MOVIDRIVE® MD_60A
Drive Inverter

Manual

Internal Synchronous Operation

Edition 11/2000

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SEW EURODRIVE

- **This information does not replace the detailed operating instructions!**
- **Installation and startup only by trained personnel observing applicable accident prevention regulations and the MOVIDRIVE® operating instructions!**

- **Read through this manual carefully before you commence installation and startup of MOVIDRIVE® drive inverters with internal synchronous operation.**
This manual assumes that the user has access to and is familiar with the documentation on the MOVIDRIVE® system, in particular the MOVIDRIVE® system manual.

- **Safety notes:**
Always follow the safety and warning instructions contained in this manual!
Safety notes are marked as follows:

Electrical hazard, e.g. during live working.

Mechanical hazard, e.g. when working on hoists.

Important instructions for safe and fault-free operation of the driven machine/system, e.g. pre-setting before startup.

- In this manual, **cross references** are marked with a □→, e.g.: (→ Sec. X.X) means that further information can be found in section X.X of this manual.

- A requirement of fault-free operation and fulfillment of any rights to claim under guarantee is that this information is observed.

1 System Description 4
1.1 Application fields 4
1.2 Functional description 4
1.3 State machine of internal synchronous operation 5
1.4 Controlling internal synchronous operation 5

2 Project Planning 6
2.1 Application examples 6
2.2 Pre-requisites 8
2.2.1 PC and software 8
2.2.2 IPOS$^{plus®}$Compiler 8
2.2.3 Inverter 8
2.2.4 Motors and encoders 9
2.3 Project planning notes 10
2.4 Synchronous start/stop 11

3 Installation 12
3.1 Software 12
3.2 Connecting the incremental encoder master to MOVIDRIVE® slave 13
3.3 Connecting MOVIDRIVE® master to MOVIDRIVE® slave 14
3.4 SBus connection of master/slave(s) 15

4 Startup 16
4.1 General information 16
4.2 Preliminary work 16
4.3 Starting up internal synchronous operation 16
4.3.1 General information 16
4.3.2 Starting up with X14 – X14 connection 17
4.3.3 Starting up with SBus connection 17

5 Working Method and Functions 18
5.1 Controlling internal synchronous operation 18
5.2 Main state machine 18
5.3 Startup cycle mode control 20
5.3.1 Time-controlled synchronization process 20
5.3.2 Travel-dependent synchronization process 20
5.3.3 Startup cycle state machine 21
5.4 Stop cycle state machine 24
5.5 Offset control 25
5.5.1 Time-controlled offset processing 25
5.5.2 Travel-dependent offset processing 25
5.5.3 Offset state machine 25
5.6 Synchronous operation 27
5.7 Virtual encoder 28
5.7.1 Virtual encoder without ramp generator 28
5.7.2 Virtual encoder with ramp generator 28
5.8 Important notes 29

6 System Variables of Internal Synchronous Operation 30

7 Sample IPOS Programs 33
7.1 Example 1: 33
7.2 Example 2: 36
7.3 Example 3: 40

1 System Description

1.1 Application fields

The internal synchronous operation function enables a group of motors to be operated at a synchronous angle in relation to one another or with an adjustable proportional relationship (electronic gear).

Internal synchronous operation is particularly suited to the following sectors and applications:

- **Beverage industry**
  - Filling stations
- **Multiple column hoist**
- **Synchronous material transport**
- **Extruder applications, cutting to length material off the roll**
  - Flying saw
  - Rotating knife

Internal synchronous operation offers the following advantages in these applications:

- Possibility of travel-dependent synchronization → smooth synchronizing without overshooting.
- Possibility of travel-dependent offset.
- Signed input of the master gear factor.
- Possibility of synchronizing with a virtual encoder.
- Possibility of synchronized SBus connection between master and slave.
- Software solution → no option pcb required.

1.2 Functional description

The internal synchronous operation function takes the form of a special firmware package which only expects increments from a master. The master can either be the X14 input (physical master drive) or any IPOS variable (virtual master drive), for example in conjunction with the SBus or a virtual encoder.

- Synchronization

  The time-controlled synchronization mechanism has been implemented. An angular differential in the slave drive resulting from free running is reduced to zero.

  In addition, a special type of synchronization can be employed. The slave drive moves at a synchronous angle to the master drive following a specified number of master increments (travel-dependent synchronization). The slave drive moves with a quadratic ramp in this synchronization mechanism.
- Synchronous operation

  Various functions are included in synchronous operation. For example, it is possible to operate with a specified offset after a specific travel distance. The offset between the master and slave drive comes into effect after a specified number of master increments.
- Disengaging

  The slave disengages from synchronous operation using the stop cycle process. This process can be started manually by setting a system variable or it may be event-driven via a binary input.

1.3 State machine of internal synchronous operation

The individual functions of internal synchronous operation are controlled using something referred to as a state machine. This state machine is divided into five main states.

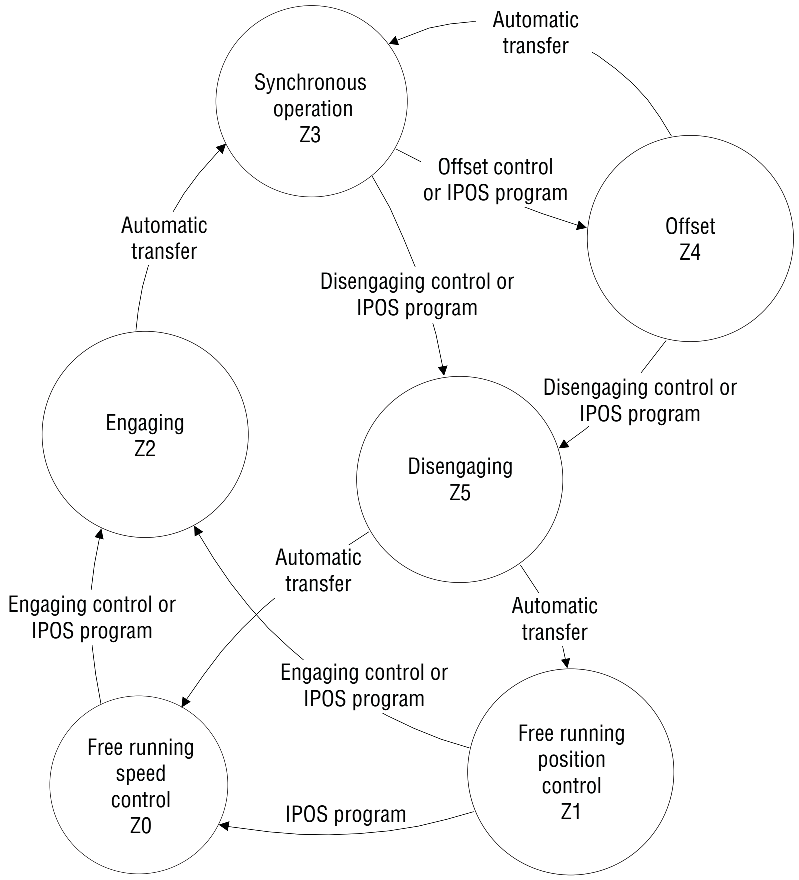

Fig. 1: Overview of the state machine for internal synchronous operation

- State Z0 = Free running speed control: The slave drive moves in free running mode with speed control. The reference to the master drive is stored in a difference counter.
- State Z1 = Free running position control: The slave drive stops with position control and therefore does not drift out of position. The reference to the master drive is not stored.
- State Z2 = Engaging: The slave drive is synchronized with the master drive either under time control or travel control.
- State Z3 = Synchronous operation: The slave drive moves in synchronicity with the master drive.
- State Z4 = Offset: An offset can be set in the synchronous operation.
- State Z5 = Disengaging: The slave drive exits synchronous operation.

1.4 Controlling internal synchronous operation

Internal synchronous operation is controlled using IPOS$^{plus®}$ variables within the IPOS$^{plus®}$ application program. All states can be viewed and set in a variable range from H360 to H446 which is reserved for internal synchronous operation (→ System variables section).

2 Project Planning

2.1 Application examples

a) Master/slave mode of two drives

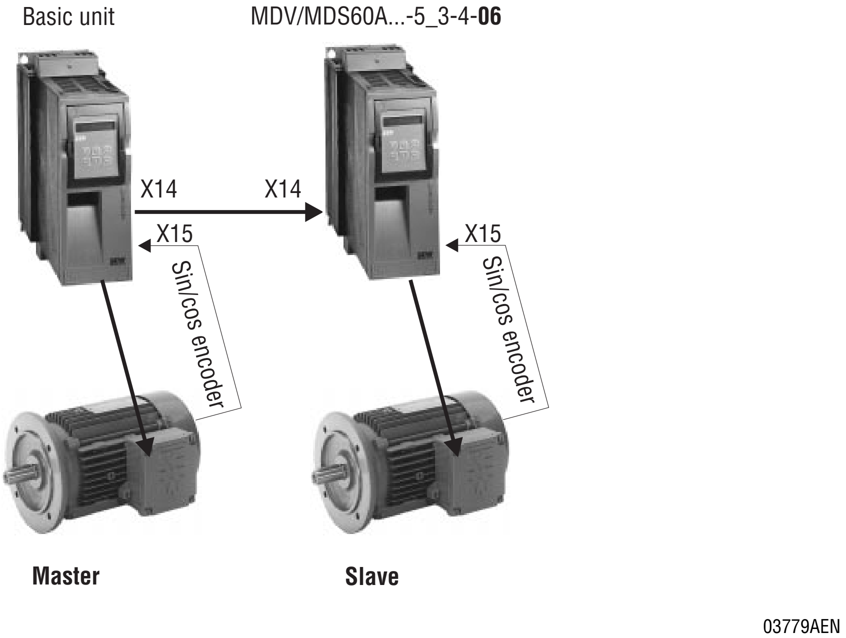

Fig. 2: Master/slave mode

b) Master/slave mode of two drives with virtual encoder as master

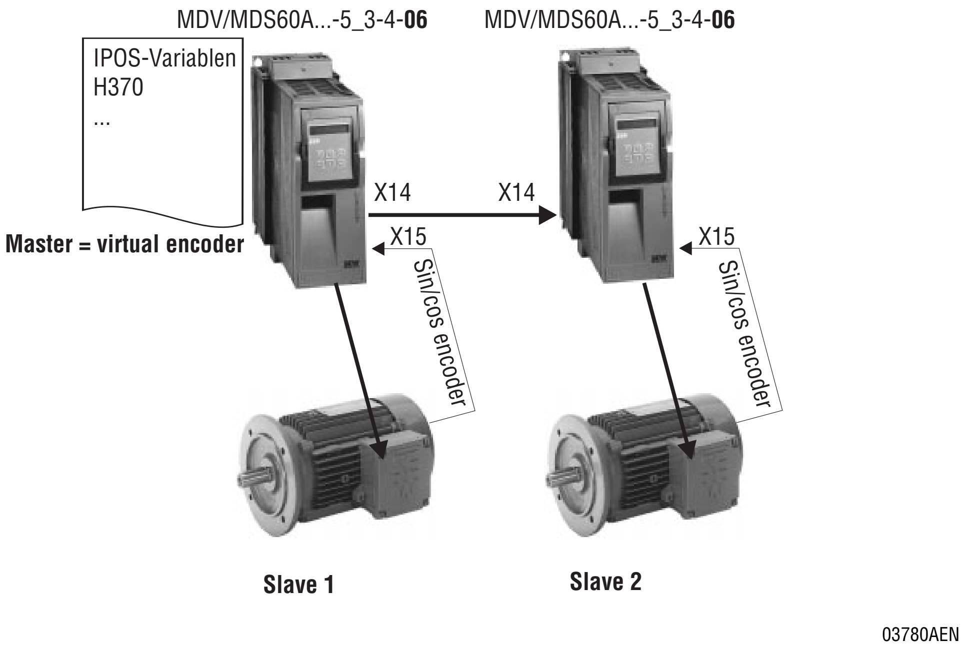

Fig. 3: Master/slave mode with virtual encoder

c) Group configuration: Master and equivalent slaves, e.g. multiple column hoist

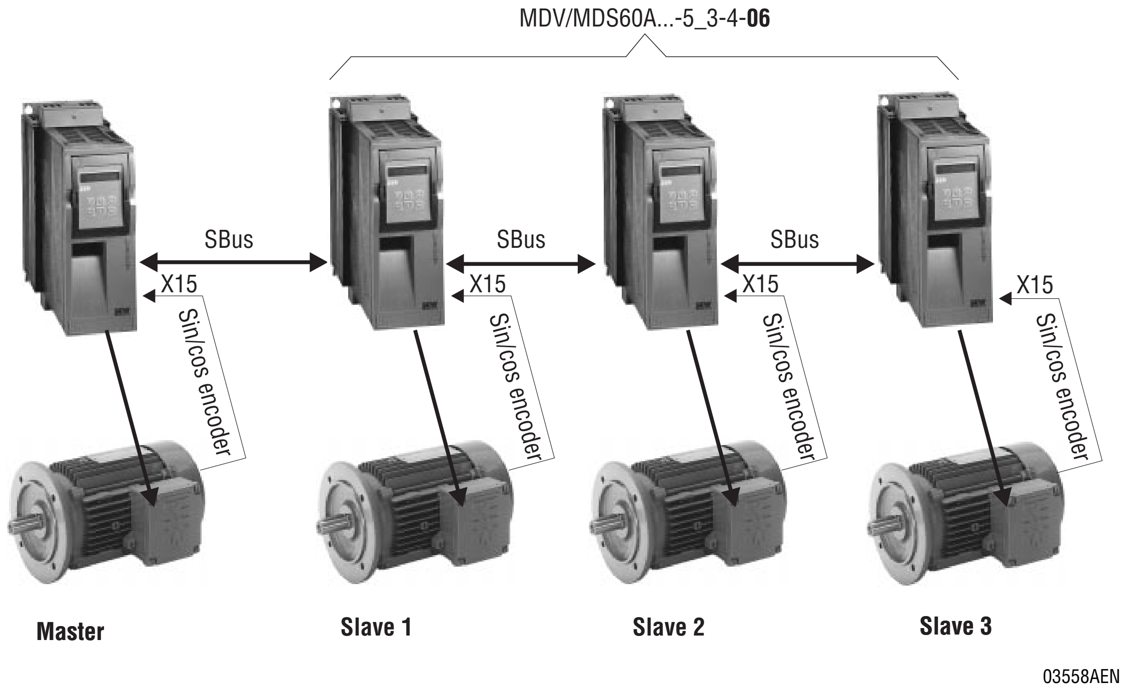

Fig. 4: Group configuration

d) Group configuration with virtual master encoder:

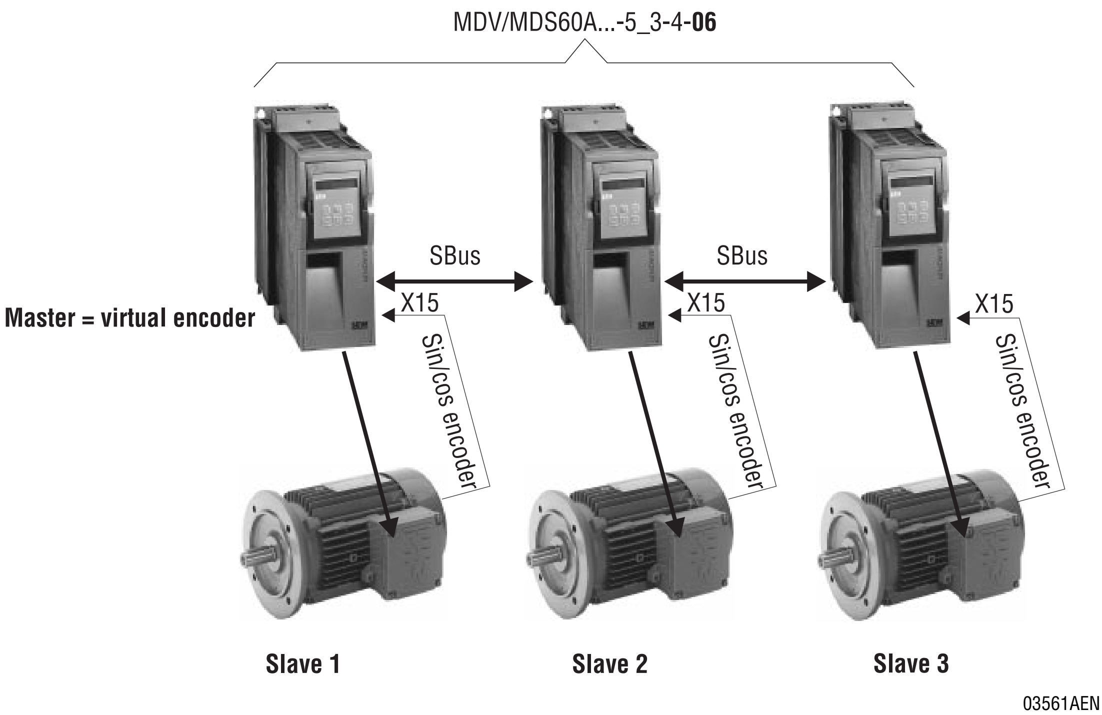

Fig. 5: Group configuration with virtual master encoder

2.2 Pre-requisites

2.2.1 PC and software

You need the SEW MOVITOOLS software package in order to be able to use internal synchronous operation. In order to use MOVITOOLS, you must have a PC with one of the following operating systems: Windows 95®, Windows 98® or Windows NT® version 4.0.

2.2.2 IPOS^plus® Compiler

The user program for internal synchronous operation must be created using IPOS^plus® compiler. Do not use the assembler (on-screen programming) for this purpose.

IPOS^plus® variables H360 to H450 are defined for internal synchronous operation.

2.2.3 Inverter

- The MOVIDRIVE® MD_60A...-5_3-4-06 special version contains a special firmware package for internal synchronous operation.
- Internal synchronous operation can only be implemented with MOVIDRIVE® MDV60A in the CFC operating modes or with MOVIDRIVE® MDS60A (SERVO). Internal synchronous operation cannot be implemented with MOVIDRIVE® MDV60A in the VFC operating modes or with MOVIDRIVE® MDF60A.
- Only 1 parameter set is available; parameter set 2 cannot be used.
- The following options are not supported and therefore may not be used: "Single-axis positioning control type DPI11A" and "Synchronous operation board type DRS11A."

The special version for internal synchronous operation has the following part numbers:

MOVIDRIVE® MDV60A...	Part number
0015-5A3-4-06	826 994 7
0022-5A3-4-06	826 995 5
0030-5A3-4-06	826 996 3
0040-5A3-4-06	826 997 1
0055-5A3-4-06	826 998 X
0075-5A3-4-06	826 999 8
0110-5A3-4-06	827 000 7
0150-503-4-06	827 001 5
0220-503-4-06	827 002 3
0300-503-4-06	827 003 1
0370-503-4-06	827 004 X
0450-503-4-06	827 005 8
0550-503-4-06	827 006 6
0750-503-4-06	827 007 4

MOVIDRIVE® MDS60A...	Part number
0015-5A3-4-06	827 008 2
0022-5A3-4-06	827 009 0
0030-5A3-4-06	827 010 4
0040-5A3-4-06	827 011 2
0055-5A3-4-06	827 012 0
0075-5A3-4-06	827 013 9
0110-5A3-4-06	827 014 7
0150-503-4-06	827 015 5
0220-503-4-06	827 016 3
0300-503-4-06	827 017 1
0370-503-4-06	827 018 X

2.2.4 Motors and encoders

- For operation on MOVIDRIVE® MDV60A:
  - Asynchronous servomotors CT/CV, high-resolution sin/cos encoder installed as standard.
  - AC motors DT/DV/D with incremental encoder option, preferably high-resolution sin/cos encoder.
- For operation on MOVIDRIVE® MDS60A:
  - Synchronous servomotors DS/DY, resolver installed as standard.

High-resolution speed detection is required for optimum operation of internal synchronous operation. The encoders installed as standard on CT/CV and DS/DY motors fulfill these requirements. SEW recommends using high-resolution sin/cos encoders ES1S, ES2S or EV1S as incremental encoders if DT/DV/D motors are used.

2.3 Project planning notes

- Do not use internal synchronous operation with systems that have a rigid mechanical connection.
- Fit slave inverters with a braking resistor.
- During project planning for the synchronous operation application, bear in mind that the slave must be able to reduce the angle differential between itself and the master to zero at any time. For this reason, set the maximum speed (P302) of the slave to a greater value than the maximum speed of the master.
- During the time-controlled synchronization process, the synchronization speed of the slave drive must be faster than the maximum speed of the master drive.
- If possible, always use the same type of drives for internal synchronous operation.
- In the case of multiple column hoists, always use the same motors and the same gear units (identical ratios).
- When drives of the same type are operating as a synchronized group (e.g. multiple column hoist), then the drive which carries the highest proportion of the load during operation must be selected as the master.
- Connect the slave motor encoder to X15 (ENCODER IN) and the master incremental encoder to X14 (ENCODER IN/OUT) → MOVIDRIVE® operating instructions.
- Master is incremental encoder on X14: use an incremental encoder with the maximum possible resolution, however no more than 200 kHz.
- It is impossible to evaluate signals from any encoders (e.g. an external encoder on the distance) other than the master incremental encoder on X14, unless an additional option card is fitted. Exception: Signals from an absolute encoder can be evaluated as from an external encoder if the slave inverter is equipped with the "absolute encoder interface type DIP11A" option.
- Only slave drives with an interlocking (= slip-free) connection between the motor shaft and the driven machine are allowed to be used.
- Operation with SBus → Setting up a **cyclical** data transfer in an IPOS program:
  - Group configuration: SBus connection between the master and all slave drives is permitted.
  - SBus synchronization with transfer of the SBus synchronization ID.
  - Transferring the position of the master drive.

  Important: Delays may occur as a result of the SBus transfer.
- Synchronous start/stop (→ Sec. 2.4)
- **Direct cable-break monitoring** (X14-X14 connection, encoder connection) is not possible. **Indirect cable-break monitoring** is possible during operation with SBus by way of the SBus timeout response (P836).

2.4 Synchronous start/stop

In certain applications such as a two-column hoist, it is essential to make sure that the master and slave can start and stop in synchronicity. This is a prerequisite for correct operation. As a result, combinations in which the master is more dynamic than the slave are not permitted.

The following table shows the possible master/slave combinations and the required settings for synchronous start/stop.

Master	Slave	Master parameter	Slave parameter	Remark
MDV	**MDV**	DOØ2 = Output stage on	DIØ3 = Enable/rapid stop (factory setting) DIØ1 and DIØ2 = No function	Connect master binary output DOØ2 to slave binary input DIØ3.
MDV	**MDS**			
MDS	**MDS**			

Essential note:

- The brake function must be active in the master and the slave (P730 "Brake function 1" = ON).
- The brake release time (P731) of the master must be increased by the premagnetizing time (P323) of the slave drive.
- The free running function of the slave is only possible if slave binary input X13:4 (DIØ3) gets a "1" signal from elsewhere.

3 Installation

3.1 Software

Proceed as follows to install MOVITOOLS® on your computer:

1. Insert the MOVITOOLS® CD into the CD ROM drive of your PC.
2. Select "Start/Run...".
3. Type "{Drive letter of your CD drive}:setup" and press the Enter key.
4. The MOVITOOLS® setup menu appears. Follow the instructions of the installation wizard.

You can now use the Program Manager to start MOVITOOLS®. If a MOVIDRIVE® unit is connected to your PC, select the correct port (PC COM port) and set point-to-point connection. Select <Update> to display the inverter in the "Connected Units" window.

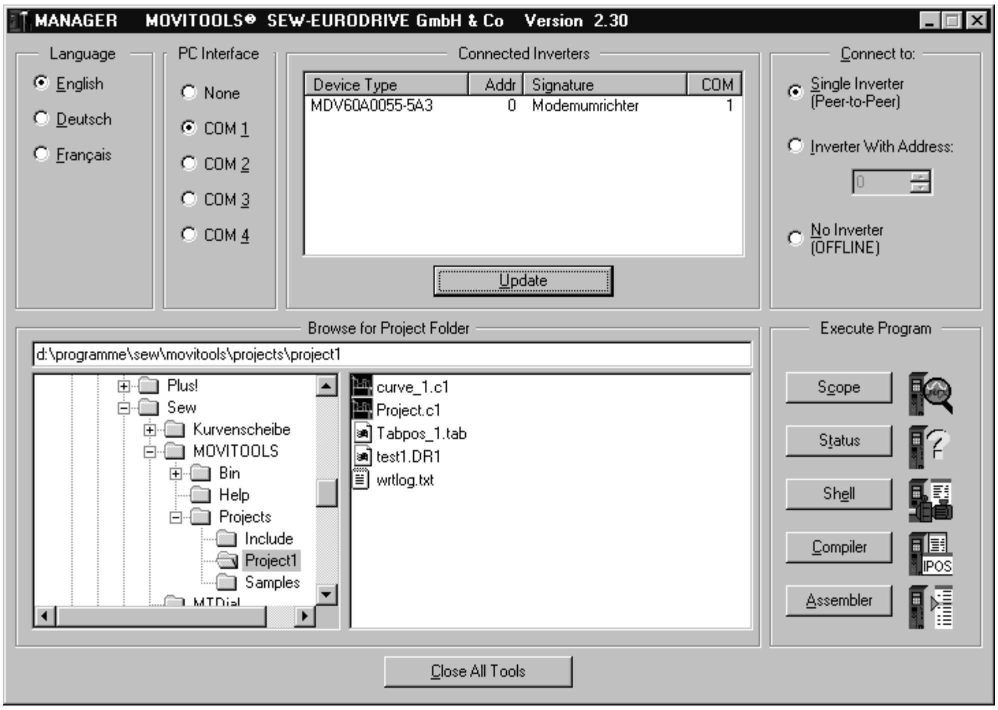

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Fig. 6: MOVITOOLS® window

3.2 Connecting the incremental encoder master to MOVIDRIVE® slave

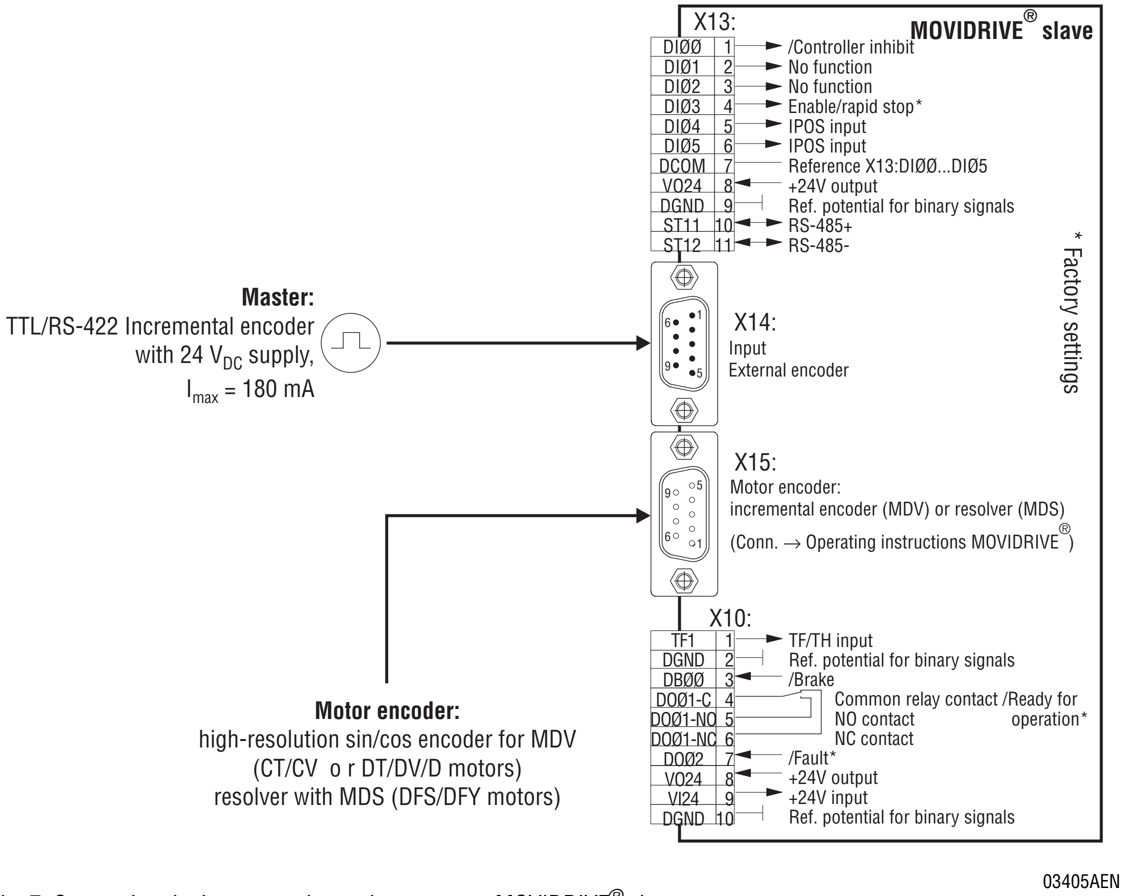
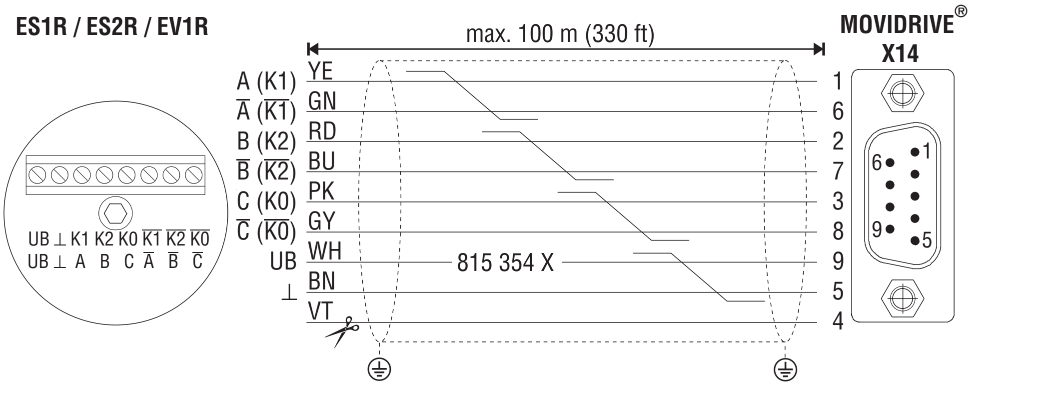


Fig. 7: Connecting the incremental encoder master to MOVIDRIVE® slave

Connect the master incremental encoder (TTL sensor with 24 V_{DC} supply, for example ES1R, ES2R or EV1R) as follows:



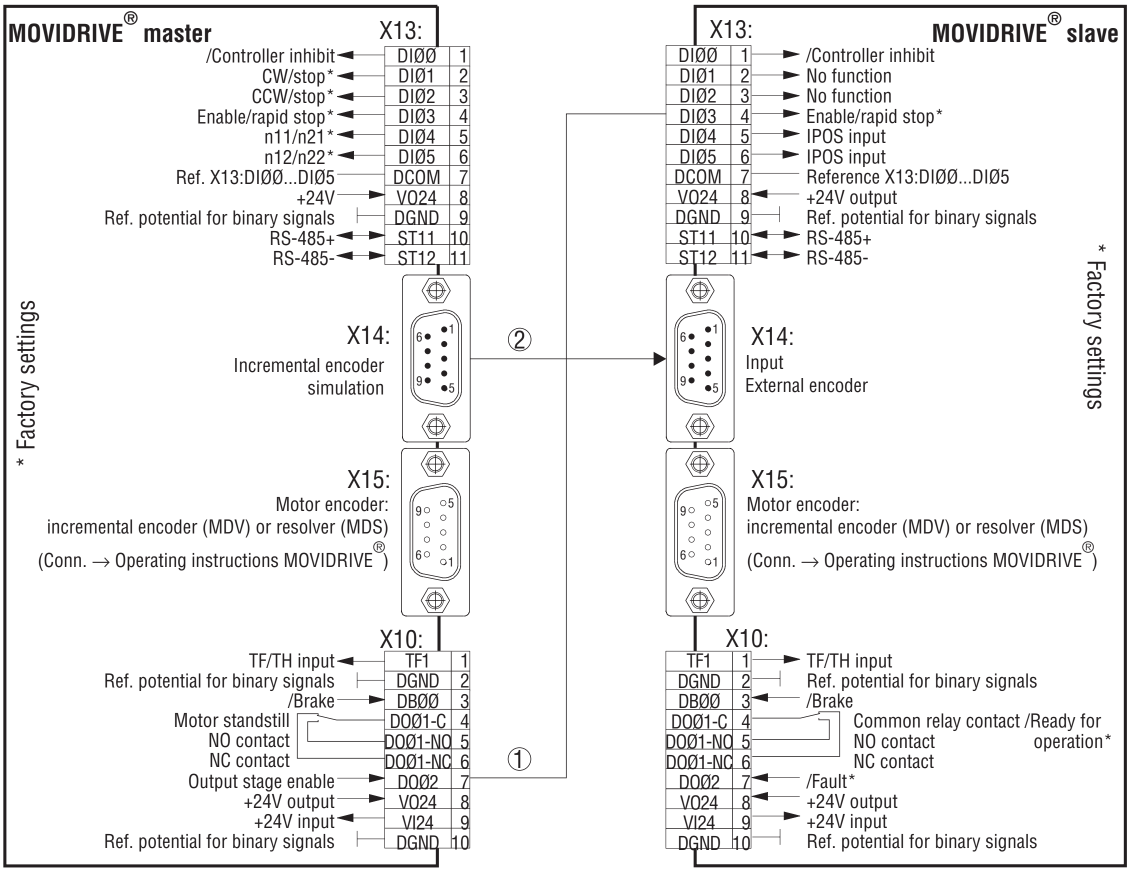
✂ Cut off the violet conductor (VT) of the cable at the encoder end.

Fig. 8: Connecting the master incremental encoder to X14

Important note:

- The maximum permitted line length of the incremental encoder/motor encoder is 100 m (330 ft).
- Only use shielded encoder cables with twisted pair conductors (A and $\overline{A}$, B and $\overline{B}$, C and $\overline{C}$). Connect the shield at both ends.
- Route the encoder cable separately from the power cables.
- SEW offers pre-fabricated cables for a simple and fault-free encoder connection.

3.3 Connecting MOVIDRIVE® master to MOVIDRIVE® slave



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① Necessary connection for synchronous start/stop (→ "Synchronous start/stop" on page 11).

② It is essential to comply with Fig. 10 and the following instructions for the X14 – X14 connection!

Fig. 9: Connecting MOVIDRIVE® master to MOVIDRIVE® slave

X14 – X14 connection:

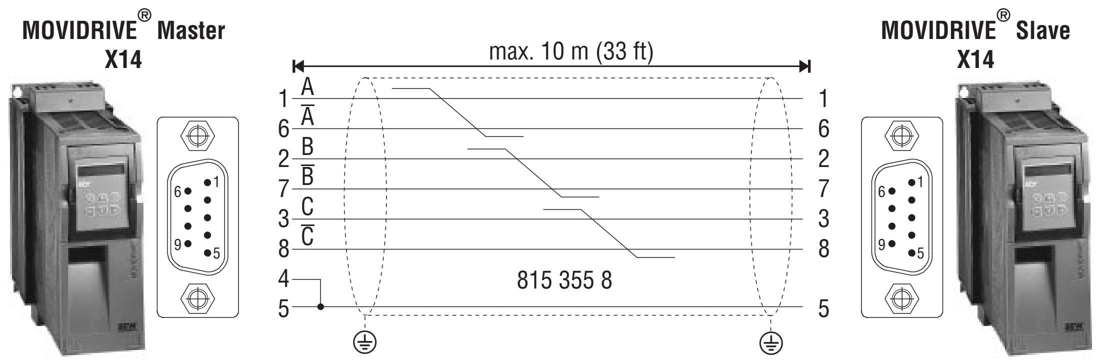

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Fig. 10: X14 – X14 master/slave connection

Essential note:

- With MOVIDRIVE® master: Jumper X14:4 with X14:5.
- Do not connect X14:4 and X14:9.
- SEW offers a prefabricated cable for a straightforward and trouble-free X14 – X14 connection. You can order this cable from SEW by quoting part number 815 355 8.

3.4 SBus connection of master/slave(s)

The "System Bus" manual contains detailed information about the system bus (SBus). This manual can be obtained from SEW, publication number 0918 0915.

Max. 64 CAN bus stations can be interconnected using the system bus (SBus). The SBus supports transmission systems compliant with ISO 11898.

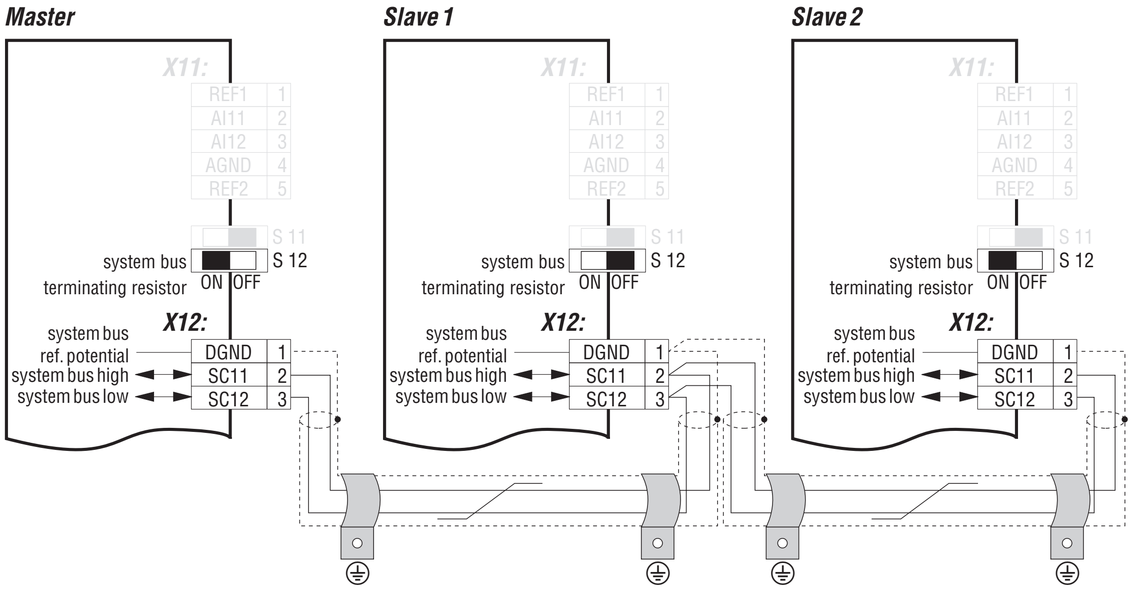

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Fig. 11: System bus connection (example: 1 master and 2 slaves)

Special note:

- Use a 2-core twisted and shielded copper cable (data transmission cable with shield comprising copper braiding). Connect the shield at either end to the electronics shield clamp of MOVIDRIVE® and ensure the shield is connected over a large area. Also connect the ends of the shield to DGND.
  The cable must meet the following specifications:
  - Conductor cross section 0.75 mm^2 (AWG18)
  - Cable resistance 120 Ω at 1 MHz
  - Capacitance per unit length ≤ 40 pF/m (12 pF/ft) at 1 kHz
  Suitable cables are CAN bus or DeviceNet cables, for example.
- The permitted total cable length depends on the baud rate setting of the SBus:
  125 kbaud → 320 m (1056 ft)
  250 kbaud → 160 m (528 ft)
  500 kbaud → 80 m (264 ft)
  1000 kbaud → 40 m (132 ft)
- Switch on the system bus terminating resistor (S12 = ON) at the start and finish of the system bus connection. Switch off the terminating resistor on the other units (S12 = OFF).
- There must not be any potential displacement between the units which are connected together using the SBus. Take suitable measures to avoid a potential displacement, e.g. by connecting the unit ground connectors using a separate lead.

4 Startup

4.1 General information

Correct project planning and installation are the pre-requisites for successful startup. Refer to the MOVIDRIVE® system manual for detailed project planning instructions. The system manual forms part of the MOVIDRIVE® documentation package (publication number 0919 3219).

Check the installation, including the encoder connection, by following the installation instructions in the MOVIDRIVE® MD_60A operating instructions and in this manual (Sec. 3, page 12).

4.2 Preliminary work

Perform the following steps before the startup of "internal synchronous operation":

- Connect the inverter to the PC using the serial port (RS-232, USS21A on PC-COM).
- Install MOVITOOLS® on the PC (Sec. 3.1, page 12) and start the program.
- "0" signal at terminal X13:1 (DIØØ, /Controller inhibit).
- Start up the inverter using <Shell>.
  - With MOVIDRIVE® MDV60A and DT/DV/D or CT/CV motors, in **CFC & IPOS** operating mode.
  - With MOVIDRIVE® MDS60A and DS/DY motors, in **SERVO & IPOS** operating mode.

4.3 Starting up internal synchronous operation

4.3.1 General information

- Start <Shell>.
- Set parameter **P916 "Ramp type"** to "I-SYNCHR.OPERAT.," thereby activating internal synchronous operation.

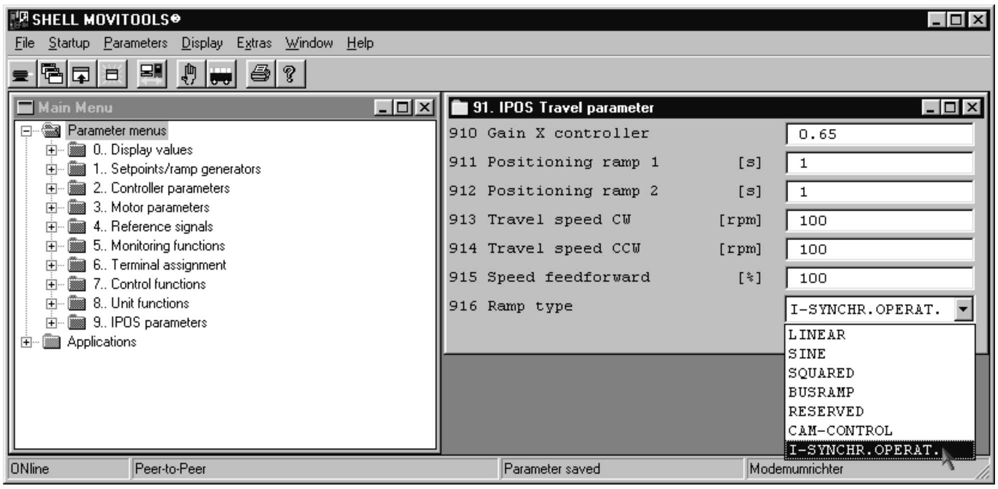

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Fig. 12: Activating internal synchronous operation with P916

This setting can also be made with the "_SetSys(SS_RAMTYPE, Hxx)" command in the IPOS application program. In this case, variable Hxx must be given the value 6.

4.3.2 Starting up with X14 – X14 connection

The incremental encoder simulation from X14 of a MOVIDRIVE® master inverter is used as the master for internal synchronous operation. Make sure that system variable H430 *MasterSource* = 0 is set in the slave inverter. Only then is X14 active as the source for the master increments.

4.3.3 Starting up with SBus connection

The master and slave(s) are interconnected via the SBus, for example in a group configuration. The master position is transmitted via this SBus. Transmitting position setpoints requires control loop synchronization between the master and slave. Comply with the following points when starting up the SBus.

With the master inverter:

- Create two SBus transmit objects (SCOM TRANSMIT CYCLIC), namely "Synchronization ID" and "Master position". Both object numbers must be greater than 1050. In addition, the object number of the synchronization ID must be lower (= with higher priority) than the object number of the master position.
- The number of the "Synchronization ID" transmit object must not be the same as its own P817 parameter value.
- The set SBus address (P813) must not be the same as the slave SBus addresses.
- The "Cycle time" in the SCOM command for the synchronization ID must be 5 ms.
- The "Cycle time" in the SCOM command for the master position must be 1 ms.

With the slave inverter:

- Create an SBus receive object (SCOM RECEIVE), namely "Master position".
- The P817 parameter value must be the same as the number of the "Synchronization ID" transmit object.
- The H430 MasterSource system variable must be the same as the value of the D pointer (→ SCOM command structure).
- The slaves must have different SBus addresses (P813).

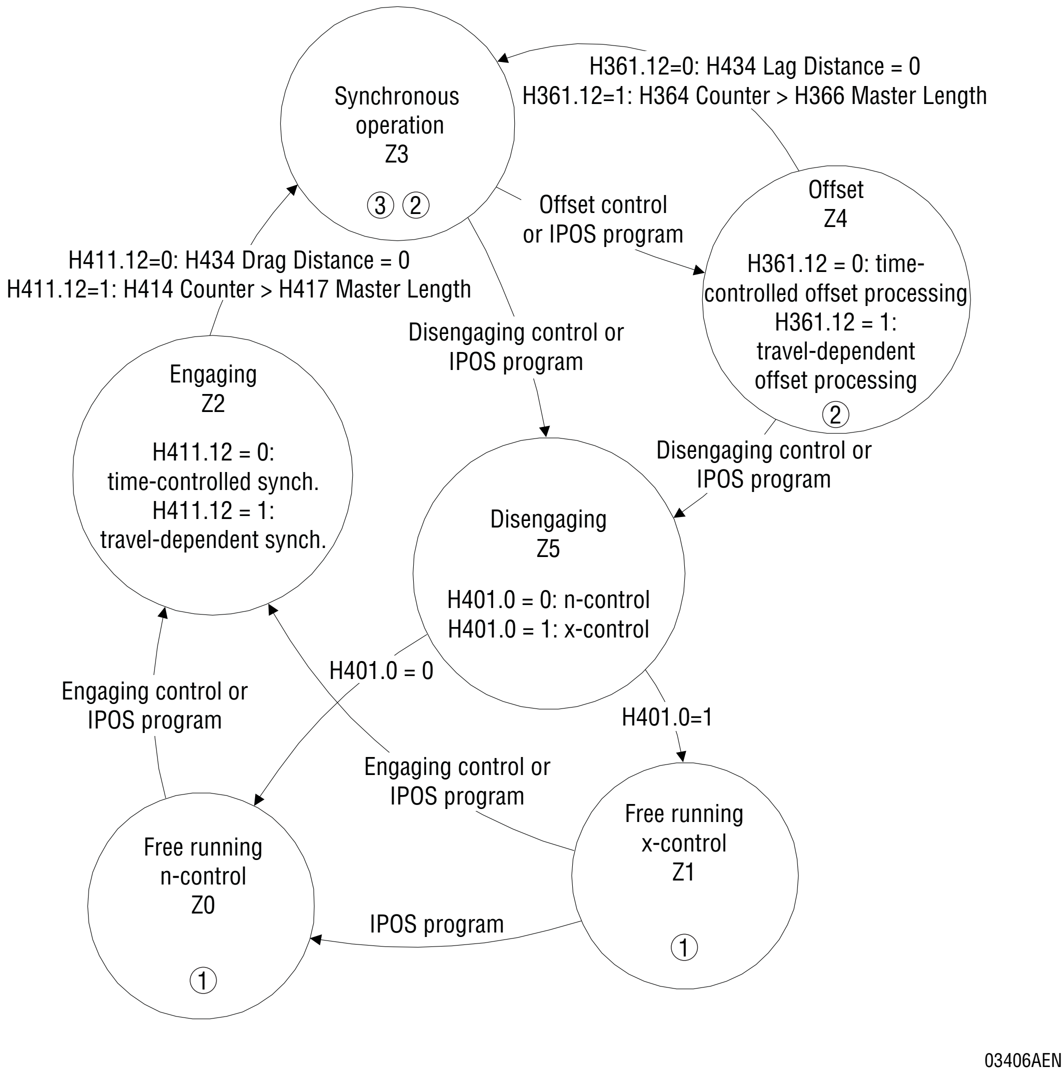
5 Operating Principle and Functions

5.1 Controlling internal synchronous operation

Internal synchronous operation is controlled using IPOS$^{plus®}$ variables within the IPOS$^{plus®}$ program, referred to below as the "application." All states of internal synchronous operation can be viewed and set in a variable range from H360 to H446 which is reserved for internal synchronous operation (see the section on system variables). All variables which are connected to internal synchronous operation have symbolic names. These variables are shown below in ***bold and italics***.

5.2 Main state machine

The following figure shows the main state machine of internal synchronous operation (H427 → ***SynchronousState***).



Sub-state machines:

- Startup cycle state machine → Sec. 5.3.3, page 21
- Stop cycle state machine → Sec. 5.4, page 24
- Offset state machine → Sec. 5.5.3, page 25

Fig. 13: Main state machine of internal synchronous operation with sub-state machines

The state machine differentiates between six (6) states saved in the ***SynchronousState*** variable (H427).

State	Description
- *SynchronousState* = 0	Free running n-control → The slave drive can be moved with speed control using H439 (*SpeedFreeMode*), a 64-bit difference counter saves the distortion.
- *SynchronousState* = 1	Free running x-control → The slave drive is held in its current position.
- *SynchronousState* = 2	Engaging phase → Synchronization takes place depending on bit 12 in H411 (*StartupCycleModeControl*).
- *SynchronousState* = 3	"Hard" synchronous operation → The slave drive follows the master drive with angular accuracy.
- *SynchronousState* = 4	Offset → The offset is set depending on bit 12 in H361 (*OffsetCycleModeControl*).
- *SynchronousState* = 5	Disengaging phase → The slave drive is disengaged with the **t11 ramp (P130)**.

Additional functions can be selected using the bits of the ***SynchronousModeControl*** variable (H426):

Bit	Name	Description
0	PosTrim	= 0: Deactivated = 1: During position control in free running mode (main state 1), causes the slave drive to move to *TargetPos* (H492)
1	Lag Error	= 0: Lag error monitoring = 1: No lag error monitoring

5.3 Startup cycle mode control

5.3.1 Time-controlled synchronization process

During the time-controlled synchronization process, the existing position differential between the master and slave drive (64-bit counter) is cancelled out by accelerating or decelerating to the synchronization speed. The time needed depends on the synchronization speed, the synchronization ramp and the lag distance (H434, ***LagDistance32***). The following diagram shows the speed profile of the slave drive during the entire process, e.g. at a constant master speed.

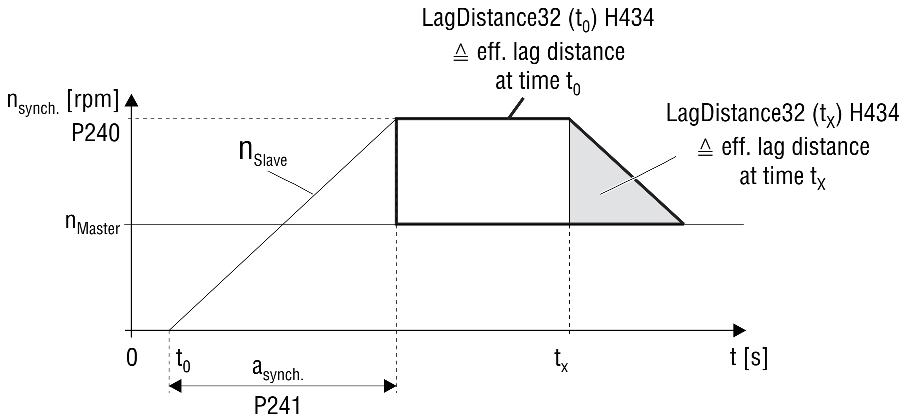


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Fig. 14: Speed profile of the time-controlled synchronization process

The synchronization speed n_{synch} and the synchronization ramp a_{synch} are set using parameters P240 "Synchronization speed" and P241 "Synchronization ramp." These two parameters only have any effect in the time-controlled synchronization process and in time-controlled offset processing.

5.3.2 Travel-dependent synchronization process

In this synchronization mechanism, the slave drive moves in synchronicity with the master drive once the master drive has covered the specified distance. The specified distance must be saved in the ***StartupCycleMasterLength*** system variable (H417), with the value given in increments in relation to the master. The restriction is that the slave drive starts with speed zero.

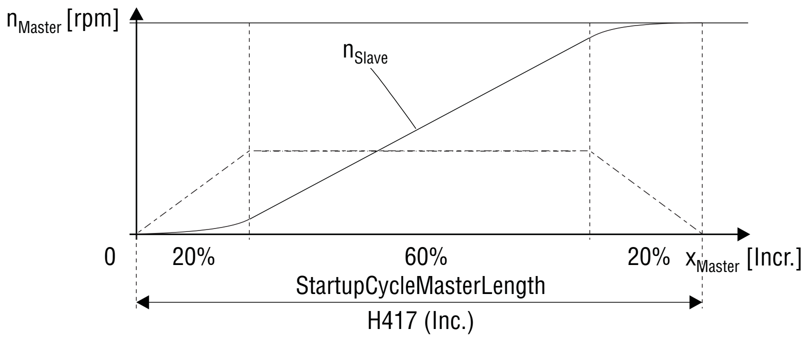

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Fig. 15: Speed profile for the travel-dependent synchronization process

5.3.3 Startup cycle state machine

Startup cycle mode control reacts in the main states Z0 and Z1 (→ Fig. 13). The startup cycle process of the slave to the master can be performed either manually, event-driven or with interrupt control. The startup cycle mode is defined with the ***StartupCycleMode*** system variable (H410). Additional functions can be programmed with the ***StartupCycleModeControl*** system variable (H411).

Variable H410 (*StartupCycleMode*) → engaging mode:

- ***StartupCycleMode*** **= 0:** Manual engaging. The startup cycle process starts when the application assigns the value 2 to the ***SynchronousState*** system variable (H427).
- ***StartupCycleMode*** **= 1:** Event-driven starting of the startup cycle process via binary input. The ***StartupCycleInputMask*** variable (H413) defines which binary input triggers the startup cycle process. The process is started as soon as a "1" level is present at the defined binary input. The terminal latency is 1 ms.

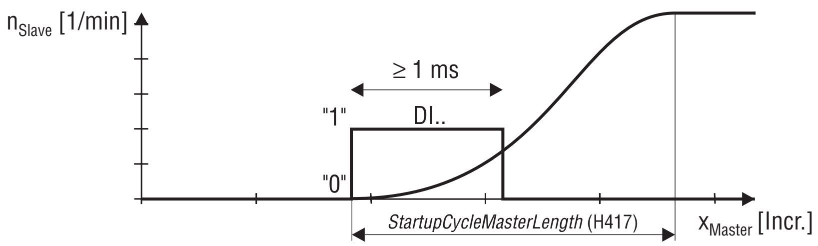

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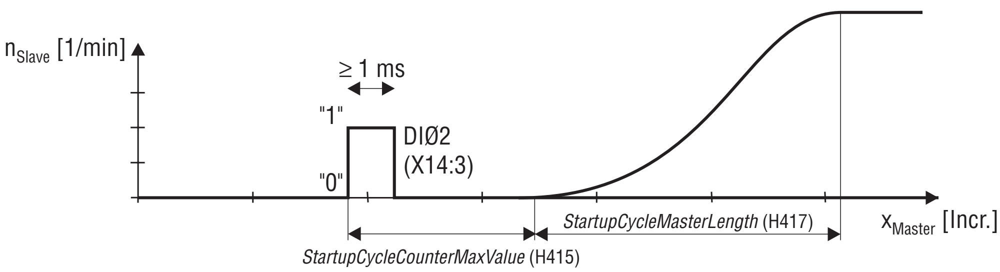
Fig. 16: Event-driven starting of the travel-dependent startup cycle process

- ***StartupCycleMode*** **= 2:** A signal edge at binary input DI02 or on the C track X14:3 triggers the startup cycle process (interrupt-controlled). To do this, binary input DI02 must be programmed to "No function." A delay in relation to the master cycle can be defined for the start of the actual startup cycle process in conjunction with the ***StartupCycleCounterMaxValue*** (H415) variable. The response time of the sensor can be taken into account using the ***StartupCycleDelayDI02*** variable (H416) (1 digit = 0.1 ms). This parameter is also effective for engaging with X14:3 (C track).



03785AXX

Fig. 17: Interrupt-controlled starting of the travel-dependent startup cycle process

Startup cycle state machine in (H412) *StartupCycleState*:

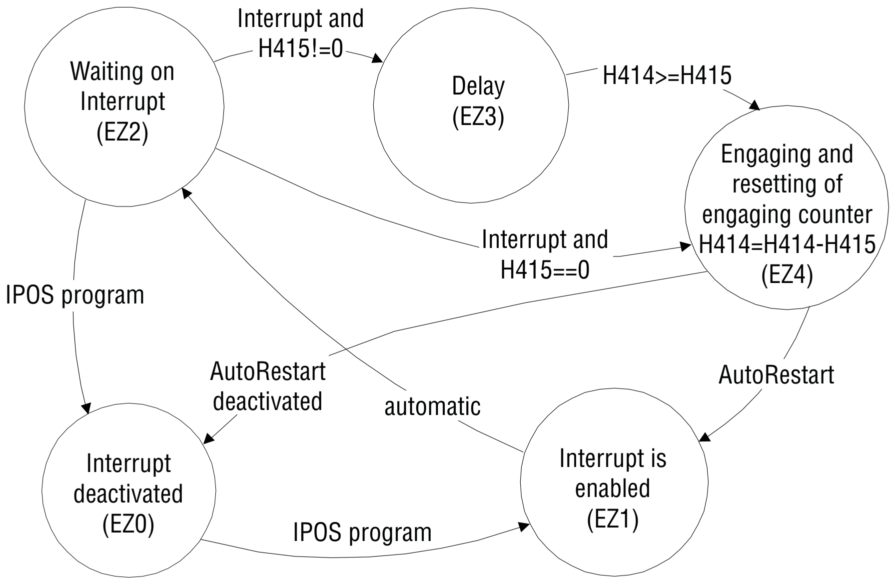


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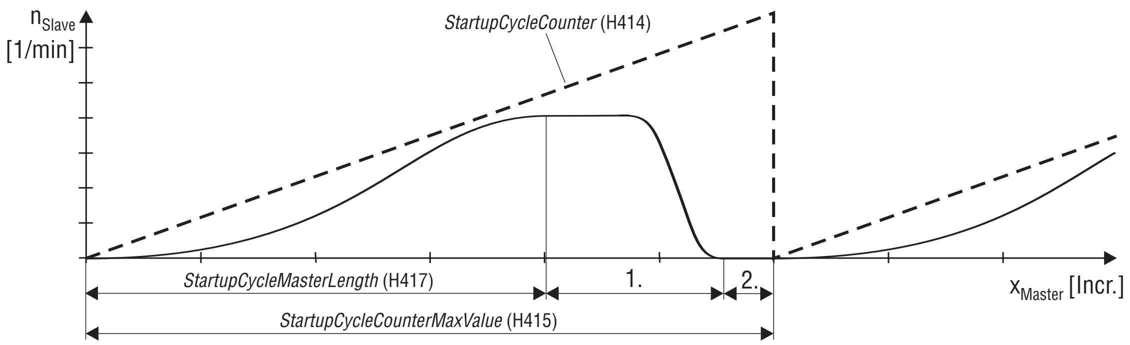
Fig. 18: Startup cycle state machine with interrupt control (engaging mode 2)

- ***StartupCycleMode* = 3:** The startup cycle process is initiated by the ***StartupCycleCounter*** position counter (H414). Engaging takes place automatically if the ***StartupCycleCounter*** value is greater than the ***StartupCycleCounterMaxValue*** counter overrun value (H415). In this case, ***StartupCycleCounterMaxValue*** must be greater than the total number of master encoder pulses in the startup cycle, master cycle and stop cycle.



03786AXX

1. Synchronous operation and stop cycle
2. Slave is disengaged, time for positioning back to the initial position

Fig. 19: Position-controlled starting of the travel-dependent startup cycle process

Startup cycle state machine in (H412) *StartupCycleState*:

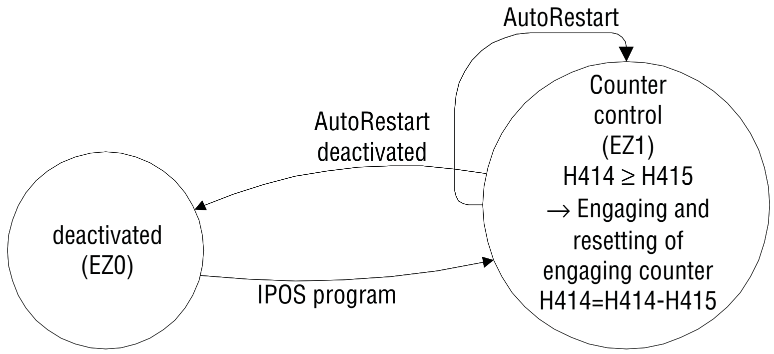


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Fig. 20: Startup cycle state machine with position control (engaging mode 3)

Variable H411 (*StartupCycleModeControl*) → Additional functions:

Bit	Name	Description
0	AutoRestart (***StartupCycleMode 2 and 3***)	= 0: AutoRestart deactivated = 1: AutoRestart activated
1	StartupDisable (***StartupCycleMode 2 and 3***)	= 0: Engaging possible = 1: Engaging inhibited
2	InterruptSelect (***StartupCycleMode 2***)	= 0: DI02 = 1: X14:3 (C track)
12	StartupMode	= 0: Time-controlled synchronization = 1: Travel-dependent synchronization

5.4 Stop cycle state machine

Stop cycle mode control reacts in the main states Z3 and Z4 (→ Fig. 13). The stop cycle process of the slave can either be performed manually or automatically. The stop cycle mode is defined with the *StopCycleMode* system variable (H400). Additional functions can be programmed with the *StopCycleModeControl* system variable (H401).

During disengaging, the drive changes to speed 0 along **ramp t11 (P130)** with x-control; alternatively, with n-control, the drive changes to the speed defined in the *SpeedFreeMode* system variable (H439).

Variable H400 (*StopCycleMode*) → disengaging mode:

- ***StopCycleMode* = 0:** Manual disengaging. The slave ceases synchronous operation with the master when the application assigns the value 5 to the *SynchronousState* system variable (H427).
- ***StopCycleMode* = 1:** Event-driven disengaging via binary input. The *StartupCycleInputMask* variable (H413) defines which binary input triggers the stop cycle process. The process is started as soon as a "1" level is present at the defined binary input. The terminal latency is 1 ms.

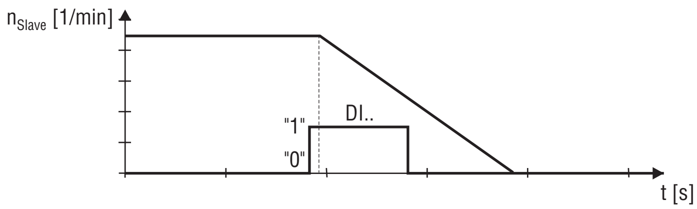

Fig. 21: Event-driven disengaging

Variable H401 (*StopCycleModeControl*) → Additional functions:

Bit	Name	Description
0	FreeMode	= 0: Disengaging in main state 0 (n-control) = 1: Disengaging in main state 1 (x-control)

5.5 Offset control

5.5.1 Time-controlled offset processing

In this state, an offset is added to the difference counter (H367, *OffsetCycleValue*). The slave drive moves an offset by the reduction in the angle differential to zero (time-controlled synchronization → Sec. 5.3.1).

5.5.2 Travel-dependent offset processing

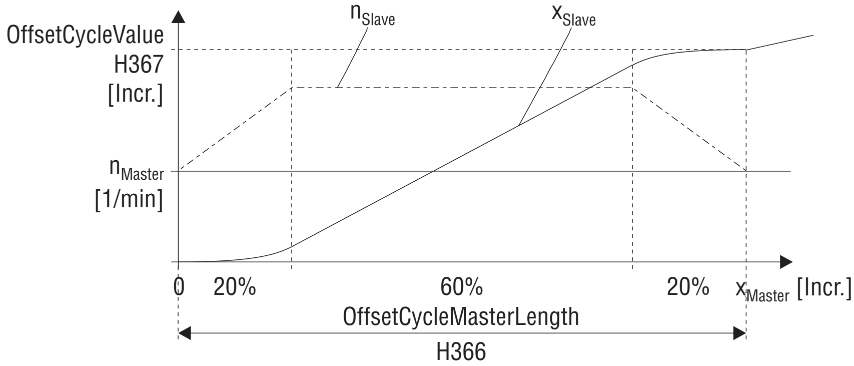

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Fig. 22: Speed profile for travel-dependent offset processing

The slave drive is subject to an offset in this state after the master drive has covered the value entered in the *OffsetCycleMasterLength* system variable (H366). The offset value must be stored in the *OffsetCycleValue* system variable (H367).

State 3 (synchronous operation) is a prerequisite for this process.

5.5.3 Offset state machine

Offset control only reacts to required events in main state Z3 (synchronous operation). The setting is made using the ***OffsetCycleMode*** system variable (H360). Additional functions can be programmed with the ***OffsetCycleModeControl*** system variable (H361).

Variable H360 (*OffsetCycleMode*) → Offset mode:

- ***OffsetCycleMode* = 0:** Manual offset processing using the IPOS program by setting H427 (*SynchronousState*) to the value 4.
- ***OffsetCycleMode* = 1:** Offset processing using binary inputs ("1" level) with H363 (*OffsetCycleInputMask*) with a resolution of 1 ms.

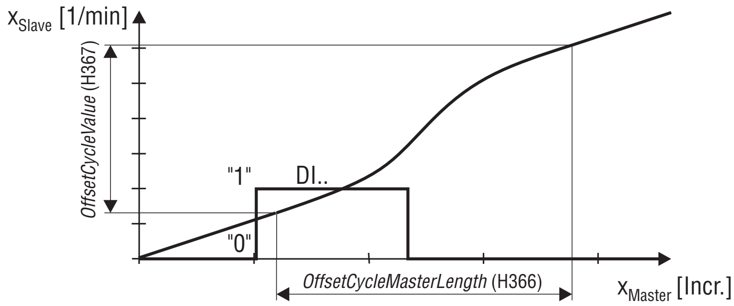

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Fig. 23: Travel-dependent offset processing controlled by binary inputs

- ***OffsetCycleMode* = 2:** Reserved
- ***OffsetCycleMode* = 3:** Position control in conjunction with variables H364 (*OffsetCycleCounter*) and H365 (*OffsetCycleCounterMaxValue*), with remaining distance carryover.

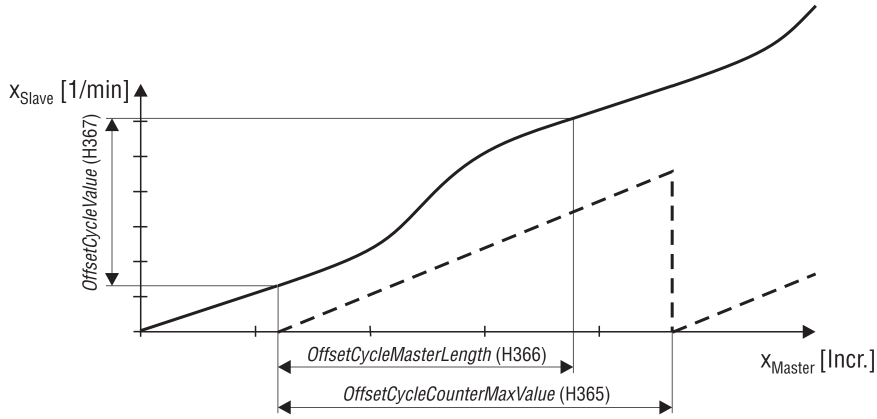

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Fig. 24: Position-controlled, travel-dependent offset processing

Variable H361 (*OffsetCycleModeControl*) → Additional functions:

Bit	Name	Description
0	AutoRestart (***OffsetCycleMode 3***)	= 0: AutoRestart deactivated = 1: AutoRestart activated
1	OffsetDisable (***OffsetCycleMode 3***)	= 0: Offset processing possible = 1: Offset processing inhibited
12	OffsetMode	= 0: Time-controlled offset processing = 1: Travel-dependent offset processing

Offset state machine in H362 (*OffsetCycleState*):

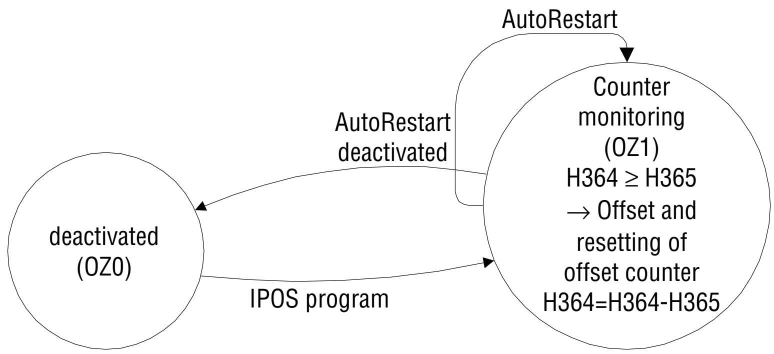

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Fig. 25: Offset state machine

5.6 Synchronous operation

Control takes place with a P-controller (P910 "Gain X controller"). The master and slave pulses are evaluated with the corresponding weighting factors and added to a 64-bit value after comparison. The P-controller together with the feedforward (P228 "Feedforward filter") and subsequent limiting to the maximum speed forms the speed setpoint for the speed controller.

A control element has been added in order to avoid the loss of master increments during the transition from travel-dependent synchronization to synchronous operation. With this element, a differential increment value (H389 → *RegisterLoopOut*) in each sampling step is added to the 64-bit difference counter by a certain number of increments (H390 → *RegisterLoopDXDTOut*). The element only takes effect in main state Z3 (synchronous operation) and can be described directly by the user.

Block diagram for internal synchronous operation:

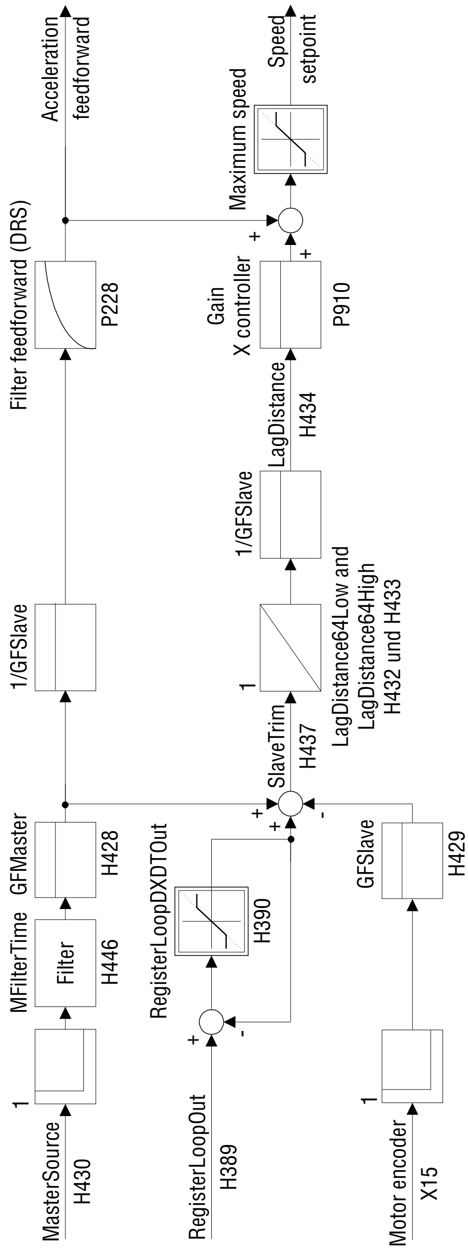

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Fig. 26: Block diagram for internal synchronous operation

5.7 Virtual encoder

5.7.1 Virtual encoder without ramp generator

The ***MasterTrimX14*** IPOS variable (H442) represents the most simple variant of a virtual encoder. If the physical encoder is activated (assignment H430 = 0), then k pulses are physically added to the master encoder every millisecond, observing the correct sign, by assigning ***MasterTrimX14*** = k.

Important: X14 can no longer be used as an encoder simulation if you are using the virtual encoder.

5.7.2 Virtual encoder with ramp generator

The virtual encoder (→ IPOS variables H370 – H377) is a software counter which can be used as the master encoder for synchronous operation. (Assignment of ***MasterSource*** **H430 = 376**.) A system bus connection (SCOM command) enables this software counter to be transferred to other MOVIDRIVE® axes by the "generator" of the virtual encoder. To do this, it is necessary to have SBus synchronization with the synch-ID (P817) for unit synchronization (every 5 ms).

The virtual encoder operates in a 1 ms cycle and is processed independently of the current synchronous operation state. It creates a travel profile depending on the traveling velocity (H373) and the set ramp (H377). The virtual encoder is started by assigning a value other than the actual position (H376) to the target position (H375). The virtual encoder is stopped (*VEncoderMode* = 0) when the *VEncoderXActual* value (H374) reaches the *VEncoderXSetpoint* value (H375).

H375 = [VEncoderXSetpoint]	= 1 "master pulse"	Target position
H376 = [VEncoderXActual]	= 1 "master pulse"	Actual position
H373 = [VEncoderNSetpoint]	= 1 "master pulse"/ms	Set speed
H374 = [VEncoderNActual]	= 1 "master pulse"/ms	Actual speed
H377 = [VEncoderdNdT]	= 1 "master pulse"/ms^2	Acceleration

Selecting the operating mode of the encoder in variable H370 (*VEncoderMode*):

- *VEncoderMode = 0:* Normal mode (specified by the travel profile programmed using variables H373, H375 and H377)
- *VEncoderMode = 1:* Reserved
- *VEncoderMode = 2:* Endless counter with travel speed *VEncoderNSetpoint* and set ramp *VEncoderdNdT*

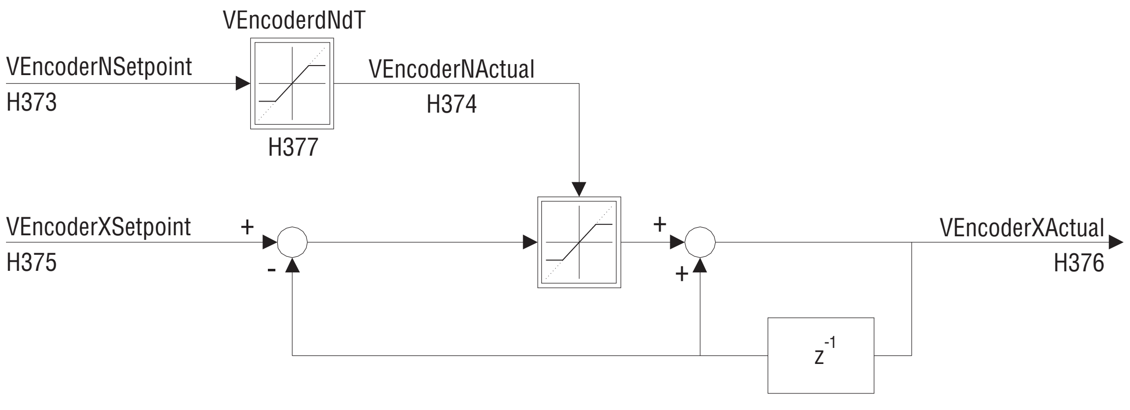

Fig. 27: Structural image of virtual encoder with ramp generator

Variable H371 (*VEncoderModeControl*):

Bit	Name	Value 0	Value 1
0	AxisStop	Axis stop deactivated	The value of *VEncoderNSetpoint* (H373) is set to 0 (stop of the virtual axis) once after a unit fault occurs.

5.8 Important notes

- The possibility of specifying a signed distance in variable H417 (StartupCycleMasterLength) or H366 (*OffsetCycleMasterLength*) for the master drive means it is important to check the direction of rotation of the master drive. In addition, the gear factor in variable H428 (*GFMaster*) can also be entered as a signed value.

- A lag error is only triggered (**P923 "Lag error window"**) in main state Z3 (synchronous operation).

- The 64-bit counter can be cleared by programming the terminals with "Set DRS zero point". This step disconnects the master branch if the drive is in main state Z3 (synchronous operation).

- A value other than zero should be entered in variable H390 (*RegisterLoopDXDTOut*) in order to achieve exact results in travel-dependent synchronization. This is so the remaining travel can be reduced to zero.

- **P910 "Gain X controller":** This parameter is set to its optimum value during startup with MOVITOOLS®.

- P228 "Feedforward filter (DRS)": Setpoint filter for feedforward of internal synchronous operation control. Factory setting = 0 = Filter has no effect. Recommended setting = 10 ms.

- The ***MFilterTime*** variable (H446) acts for interpolation of the incoming master pulses. Increasing it causes the weighting of the master pulses to be changed. A correction can be made by multiplying the ***GFSlave*** variable (H429) with the ***MFilterTime*** variable (H446), for example.

- Absolute master gear factor = ***GFMaster*** (H428) × ***MFilterTime*** (H446)
  Make sure the result does not exceed 32767.

6 System Variables of Internal Synchronous Operation

Variable	Name and range of values	Status	Description
			Offset control
H360	OffsetCycleMode 0 to 3	R/W	Offset mode = 0: Offset via IPOS program = 1: Offset via input terminals = 2: Reserved = 3: Offset via position control
H361	OffsetCycleModeControl	R/W	Activation of various functions Bit 0: AutoRestart (in mode 3) = 0: AutoRestart deactivated = 1: AutoRestart activated Bit 1: OffsetDisable (in mode 3) = 0: Offset processing possible = 1: Offset processing inhibited Bit 12: OffsetMode = 0: Time-controlled offset processing = 1: Travel-dependent offset processing
H362	OffsetCycleState Max. 0 to 1 (depending on OffsetCycleMode)	R/W	Control of the various modes
H363	OffsetCycleInputMask	R/W	Terminal window (identical to H483 "InputLevel")
H364	OffsetCycleCounter	R/W	Master counter for offset processing
H365	OffsetCycleCounterMaxValue	R/W	In mode 3: Length limit for automatic offset processing
H366	OffsetCycleMasterLength	R/W	Specified distance for the master drive in offset processing
H367	OffsetCycleValue	R/W	Offset value for slave drive
			Virtual encoder
H370	VEncoderMode 0 to 2	R/W	Virtual encoder operating mode = 0: Normal mode = 1: Reserved = 2: Infinite counter
H371	VEncoderModeControl	R/W	Bit 0: AxisStop = 0: Deactivated = 1: Axis stop on unit fault
H372	VEncoderState	R/W	No function
H373	VEncoderNSetpoint	R/W	Set travel speed in 1 incr./ms
H374	VEncoderNActual	R/W	Actual travel speed in 1 incr./ms
H375	VEncoderXSetpoint	R/W	Target position in incr.
H376	VEncoderXActual	R/W	Current position in incr.
H377	VEncoderdNdT	R/W	Acceleration (ramp) in 1 incr./ms^2
			Control element
H389	RegisterLoopOut	R/W	The value to be reduced in connection with RegisterLoopDXDTOut
H390	RegisterLoopDXDTOut	R/W	Control element limit Max. addition (64-bit counter) per ms

Variable	Name and range of values	Status	Description
Stop cycle mode control			
H400	StopCycleMode 0 to 1	R/W	Stop cycle mode = 0: Disengaging via IPOS program = 1: Disengaging via input terminals
H401	StopCycleModeControl	R/W	Activation of various functions Bit 0: FreeMode = 0: Disengaging in main state 0 (n-control) = 1: Disengaging in main state 1 (x-control)
H402	StopCycleState		No function
H403	StopCycleInputMask	R/W	Terminal window (identical to H483 "InputLevel")
Startup cycle mode control			
H410	StartupCycleMode 0 to 3	R/W	Startup cycle mode = 0: Engaging via IPOS program = 1: Engaging via input terminals = 2: Engaging via interrupt control = 3: Engaging via position control
H411	StartupCycleModeControl	R/W	Activation of various functions Bit 0: AutoRestart (in mode 2 and 3) = 0: AutoRestart deactivated = 1: AutoRestart Bit 1: StartupDisable (in mode 2 and 3) = 0: Engaging possible = 1: Engaging inhibited Bit 2: InterruptSelect (in mode 2) = 0: DI02 = 1: X14C track Bit 12: StartupMode = 0: Time-controlled synchronization = 1: Travel-dependent synchronization
H412	StartupCycleState Max. 0 to 3 (depending on mode)	R/W	Control of the various modes
H413	StartupCycleInputMask	R/W	Terminal window (identical to H483 "InputLevel")
H414	StartupCycleCounter	R/W	Master counter for engaging
H415	StartupCycleCounterMaxValue	R/W	In mode 2: Delay for startup cycle process In mode 3: Length limit for automatic engaging
H416	StartupCycleDelayDI02 -32768 to 32767	R/W	Delay in units of 0.1 ms Delay time of the sensor connected to touch-probe input 2
H417	StartupCycleMasterLength	R/W	Specified distance for the master drive in travel-dependent engaging

Variable	Name and range of values	Status	Description
			General variables
H425	SynchronousMode		No function
H426	SynchronousModeControl	R/W	Activation of various functions Bit 0: PosTrim (only active in main state Z1 "X-control") = 0: Activated = 1: Movement to *TargetPos* (H492) Bit 1: LagError (in state 3 → Synchronous operation) = 0: Lag error monitoring = 1: No lag error monitoring
H427	SynchronousState 0 to 5	R/W	Main state machine integrated synchronous operation = 0: Free running n-control = 1: Free running x-control = 2: Engaging = 3: Synchronous operation = 4: Offset processing = 5: Disengaging
H428	GFMaster -32768 to 32767	R/W	Weighting factor of the master increments, value = i_S
H429	GFSlave 1 to 32767	R/W	Weighting factor of the slave increments, value = i_M
H430	MasterSource 0 to 511	R/W	Source of the master increments = 0: X14 + Virtual axis (H442) > 0: Pointer to variable
H431	Reserved1		
H432	LagDistance64Low	R/-	Low 32 bits of the 64-bit counter
H433	LagDistance64High	R/-	High 32 bits of the 64-bit counter
H434	LagDistance32	R/-	32-bit lag distance in relation to GFSlave
H435	Reserved2		
H436	Reserved3		
H437	SlaveTrim	R/W	Current position setpoint of the slave drive
H438	XMasterPos	R/-	Display value of the master counter during startup cycle process and during offset processing
H439	SpeedFreeMode	R/W	Speed setpoint in free running n-control in 0.2 rpm
H440	Reserved4		
H441	Reserved5		
H442	MasterTrimX14 -32768 to 32767	R/W	Virtual axis Pulse number 1 incr./ms
H443	Reserved6		
H444	ReSprintClose 0 to 2	R/W	Direction of rotation inhibit = 0: Enable both directions of rotation = 1: Only CCW direction of rotation = 2: Only CW direction of rotation
H445	Reserved7		
H446	MFilterTime 1 to 30	R/W	Interpolation time in ms = 1: Without filter ≤ 30: Scaling up, absolute weighting factor of the master pulses = GFMaster × MFilterTime

7 Sample IPOS Programs

7.1 Example 1:

Objective:

A slave drive is to be operated at a synchronous angle to a master drive. The gear units used in this case are the same. The gear ratio is 1:1. The master and slave inverters are connected via X14. Control of the slave inverter is via the binary inputs. Binary inputs X13:5 (DIØ4) and X13:6 (DIØ5) should be used for controlling the startup and stop cycle processes. Both binary inputs must be programmed to "NO FUNCTION."

- "1" signal on DIØ4 → The startup cycle process is started. The startup cycle process should be travel-dependent and completed after 10,000 master increments.
- "1" signal on DIØ5 → The stop cycle process is started.

The necessary IPOS system variables are set in the initialization function.

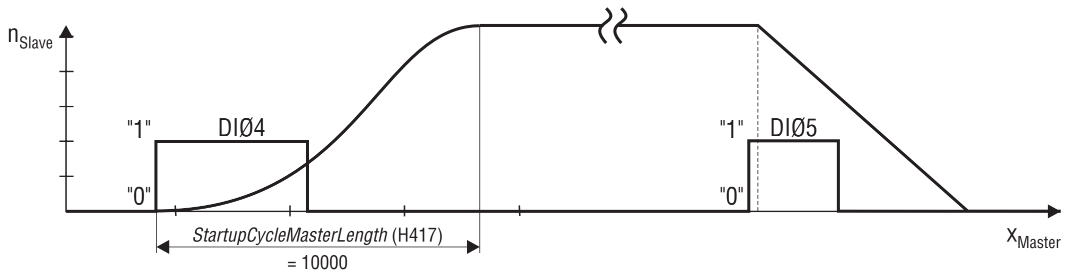

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Fig. 28: Event-driven engaging and disengaging

IPOS program:

```
/*=============================================
             IPOS source file
       for Synchronous Drive Control
  --------------------------------------------
          SEW-Eurodrive GmbH & Co.
           Ernst-Blickle-Str. 42
             D-76646 Bruchsal

            sew@sew-eurodrive.de
         http://www.SEW-EURODRIVE.de
===============================================*/
#pragma  var        300  309
#pragma  globals    310  349

#include <const.h>
#include <Example01.h>             // Header file with
                                   // variable designations
                                   // and initialization function

/*=============================================
       Main function (IPOS start function)
===============================================*/
main()
  {

  /*-------------------------------------
       Startup
  --------------------------------------*/
  InitSynchronization();           // Call the initialization function

  /*-------------------------------------
       Main program loop
  --------------------------------------*/
  while(1)
    {
    }
  }
```

Header file with variable designation:

```
/*****************************************************************
Example01.h
Data and startup header file for IPOS+ Compiler.
For startup after power on call "InitSynchronization();"
Datafile Movidrive Synchronous Drive Control  Version 1.0
******************************************************************/

#define  SynchronousMode            H425
#define  SynchronousModeControl     H426
#define  SynchronousState           H427
#define  GFMaster                   H428
#define  GFSlave                    H429
#define  MasterSource               H430
#define  Reserved1                  H431
#define  LagDistance64Low           H432
#define  LagDistance64High          H433
#define  LagDistance32              H434
#define  Reserved2                  H435
#define  Reserved3                  H436
#define  SlaveTrim                  H437
#define  XMasterPos                 H438
#define  SpeedFreeMode              H439
#define  Reserved4                  H440
#define  Reserved5                  H441
#define  MasterTrimX14              H442
#define  Reserved6                  H443
```

```
#define  ReSprintClose               H444
#define  Reserved7                   H445
#define  MFilterTime                 H446

// Variables for StartupCycle, StopCycle and OffsetCycle
#define StopCycleMode                H400
#define StopCycleModeControl         H401
#define StopCycleState               H402
#define StopCycleInputMask           H403

#define StartupCycleMode             H410
#define StartupCycleModeControl      H411
#define StartupCycleState            H412
#define StartupCycleInputMask        H413
#define StartupCycleCounter          H414
#define StartupCycleCounterMaxValue H415
#define StartupCycleDelayDI02        H416
#define StartupCycleMasterLength     H417

#define OffsetCycleMode              H360
#define OffsetCycleModeControl       H361
#define OffsetCycleState             H362
#define OffsetCycleInputMask         H363
#define OffsetCycleCounter           H364
#define OffsetCycleCounterMaxValue   H365
#define OffsetCycleMasterLength      H366
#define OffsetCycleValue             H367

// variables to Register Control
#define RegisterLoopOut              H389
#define RegisterLoopDXDTOut          H390

// Variables for Virtual Encoder
#define VEncoderMode                 H370
#define VEncoderModeControl          H371
#define VEncoderState                H372
#define VEncoderNSetpoint            H373
#define VEncoderNActual              H374
#define VEncoderXSetpoint            H375
#define VEncoderXActual              H376
#define VEncoderdNdT                 H377


// Startup data from: 08.08.2000 - 16:35:22
InitSynchronization()
{
  for (H0=128; H0<=457; H0++)              // Reset variables greater than H128
  {
    *H0=0;
  }
  _Memorize(MEM_LDDATA);
  _Wait(100);

  GFMaster                        = 1;      // Evaluation of master increments
  GFSlave                         = 1;      // Evaluation of slave increments
  MFilterTime                     = 1;      // Processing of master incr. w/o filter
  StartupCycleMode                = 1;      // Startup cycle mode 1: Event-driven starting
                                          // of the startup cycle process via binary input
  StartupCycleInputMask           = 16;     // Selection of terminal DI04 for engaging
  StartupCycleMasterLength       = 10000;  // Length of master travel until engag.finished
  _BitSet(StartupCycleModeControl, 12);    // Sel. of "travel-dep. startup cycle process"
  RegisterLoopDXDTOut             = 2;      // Limiting of correction mechanism
  StopCycleMode                   = 1;      // Stop cycle mode 1: Event-driven starting
                                            // of the stop cycle process via binary input
  StopCycleInputMask              = 32;     // Selection of terminal DI05 for disengaging
}
```

7.2 Example 2:

Objective:

Extruded material is to be cut off using a flying saw. The travel increments of the extruded material are used as master increments at input X14 of the saw feed drive = slave drive. The slave drive waits in its start position. The startup cycle process is initiated with position control by the StartupCycleCounter position counter (H414). The extruded material is sawn during synchronous operation. The slave drive disengages after the sawing operation and moves back to its start position. The gear ratio is 1:1.

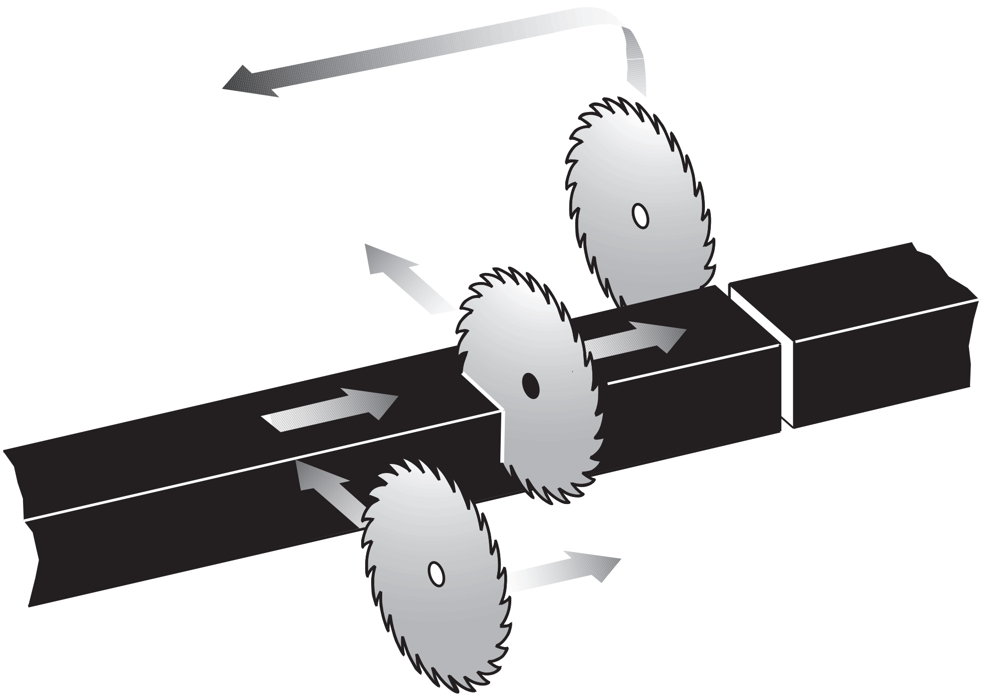

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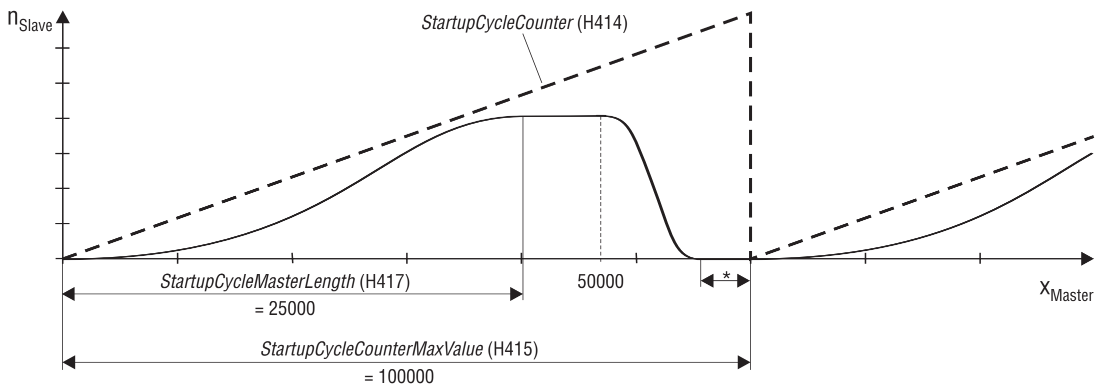
Fig. 29: Flying saw



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* Slave is disengaged

Fig. 30: Position-controlled starting of the startup cycle process

Important notes:

- Reference travel type 3 (P903) is set for reference travel.
- The reference offset (P900) is set to 300,000, for example.
- The CW and CCW limit switches must have their parameters set and must be connected.

IPOS program:

```
/*=============================================
            IPOS source file
       for Synchronous Drive Control
  --------------------------------------------
          SEW-Eurodrive GmbH & Co.
           Ernst-Blickle-Str. 42
             D-76646 Bruchsal

            sew@sew-eurodrive.de
         http://www.SEW-EURODRIVE.de
===============================================*/
#pragma  var        300  309
#pragma  globals    310  349

#include <const.h>
#include <io.h>
#include <Example02.h>                          // Header file with
                                                // variable designations
                                                // and initialization function

#define LINEAR           0                      // Positioning with linear ramp
#define SYNCHRONLAUF     6                      // Internal synchronous operation

#define Halt      _BitSet(ControlWord, 2)       // CW bit is set
#define Freigabe  _BitClear(ControlWord, 2)     // CW bit is canceled

long Rampenform, tmp;

/*=============================================
   Main function (IPOS start function)
===============================================*/
main()
  {

  /*-------------------------------------
                Startup
  --------------------------------------*/
  InitSynchronization();                        // Call up initialization function

  Rampenform=LINEAR;                            // Positioning ramp
  _SetSys(SS_RAMPTYPE, Rampenform);

  while (!DI00);                       // Wait for high level on DI00 "/Controller inhibit"

  _Go0(GO0_C_W_ZP);                      // Referencing with ref. type 3 / CW limit switch
                                             // P900 "Reference offset": 300000 increments
  _GoAbs(GO_WAIT, 0);                           // Move to start position

  Rampenform=SYNCHRONLAUF;                      // Activate internal synchronous operation
  _SetSys(SS_RAMPTYPE, Rampenform);

  StartupCycleCounter = 0;                      // Reset counter
  StartupCycleState = 1;                        // Activate startup cycle mode control

  /*-------------------------------------
          Main program loop
  --------------------------------------*/
  while(1)
    {
     tmp=StartupCycleCounter;                   // Save engagement counter in temp. memory
     if ((tmp>50000)&&(SynchronousState==3))    // Switchover ramp function,
                                                // if counter > 50,000 master incr.
                                                // and drive in synchronous operation
     {
        Halt;                                   // Inhibit drive
        SynchronousState=5;                     // Disengage (in position control)
        Rampenform=LINEAR;                      // Positioning ramp
        _SetSys(SS_RAMPTYPE, Rampenform);
```

```
        Freigabe;                            // Enable drive
        _GoAbs(GO_WAIT, 0);                  // Move to start position
        Halt;                                // Inhibit drive
        Rampenform=SYNCHRONLAUF;             // Activate internal synchronous operation
        _SetSys(SS_RAMPTYPE, Rampenform);
        Freigabe;                            // Enable drive
     }
    }
  }
```

Header file with variable designation:

```
/*****************************************************************
Example02.h
Data and startup header file for IPOS+ Compiler.
For startup after power on call "InitSynchronization();"
Datafile Movidrive Synchronous Drive Control  Version 1.0
*******************************************************************/

#define  SynchronousMode            H425
#define  SynchronousModeControl     H426
#define  SynchronousState           H427
#define  GFMaster                   H428
#define  GFSlave                    H429
#define  MasterSource               H430
#define  Reserved1                  H431
#define  LagDistance64Low           H432
#define  LagDistance64High          H433
#define  LagDistance32              H434
#define  Reserved2                  H435
#define  Reserved3                  H436
#define  SlaveTrim                  H437
#define  XMasterPos                 H438
#define  SpeedFreeMode              H439
#define  Reserved4                  H440
#define  Reserved5                  H441
#define  MasterTrimX14              H442
#define  Reserved6                  H443
#define  ReSprintClose              H444
#define  Reserved7                  H445
#define  MFilterTime                H446

// Variables for StartupCycle, StopCycle and OffsetCycle
#define StopCycleMode               H400
#define StopCycleModeControl        H401
#define StopCycleState              H402
#define StopCycleInputMask          H403

#define StartupCycleMode            H410
#define StartupCycleModeControl     H411
#define StartupCycleState           H412
#define StartupCycleInputMask       H413
#define StartupCycleCounter         H414
#define StartupCycleCounterMaxValue H415
#define StartupCycleDelayDI02       H416
#define StartupCycleMasterLength    H417

#define OffsetCycleMode             H360
#define OffsetCycleModeControl      H361
#define OffsetCycleState            H362
#define OffsetCycleInputMask        H363
#define OffsetCycleCounter          H364
#define OffsetCycleCounterMaxValue  H365
#define OffsetCycleMasterLength     H366
#define OffsetCycleValue            H367

// Variables to Register Control
#define RegisterLoopOut             H389
```

```
#define RegisterLoopDXDTOut         H390

// Variables for Virtual Encoder
#define VEncoderMode                H370
#define VEncoderModeControl         H371
#define VEncoderState               H372
#define VEncoderNSetpoint           H373
#define VEncoderNActual             H374
#define VEncoderXSetpoint           H375
#define VEncoderXActual             H376
#define VEncoderdNdT                H377


// Startup data from: 08.08.2000 - 15:54:37
InitSynchronization()
{
  for (H0=128; H0<=457; H0++)              // Reset variables greater than H128
  {
    *H0=0;
  }
  _Memorize(MEM_LDDATA);
  _Wait(100);

  GFMaster                       = 1;       // Evaluation of master increments
  GFSlave                        = 1;       // Evaluation of slave increments
  MFilterTime                    = 1;       // Processing of master incr. w/o filter
  StartupCycleMode               = 3;       // Startup cycle mode 3: Position-controlled
                                             starting of
                                          //  engaging by overrun of the engaging counter
  _BitSet(StartupCycleModeControl, 0);     // AutoRestart of startup cycle proc. activated
  StartupCycleCounterMaxValue    = 100000; // Overrun value of the engaging counter
  StartupCycleMasterLength      = 25000;  // Length of master travel until engag.finished
  _BitSet(StartupCycleModeControl, 12);    // Sel. of "travel-dep. startup cycle process"
  RegisterLoopDXDTOut            = 2;      // Limiting of correction mechanism
  _BitSet(StopCycleModeControl, 0);        // Disengaging in main state 1 (x-control)
  _BitSet(SynchronousModeControl, 0);      // "Movement to TargetPos (H492)" activated
  _BitSet(SynchronousModeControl, 1);      // No lag error monitoring
}
```

7.3 Example 3:

Objective:

A slave drive is to be operated at a synchronous angle to a master drive. The gear units used in this case are the same. The gear ratio is 1:1. The master and slave inverters are connected via SBus. Control of the slave inverter is via the binary inputs. Binary inputs X13:5 (DIØ4) and X13:6 (DIØ5) should be used for controlling the startup and stop cycle processes. Both binary inputs must be programmed to "NO FUNCTION."

- "1" signal on DIØ4 → The startup cycle process is started. The startup cycle process should be travel-dependent and completed after 10,000 master increments.
- "1" signal on DIØ5 → The stop cycle process is started.

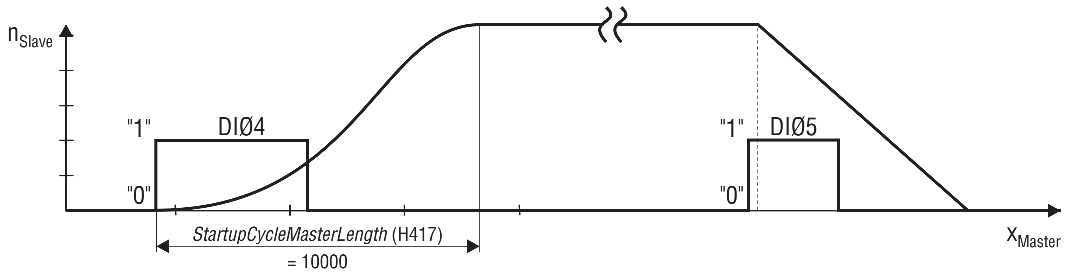

Fig. 31: Event-driven engaging and disengaging

The necessary IPOS system variables are set in the initialization function.

Two transmit data objects (master position H511 and synchronization ID) are set up in the main program of the master inverter and sent on the SBus when cyclical data transmission starts.

One receive data object for the master position sent on the SBus is set up in the main program of the slave inverter and cyclical data transmission is started.

The master and slave inverters must have different SBus addresses (P813).

Note the following settings on the master inverter:

- The number of the "Synchronization ID" transmit object must not be the same as parameter value P817.
- The "Cycle time" in the SCOM command for the synchronization ID must be 5 ms.
- The "Cycle time" in the SCOM command for the master position must be 1 ms.

Note the following settings on the slave inverter:

- The P817 parameter value must be the same as the number of the "Synchronization ID" transmit object.
- The H430 MasterSource system variable must be the same as the value of the D pointer (→ SCOM command structure).

In contrast to the X14 – X14 connection (example 1), it is possible to implement cable-break monitoring with the SBus connection (→ Timeout error).

IPOS program master inverter:

```
/*=============================================
              IPOS source file
===============================================*/
#include <const.h>

  SCTRCYCL Position;                 // SEW standard structure for the _SbusCommDef
statement
  SCTRCYCL SynchID;

/*=============================================
   Main function (IPOS initial function)
===============================================*/
main()
  {

  /*-------------------------------------
             Initialization
  --------------------------------------*/

  SynchID.ObjectNo=1090;             // Describe the SEW standard structure:
  SynchID.CycleTime=5;               // Data object no. 1090 (sync telegram to be sent)
  SynchID.Offset=0;                  // is sent on the SBus (cycle time 5 ms)
  SynchID.Format=0;
  SynchID.DPointer=0;
  SynchID.Result=0;

  Position.ObjectNo=1100;            // Describe the SEW standard structure:
  Position.CycleTime=1;              // Data obj.no. 1100 (32-bit master pos. to send/H511)
  Position.Offset=0;                 // is sent on SBus (cycle time 1 ms, MOTOROLA format)
  Position.Format=4;
  Position.DPointer=511;
  Position.Result=0;

  _SBusCommDef(SCD_TRCYCL, SynchID); // Setting up the transmit data objects
                                     // for cyclical data transmission using
  _SBusCommDef(SCD_TRCYCL, Position);// an SBus connection

  _SBusCommOn();                     // Initialization of the send data objects and
                                     // start of cyclical data transmission via SBUS

  /*-------------------------------------
        Main program loop
  --------------------------------------*/
  while(1)
    {
    }
  }
```

IPOS program slave inverter:

```
/*=============================================
              IPOS source file
       for Synchronous Drive Control
  ---------------------------------------------
          SEW-Eurodrive GmbH & Co.
           Ernst-Blickle-Str. 42
             D-76646 Bruchsal

            sew@sew-eurodrive.de
         http://www.SEW-EURODRIVE.de
==============================================*/
#pragma  var        300  309
#pragma  globals    310  349

#include <const.h>
#include <Example03.h>              // Header file with
                                    // variable designations
                                    // and initialization function

SCREC Position;                     // SEW standard structure for the _SBusCommDef
statement

/*=============================================
   Main function (IPOS start function)
==============================================*/
main()
  {

  /*-------------------------------------
                  Startup
  --------------------------------------*/
  InitSynchronization();            // Call up initialization function

  Position.ObjectNo=1100;           // Describe the SEW standard structure:
  Position.Format=4;               // Data obj.no. 1100 (32-bit master pos. to be recvd.)
  Position.DPointer=200;            // is sent to variable H200


  _SBusCommDef(SCD_REC, Position);  // Setting up a receive data object
                                    // for cyclical data transmission using
                                    // an SBus connection

  _SBusCommOn();                    // Initialization of the receive data object and
                                    // start of cyclical data transmission via SBUS




  /*-------------------------------------
            Main program loop
  --------------------------------------*/
  while(1)
    {


    }

  }
```

Header file with variable designation:

```
/*****************************************************************
Example03.h
Data and startup header file for IPOS+ Compiler.
For startup after power on call "InitSynchronization();"
Datafile Movidrive Synchronous Drive Control  Version 1.0
*****************************************************************/

#define  SynchronousMode            H425
#define  SynchronousModeControl     H426
#define  SynchronousState           H427
#define  GFMaster                   H428
#define  GFSlave                    H429
#define  MasterSource               H430
#define  Reserved1                  H431
#define  LagDistance64Low           H432
#define  LagDistance64High          H433
#define  LagDistance32              H434
#define  Reserved2                  H435
#define  Reserved3                  H436
#define  SlaveTrim                  H437
#define  XMasterPos                 H438
#define  SpeedFreeMode              H439
#define  Reserved4                  H440
#define  Reserved5                  H441
#define  MasterTrimX14              H442
#define  Reserved6                  H443
#define  ReSprintClose              H444
#define  Reserved7                  H445
#define  MFilterTime                H446

// Variables for StartupCycle, StopCycle and OffsetCycle
#define StopCycleMode               H400
#define StopCycleModeControl        H401
#define StopCycleState              H402
#define StopCycleInputMask          H403

#define StartupCycleMode            H410
#define StartupCycleModeControl     H411
#define StartupCycleState           H412
#define StartupCycleInputMask       H413
#define StartupCycleCounter         H414
#define StartupCycleCounterMaxValue H415
#define StartupCycleDelayDI02       H416
#define StartupCycleMasterLength    H417

#define OffsetCycleMode             H360
#define OffsetCycleModeControl      H361
#define OffsetCycleState            H362
#define OffsetCycleInputMask        H363
#define OffsetCycleCounter          H364
#define OffsetCycleCounterMaxValue  H365
#define OffsetCycleMasterLength     H366
#define OffsetCycleValue            H367

// Variables to Register Control
#define RegisterLoopOut             H389
#define RegisterLoopDXDTOut         H390

// Variables for Virtual Encoder
#define VEncoderMode                H370
#define VEncoderModeControl         H371
#define VEncoderState               H372
#define VEncoderNSetpoint           H373
#define VEncoderNActual             H374
#define VEncoderXSetpoint           H375
#define VEncoderXActual             H376
#define VEncoderdNdT                H377
```

```
// Startup data from: 08.08.2000 - 16:14:58
InitSynchronization()
{
  for (H0=128; H0<=457; H0++)              // Reset variables greater than H128
  {
    *H0=0;
  }
  _Memorize(MEM_LDDATA);
  _Wait(100);

  GFMaster                         = 1;      // Evaluation of master increments
  GFSlave                          = 1;      // Evaluation of slave increments
  MasterSource                     = 200;    // Source of master increments:
                                             // Variable H200 "Master position" (via SBus)
  MFilterTime                      = 1;      // Processing of master incr. w/o filter
  StartupCycleMode                 = 1;      // Startup cycle mode 1: Event-driven starting
                                           // of the startup cycle process via binary input
  StartupCycleInputMask            = 16;     // Selection of terminal DI04 for engaging
  StartupCycleMasterLength         = 10000;  // Length of master travel until eng. finished
  _BitSet(StartupCycleModeControl, 12);      // Sel. of "travel-dep. startup cycle process"
  RegisterLoopDXDTOut              = 2;      // Limiting of correction mechanism
  StopCycleMode                    = 1;      // Stop cycle mode 1: Event-driven starting
                                             // of the stop cycle process via binary input
  StopCycleInputMask               = 32;     // Selection of terminal DI05 for disengaging

}
```

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