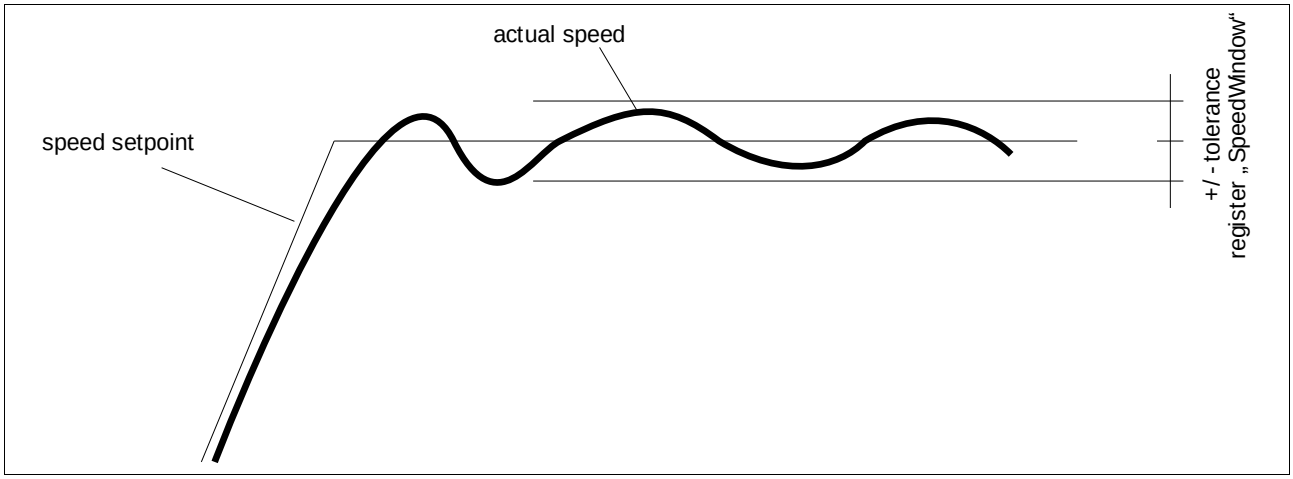
When using Operating Modes for positioning, Bit 0 of register 'Status16' is set to '1' when the motor is 'In Position'. This is the case if the difference between actual position and target position is smaller than set in Register 'PositioningWindow'. Usually this process is accompanied by a transient effect , i.e. 'In Position' is not stable at the beginning. To avoid oscillation, you may apply a filter.



The time constant for the filtering is set in register 'InPosTimeConst' in [ms]. The value '0' deactivates the filtering function.

5.13.3 Annex C – 'In Speed'

With several Operating Modes for speed setpoint setting, Bit 0 of register 'Status16' is set to '1' when the motor's actual speed lies within the tolerance range set in Register 'SpeedWindow'. If the tolerance range is exceeded, Bit 0 is reset to '0'.



When determining the tolerance range, please take into account that considerable speed deviations may occur, caused by:

- Overshooting of actual speed during acceleration and deceleration,
- inaccuracy of feedback system (especially when using resolvers the speed seems to oscillate which repeats itself in each revolution, however the real speed of the motor is much more consistent),
- noise caused by analog signals.

6 Technology Functions

6.1 Basic Information

Technology Functions allow for autonomous execution of operations, e.g. by the Job Control.

Technology Functions are selected and activated via Register 'TechFunc'. To actually apply the specified function, save any change you made in the parameter settings in the EEPROM and then reset NOVODRIVE.

To verify if a certain Technology Function is supported by NOVODRIVE, you may check Registers 116 and 117. For each supported Technology Function the respective Bit is set.

Parameter

Address	Name	Function
301	TechFunc	Selection and activation of Technology Function

6.2 List of Technology Functions

ID number	Name	Function
0	---	Deactivation of Technology Function
1	Job Control	Selection and activation of positioning and other jobs
8	---	Customer specific function for speed profiles (see pertinent description)

6.3 Job Control

6.3.1 General Description

The Job Control allows you to activate and save positioning and other jobs in the NOVODRIVE. Jobs can be activated either via the digital inputs or via a 16-bit bus interface. It is possible to combine several jobs.

Each job consists of

- an Operating Mode,
- a speed setpoint,
- an acceleration/deceleration ramp,
- a target position, and
- a time variable.

The Job Control not only allows to do positioning jobs but to perform any Operating Mode supported by NOVODRIVE, for example to modify control parameters or to calibrate the analog input offset.

6.3.2 Connection

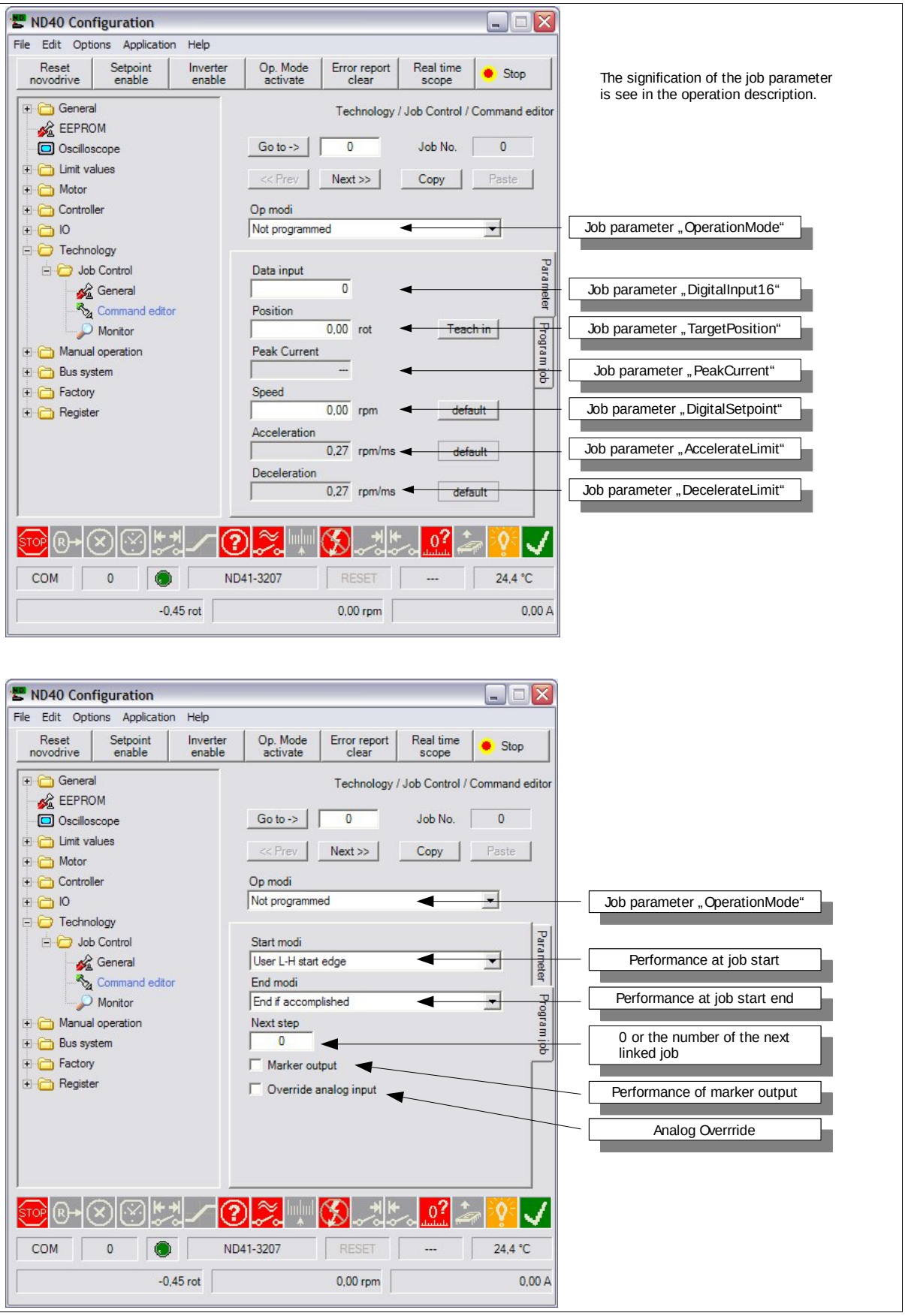
Input functions for Job Control	**Control via digital I/O** Connector X3		**Control via NOVOBUS/ CAN-NOVOTRON** Register 'AsInput'		**Control via bus interface PROFIBUS/CANopen** Field 'DigitalInput16'	
Inverter Enable	GPIn1: 0: Inverter Disable 1: Inverter Enable		Bit 0 Reserved = 0		Bit 0: 0: Inverter Disable 1: Inverter Enable	
Setpoint Enable	GPIn2: 0 = Setpoint Disable 1 = Setpoint Enable 0→1 = Start		Bit 1: 0 = Setpoint Disable 1 = Setpoint Enable 0→1 = Start		Bit 1: 0 = Setpoint Disable 1 = Setpoint Enable 0→1 = Start	
	---		Bit 2 Reserved = 0		Bit 2 Reserved = 0	
	...		...		...	
	---		Bit 7 Reserved = 0		Bit 7 Reserved = 0	
ID number of the job to be started next, between 1...127 (bus interface), 1...63 (GPIn)	GPIn9	$2^0 = 1$	Bit 8	Job ID number 1...127	Bit 8	Job ID number 1...127
	GPIn10	$2^1 = 2$	Bit 9		Bit 9	
	GPIn11	$2^2 = 4$	Bit 10		Bit 10	
	GPIn12	$2^3 = 8$	Bit 11		Bit 11	
	GPIn13	$2^4 = 16$	Bit 12		Bit 12	
	GPIn14	$2^5 = 32$	Bit 13		Bit 13	
	---		Bit 14		Bit 14	
	---		Bit 15 Reserved = 0		Bit 15 Reserved = 0	

Input functions for Job Control	**Control via digital I/O** Connector X3	**Control via NOVOBUS/ CAN-NOVOTRON** Register 'AsOutput'	**Control via bus interface PROFIBUS/CANopen** Field 'DigitalOutput16'
Ready to operate (reset done, line voltage connected, no error)	GPO1 (BTB1 and BTB2)	Bit 0 Reserved = 0	Bit 0 Reserved = 0
Control output for motor brake	GPO2 (MB1 and MB2)	Bit 1 Reserved = 0	Bit 1 Reserved = 0
	---	Bit 2...7 Reserved = 0	Bit 2...7 Reserved = 0
0 = Job is complete. 1 = Job is in progress or waits for error acknowledgment by Setpoint Disable	GPO9	Bit 8	Bit 8
0 = Job is in progress 1 = Job is complete and waits for acknowledgment by Setpoint Disable	GPO10	Bit 9	Bit 9
0 = Job is in progress 1 = Job has been aborted by Inverter Disable or Setpoint Disable	GPO11	Bit 10	Bit 10
0 = Marker output is reset 1 = Marker output is set	GPO12	Bit 11	Bit 11
	---	Bit 12...15 Reserved = 0	Bit 12...15 Reserved = 0

6.3.3 Programming

Make sure you save all parameter settings in the EEPROM after any alteration of values, otherwise the data will be lost after power-off or reset.

- By means of the 'Teach In' button the value of the actual position can be assigned to a job.
- By means of the 'Default' buttons default values can be set. Default values can be specified on page 'Technology - Job Control/General'. This is very useful to make alterations of values that apply to all jobs, for example if you do all jobs at the same speed.
- Jobs not required can be deleted by setting Operating Mode #127 'Invalid Operating Mode'. If you have activated a deleted job, Error 108 will be generated.
- Jobs 0 and 1 can be skipped by programming them with Operating Mode #66 'Void Operating Mode'. If 'Autostart' has been selected, the Job Control automatically continues with the next job.


ND40 Configuration
File Edit Options Application Help
Reset novodrive
Setpoint enable
Inverter enable
Op. Mode activate
Error report clear
Real time scope
Stop
General
EEPROM
Oscilloscope
Limit values
Motor
Controller
IO
Technology
Job Control
General
Command editor
Monitor
Manual operation
Bus system
Factory
Register
Technology / Job Control / Command editor
Go to ->
0
Job No.
0
<< Prev
Next >>
Copy
Paste
Op modi
Not programmed
Job parameter „OperationMode“
Parameter
Program job
Data input
0
Job parameter „DigitalInput16“
Position
0,00 rot
Teach in
Job parameter „TargetPosition“
Peak Current

Job parameter „PeakCurrent“
Speed
0,00 rpm
default
Job parameter „DigitalSetpoint“
Acceleration
0,27 rpm/ms
default
Job parameter „AccelerateLimit“
Deceleration
0,27 rpm/ms
default
Job parameter „DecelerateLimit“
COM
0
ND41-3207
RESET

24,4 °C
-0,45 rot
0,00 rpm
0,00 A
The signification of the job parameter is see in the operation description.
ND40 Configuration
File Edit Options Application Help
Reset novodrive
Setpoint enable
Inverter enable
Op. Mode activate
Error report clear
Real time scope
Stop
Technology / Job Control / Command editor
Go to ->
0
Job No.
0
<< Prev
Next >>
Copy
Paste
Op modi
Not programmed
Job parameter „OperationMode“
Start modi
User L-H start edge
Performance at job start
End modi
End if accomplished
Performance at job start end
Next step
0
0 or the number of the next linked job
Marker output
Performance of marker output
Override analog input
Analog Overrride

6.3.4 Procedure

Job list

Job Nr.	Function
0	After switch on this job is executed first. This allows you to start a routine for initialization. If the job is not to be used, then it must be programmed with begin with Operation Mode #66 and "End if accomblished".
1	After acknowledge of an error this job is executed first. Thus, you can start a special procedure for error handling. If the job is not to be used, then it must be programmed with begin with Operation Mode #66 and "End if accomblished".
2	Free available jobs that can be directly selected via digital inputs, a bus interface or through the "next step".
...	
63	
64	Free available jobs that can only be selected via a bus interface or through the "next step".
...	
127	

Job selection

- Upon Inverter Enable the Job Control starts with Job 0.
- Upon error acknowledgement Job 1 will be executed next.

If Job 0 and Job 1 are not processed, the job to be executed next will be determined by the 'Next step' field.

- If 'Next step' is zero, the job to be executed next will be determined by the digital inputs GPIn 9...14.
- If 'Next step' is other than zero, the number shown is the number of the job to be executed next.

GPin	Example	Value
9	0 V	$2^0 = 1$
10	0 V	$2^1 = 2$
11	24 V	$2^2 = 4$
12	0 V	$2^3 = 8$
13	24 V	$2^4 = 16$
14	0 V	$2^5 = 32$
		→ Job 20

Job start

The Job Control's behavior when a job is started can be selected:

Name	Function	Use it ...
“User L-H start edge”	Job starts with L-H edge of Setpoint Enable (start signal)	... to determine the time of job start by an external control unit
“Autostart”	Job starts immediately without internal generation of a start signal	... for execution of interrelated Operating Modes which do not require an explicit start signal (e.g. positioning with different speed setpoints)

“Autostart with internal L-H start edge”	Job starts immediately upon internal generation of a start signal	... for execution of interrelated Operating Modes which do require an explicit start signal (e.g. relative positioning)

Job end

Depending on the Operating Mode selected there are two possibilities for job end:

Name	Function	Use it ...
“Never end until stopped”	Job will not end until Setpoint Disable	... when working with an Operating Mode that does not lead to a final result (e.g. speed setpoint setting via analog input)
“End if accomplished”	Job will end upon successful execution, i.e. Bit 0 of Register 'Status16' = '1'	... if, for example, a positioning task has been fully completed

“Peak Current” (from version 01.03)

Herewith the limitation of peak current can be changed per sentence. The indication takes place in per cent of the permissible motor peak current. 3 cases are distinguished:

0	no change of Parameter „CurrentPeakLimit1“
1 ... 99	$CurrentPeakLimit1 = \frac{Percent}{100} * CurrentPeakLimit2$
100 ... 255	$CurrentPeakLimit1 = CurrentPeakLimit2$

“Marker output” option

Set this option to set digital output GPO12 when a job has been fully completed. Upon start of the next job, the digital output will be reset again.

“Override analog input” option

Set this option to scale the speed value via the analog input every 10 ms during operation:

$$speed\,setpoint = \frac{Voltage[V]}{11{,}6\,V} \cdot programmed\,speed$$

By means of Register 'AsAnInCorrection' a position correction factor can be calculated:

$$correction\,value\,of\,position[Inc.] = \frac{Voltage[V]}{11{,}6\,V} \cdot AsInInCorrection[Inc.]$$

This correction factor is used by Operating Mode #44 only.

Error treatment

1. Upon occurrence of an error the ready-to-operate relay is switched off.
2. The Job Control stops executing the current job.
3. Upon Inverter Disable the error is cleared and the ready-to-operate relay is switched on again.
4. Upon Setpoint Disable the Job Control goes to Job 1.
5. Upon Setpoint Enable Job 1 will be executed.

6.3.5 Differences at V02.05 and later

Timing of inputs

The ID number of the job to be started next (GPIn 9...14) will be read 10 ms later after the 0→1 edge of Setpoint Enable (GPIn2). Through the change GPIn 9...14 and GPIn2 can be switched together.

First job after Inverter Enable

Normally the first job after inverter enable is job 0. If job 0 is programmed with operation mode “No function – Void” and the field “next job” contains zero then job 0 is ignored and the first job is selected by register “AsInput” respectively GPIn 9...14.

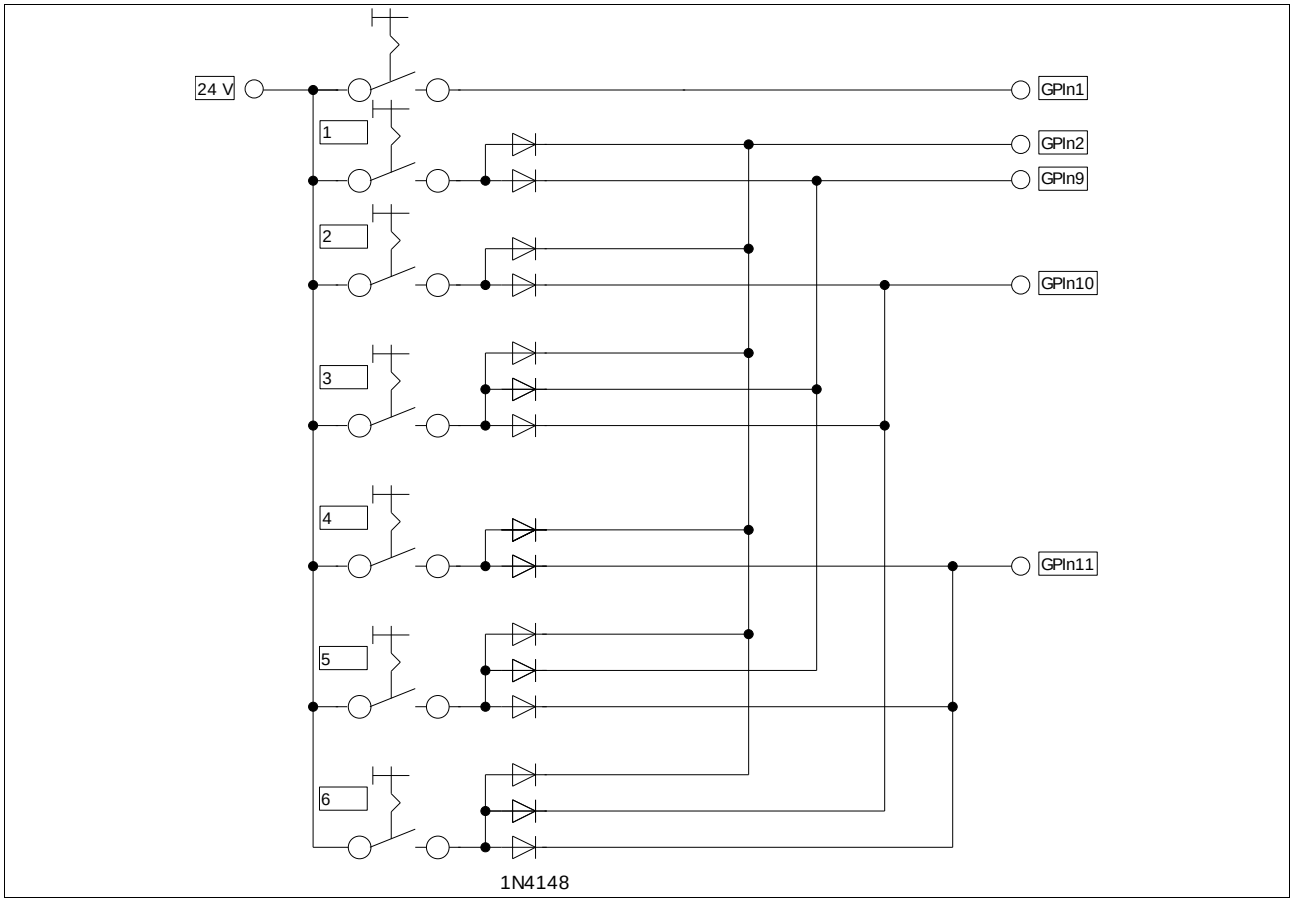
6.4 Example

Function

Several jobs are to be executed over six digital 24-V inputs.

Switch	Function	
0	Inverter Enable	
1	Job 1 = 00001 binary	An error is cleared
2	Job 2 = 00010 binary	Right-jog at 20 rpm
3	Job 3 = 00011 binary	Left-jog at 20 rpm
4	Job 4 = 00100 binary	Speed setpoint setting via analog input by means of potentiometer
5	Job 5 = 00101 binary	Positioning within one revolution to 30 degree
6	Job 6 = 00110 binary	Positioning within one revolution to -180 degree

Connection scheme



Programmed jobs

Default values		
Speed	200,0 rpm	Speed
Acceleration	100,0 rpm/ms	Acceleration ramp
Deceleration	100,0 rpm/ms	Deceleration ramp

Job 0			
Op modi		No function – Void	
Parameter		**Program job**	
Data input	0	**Start modi**	Autostart
Position	0	**End modi**	End if accomplished
Peak Current	---	**Next step**	0
Speed	default	**Marker output**	-
Acceleration	default	**Override analog input**	-
Deceleration	default		

Job 1			
Op modi		No function – Void	
Parameter		**Program job**	
Data input	0	**Start modi**	Autostart
Position	0	**End modi**	End if accomplished
Peak Current	---	**Next step**	0
Speed	default	**Marker output**	-
Acceleration	default	**Override analog input**	-
Deceleration	default		

Job 2			
Op modi		Digital speed setpoint setting without position control	
Parameter		**Program job**	
Data input	0	**Start modi**	User L-H start edge
Position	0	**End modi**	Never end until stopped
Peak Current	---	**Next step**	0
Speed	19,9 rpm	**Marker output**	-

Acceleration	default	**Override analog input**	-
Deceleration	default		

Job 3			
Op modi		Digital speed setpoint setting without position control	
Parameter		**Program job**	
Data input	0	**Start modi**	User L-H start edge
Position	0	**End modi**	Never end until stopped
Peak Current	---	**Next step**	0
Speed	-19,9 rpm	**Marker output**	-
Acceleration	default	**Override analog input**	-
Deceleration	default		

Job 4			
Op modi		Analog speed setpoint setting without position control	
Parameter		**Program job**	
Data input	0	**Start modi**	User L-H start edge
Position	0	**End modi**	Never end until stopped
Peak Current	---	**Next step**	0
Speed	default	**Marker output**	-
Acceleration	default	**Override analog input**	-
Deceleration	default		

Job 5			
Op modi		Positioning within a 16-bit revolution with linear ramp	
Parameter		**Program job**	
Data input	0	**Start modi**	User L-H start edge
Position	30 degree	**End modi**	Never end until stopped
Peak Current	---	**Next step**	0
Speed	default	**Marker output**	-
Acceleration	default	**Override analog input**	-
Deceleration	default		

Job 6	
Op modi	Positioning within a 16-bit revolution with linear ramp

Parameter		**Program job**	
Data input	0	**Start modi**	User L-H start edge
Position	-180 degree	**End modi**	Never end until stopped
Peak Current	---	**Next step**	0
Speed	default	**Marker output**	-
Acceleration	default	**Override analog input**	-
Deceleration	default		