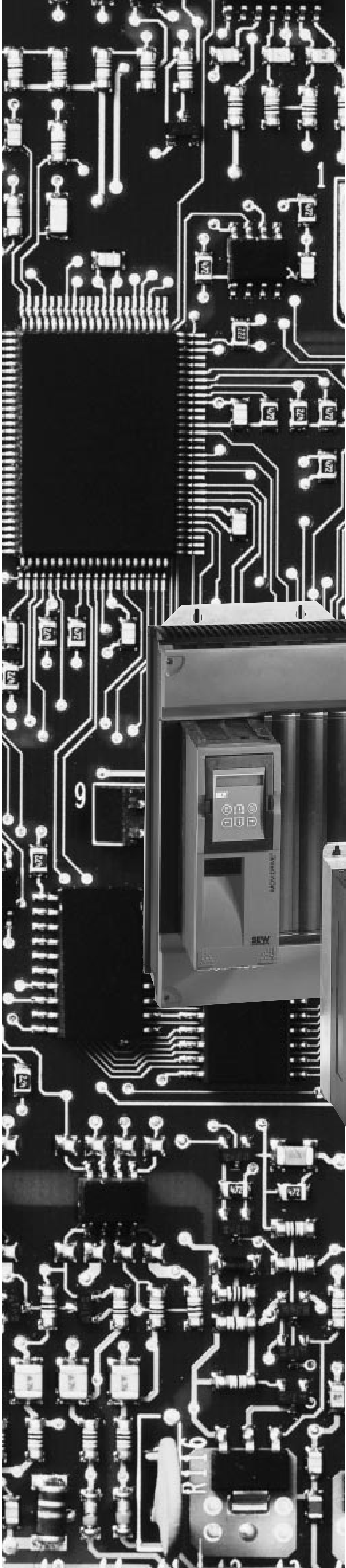
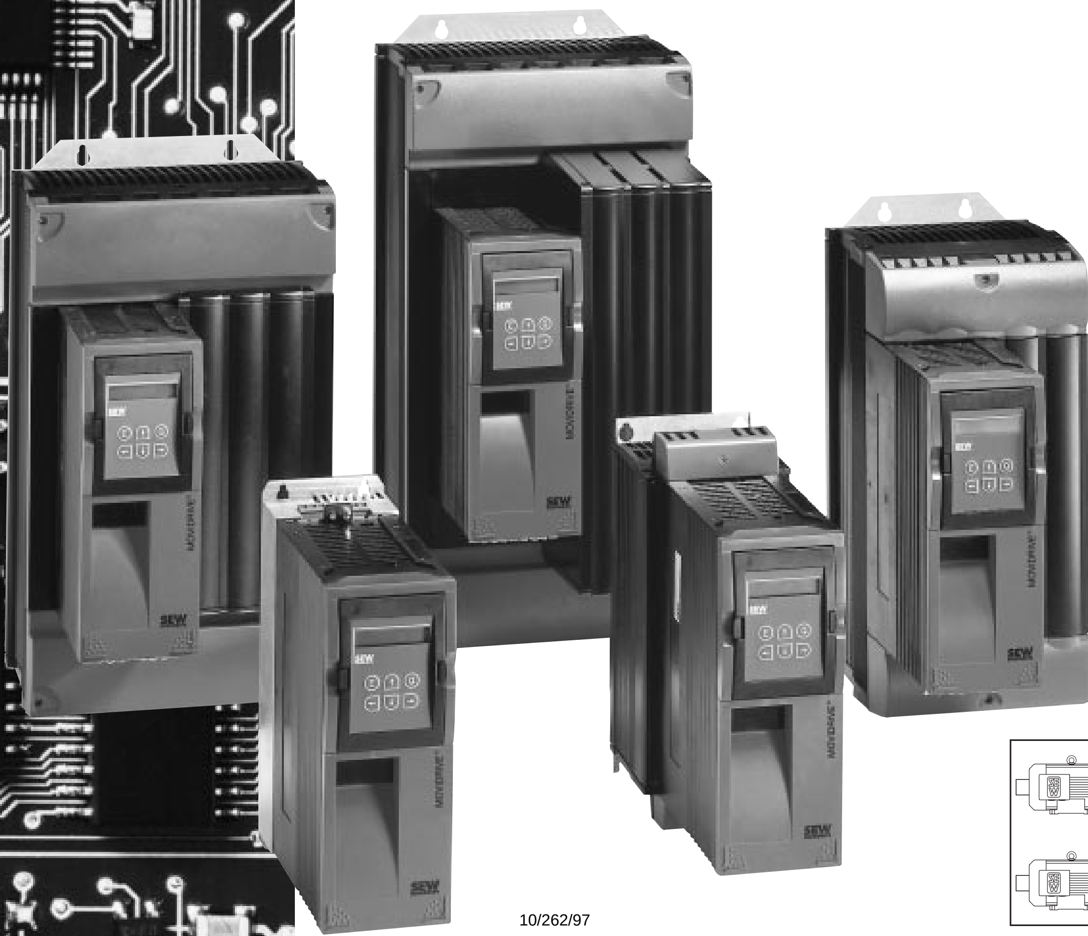


# MOVIDRIVE®
# Drive Inverters

## Manual

## Synchronous Operation Type DRS11A

**Edition 04/99**



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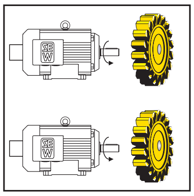

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DIN EN ISO 9001

SEW EURODRIVE

- **This supplementary information does not replace the detailed operating instructions!**
- **Only specialist electricians are permitted to install and commission this system; they must observe the applicable accident prevention regulations and work in accordance with the MOVIDRIVE® operating instructions.**

- **Read this manual carefully before you start installation and commissioning work on MOVIDRIVE® drive inverters fitted with synchronous operation.**
  This manual assumes that the user has access to and is familiar with the documentation on the MOVIDRIVE® system, in particular the system manual.

- **Safety notes:**
  Always follow the warning and safety notes 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.

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

- In this manual, **cross references** are marked with a →, e.g.:
  (→ MX_SCOPE) means: Please refer to the MX_SCOPE manual for detailed information or information on how to carry out this instruction.
  (→ Sec. X.X) means: Further information can be found in section X.X of this manual.

- Each unit is manufactured and tested to current SEW-EURODRIVE technical standards and specifications.
  A requirement of fault-free operation and fulfilment of any rights to claim under guarantee is that this information is observed.
  This manual contains important information about servicing work; for this reason, it should be kept close by the unit.

Page

# 1 Introduction

## 1.1 Description

The "synchronous operation" process permits a group of motors to be operated with synchronous angular rotation or else with an adjustable proportional relation (electronic gear unit).

The master drive is the one which specifies the position. It can also be an incremental encoder. The slave drive is the one which has to follow this position specification.

Synchronous operation is based on a constant comparison between the motor rotor angular position of the master and that of the slave. The master and slave motors have to be equipped with incremental encoders (DT/DV motors) or resolvers (DY motors) for this purpose. MOVIDRIVE® with the synchronous operation card type DRS11A is used as the slave drive. The DRS11A option can only be used with MOVIDRIVE® types MDV and MDS; it cannot be used with MOVIDRIVE® type MDF (due to the lack of encoder or resolver feedback!).

The DRS11A option is plugged into the OPTION1 or OPTION2 slot in accordance with the prescribed option combinations ( → MOVIDRIVE® operating instructions).

STOP

For synchronous operation of master and slave, it is necessary to equip the slave inverter with a braking resistor. Depending on the drive a braking resistor may also be required for the master inverter during regenerative operation.

Using the P221 and P222 parameters (master and slave gear factor), the master and slave pulses counted are converted for the output side of the gear. They are a measure of the pulses counted per unit of travel distance.

The system determines the difference in the distance information between the master and the slave and stores this value in the form of incremental encoder signals in an internal difference counter. Binary indications such as "DRS SLAVE IN POS", "LAG ERROR", etc. are set depending on this difference.

This counter is evaluated differently for the different operating modes (P223).

- **In synchronous operation** (X40:1 = "0", for all 1 – 8 modes), the internal difference counter is used for correcting to anglular deviation $\Delta\alpha = 0$.
- A "1" signal on X40:1 causes synchronous operation to be switched off and **free-running operation** to become effective. Free-running operation means that the slave no longer receives its setpoint from the master but that the setpoint source set in P100 is effective. Master and slave do not run in angular synchronization to each other. In **mode 1**, **the difference counter** is **switched off** during free-running, the angular difference cannot be reduced to zero.
  In **modes 2-8**, the **angular difference** arising during free-running operation is **recorded** and processed according to the selected mode.
- **Mode 2/4:** The angular difference resulting from free-running operation is reduced to zero in synchronous operation, the slave runs again with the previous position synchronously to the master.
  In mode 2, a "0" signal on terminal X40:1 switches free-running to synchronous operation. In mode 4, free-running operation switches automatically to synchronous operation when the angular difference has reached the value of "slave counter" P224.
- **Mode 3/5/8:** The angular difference resulting from free-running operation is not reduced to zero during synchronous operation, but the value of "slave counter" P224 becomes the new reference point of the slave to the master.
  In mode 3, a "0" signal in terminal X40:1 switches from free-running operation to synchronous operation. In mode 5, free-running operation automatically switches over to synchronous operation when the angular difference resulting from free-running operation reaches the value of "slave counter" P224. In mode 8, a "0" signal on terminal X40: 1 also switches free-running operation to synchronous operation and the internal difference counter with the 1 → 0 edge to X40:1 is additionally set to zero.

- **Mode 6/7:** The angular difference resulting from free-running operation is reduced back down to zero in synchronous operation. During synchronous operation (X40:1 = "0"), the internal difference counter is additionally used for correction to an adjustable offset angular deviation between master and slave. A "1" signal on the binary inputs X40:2, X40:3 or X40:4 makes the offset values 1, 2 or 3 (P225, P226, or P227) effective. In mode 6, the offset value is effective as long as the "1" signal is on X40:2, X40:3 or X40:4. A "0" signal reduces the angular difference (offset value) back down to zero. In mode 7, the offset value also remains effective with a "0" signal. The angular difference is not reduced back to zero (phase trimming). A permanent signal ($t \geq 3$ s) on X40:2, X40:3 or X40:4 causes a repetitive angular deviation.

The synchronous controller calculates the speed correction value for the slave drive to minimize the angular difference between the master and slave. To do this, the current angular difference is multiplied by parameter P220 (P-gain). The result is a correction value for the slave speed.

- Master and slave run synchronously, diff. value = 0 → correction value = 0
- Slave runs behind, angular difference > 0 → correction value > 0, slave accelerates
- Slave runs ahead, angular difference < 0 → correction value < 0, slave decelerates

To a large extent, the travel characteristics of the synchronous operation control are determined by the magnitude of the P-gain P220.

- The system tends to oscillate if the current angular difference between the master and slave is boosted too much.
- If the P-gain is set too low, it is not possible to reduce the angular difference in the transient status (acceleration or deceleration).

A difference counter in the slave counts the pulse differential in respect of the master, i.e. the deviation of the angular positions between the master and the slave.

## 1.2 Block Diagram for Synchronous Operation

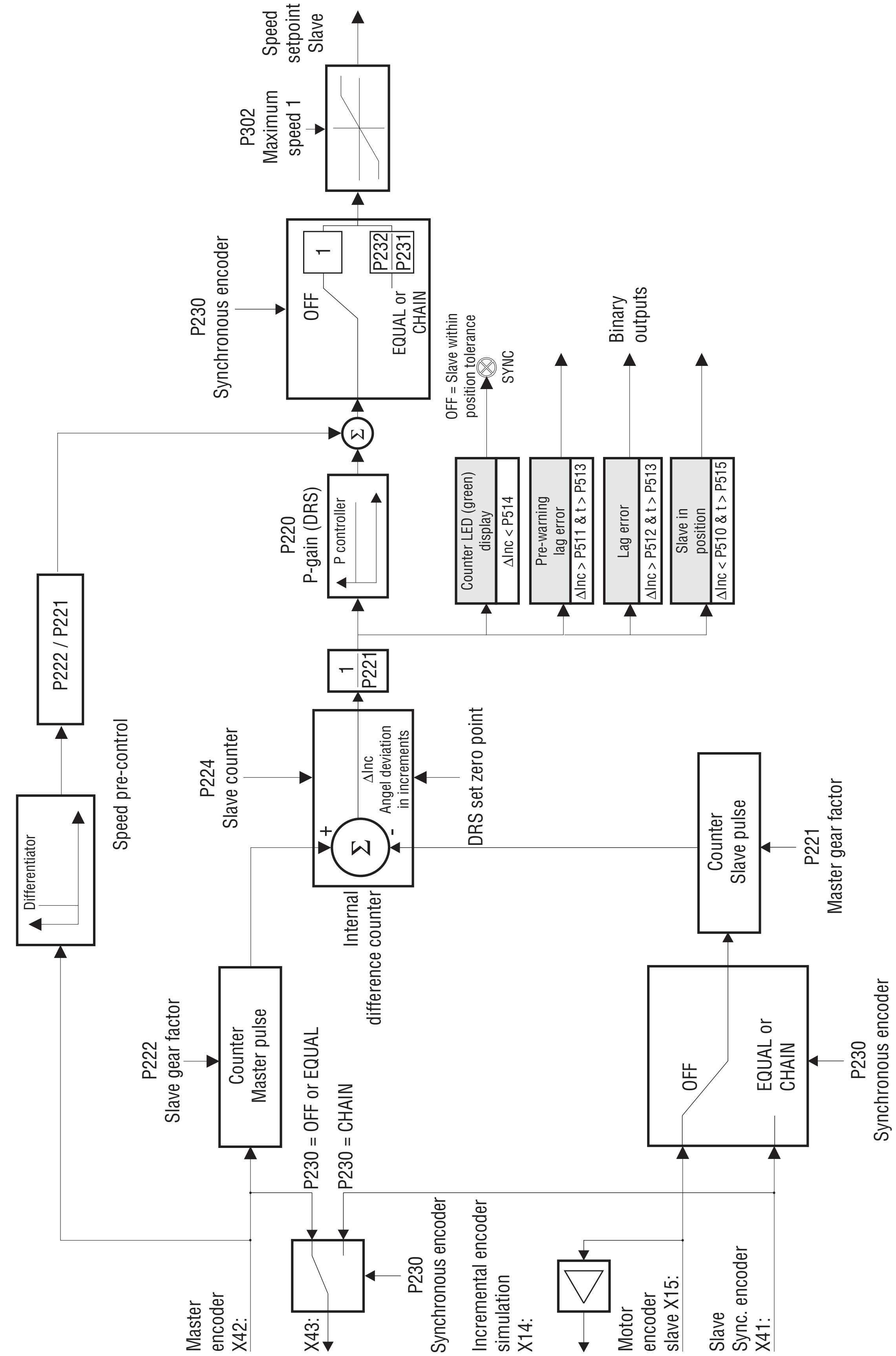


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*Fig. 1: Block diagram for synchronous operation*

# 2 Project Planning

## 2.1 Sample Applications

1. Group configuration: Master and equal slaves e.g. multiple column hoist

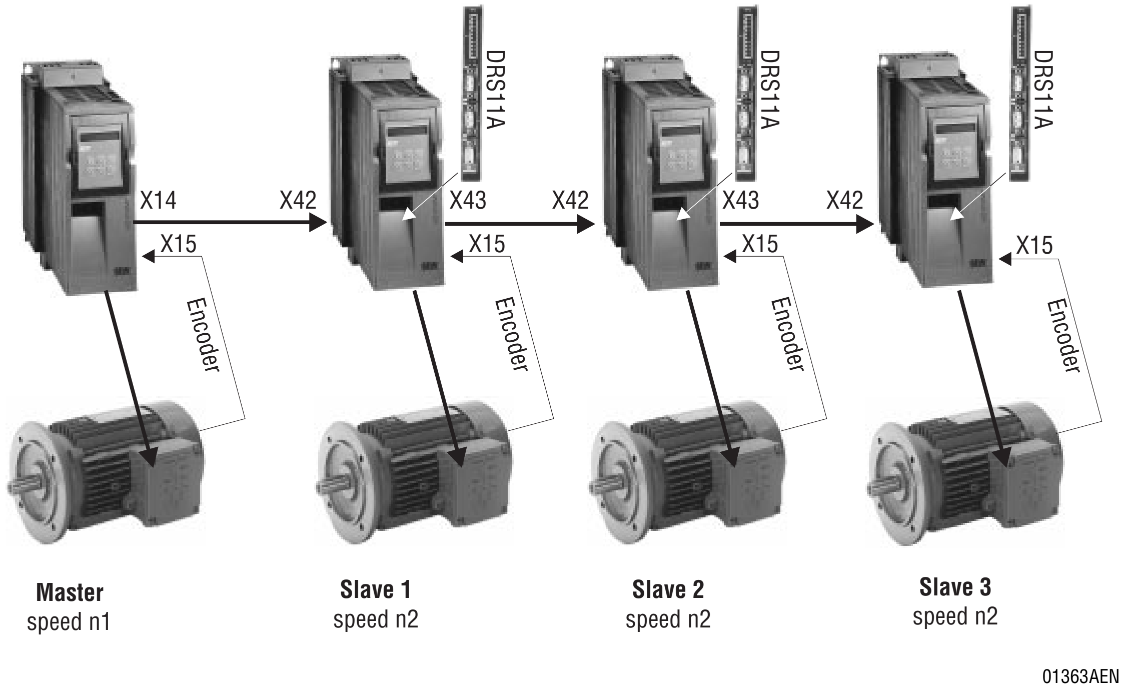



*Fig. 2: Group configuration*

2. Master-slave chain: e.g. conveyor belts connected one after the other

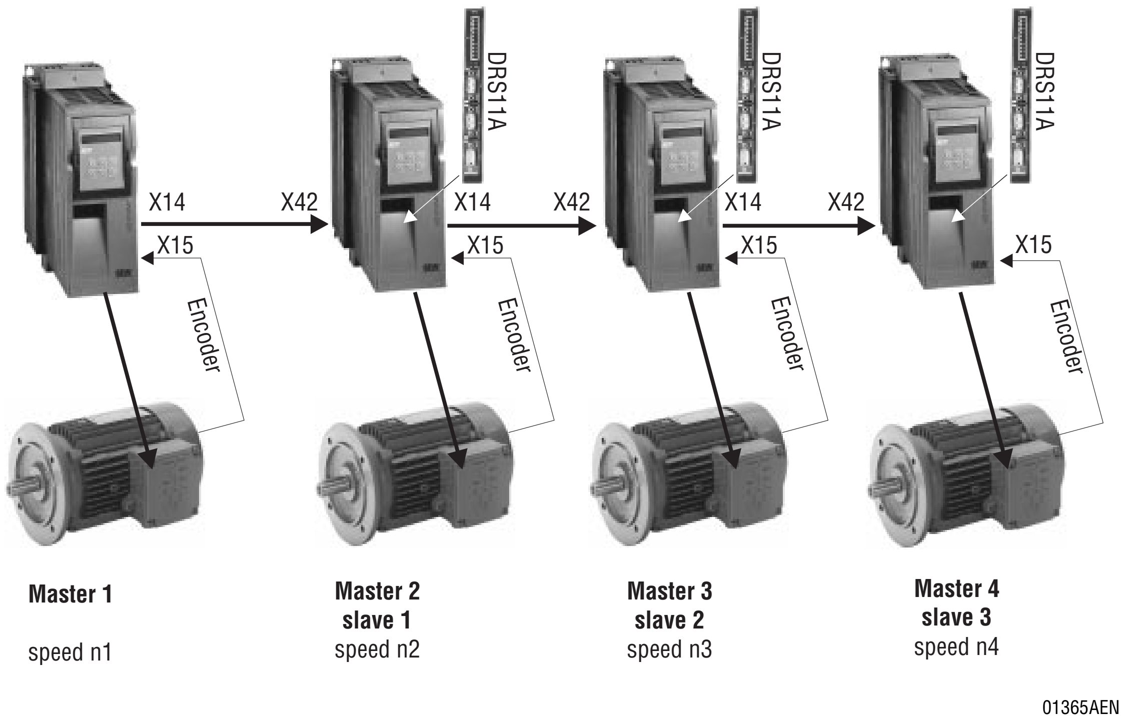



*Fig. 3: Master-slave chain*

3. Master-slave chain with external master incremental encoder:

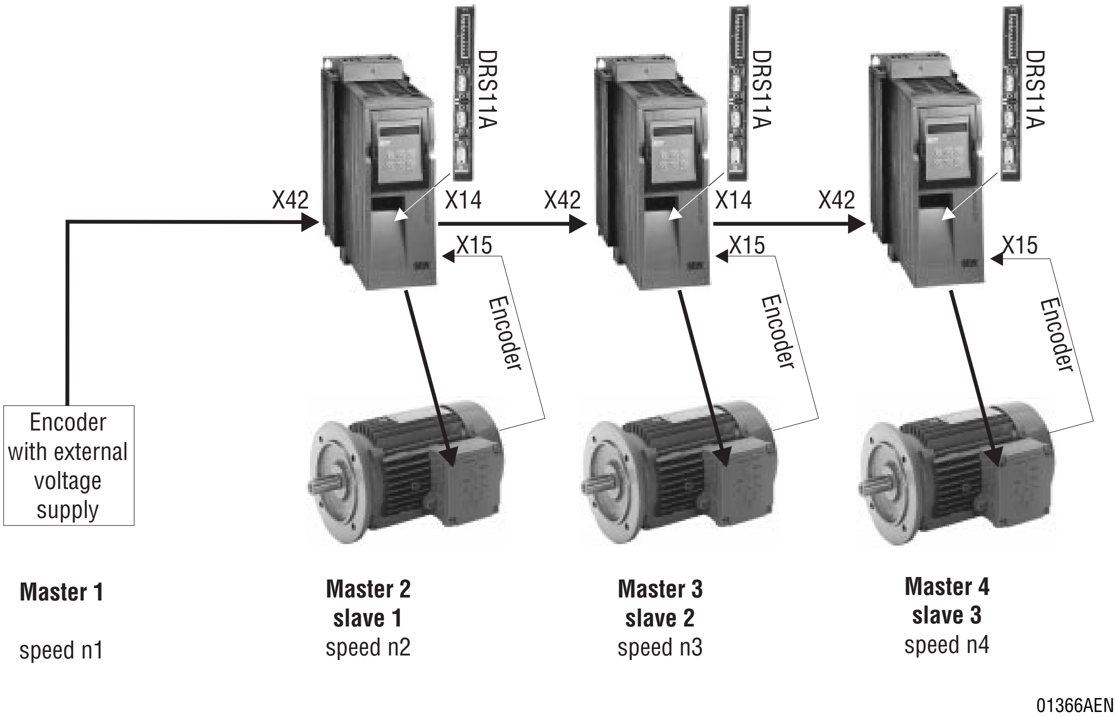



*Fig. 4: Master-slave chain with external master incremental encoder*

4. Master-slave chain with additional sync. encoders:

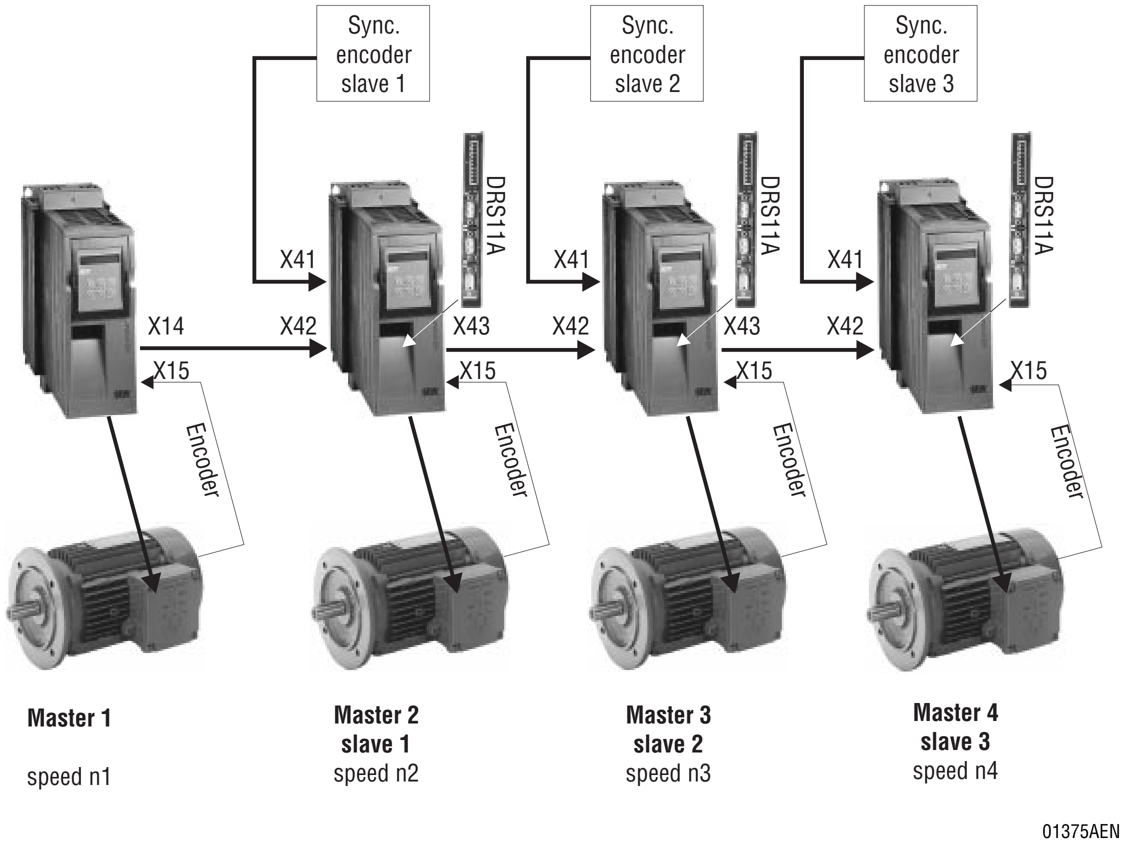



*Fig. 5: Master-slave chain with sync. encoder*

## 2.2 Project Planning Notes

- Do not use synchronous operation on systems with a rigid mechanical connection.
- Ensure that the slave inverter is equipped with a braking resistor.
- When planning the synchronous operation application, note that the slave has to be able to reduce the angle differential in respect of the master to zero at any time. Consequently, set the maximum speed (P302) of the slave to a higher value than the maximum speed of the master.
  With AC squirrel-cage asynchronous motors, the full motor torque is no longer available in the field weakening range if the maximum speed is set to a higher value than the nominal speed of the motor. This can give rise to lag errors (F42) in special master-slave combinations.
  Furthermore, the progressive synchronisation can take place at maximum possible acceleration or along a variable ramp (P24_ "Synchronous operation with catch-up") during the transition from free-running operation to synchronous operation.
- Always operate synchronous operation with open-circuit monitoring (→ Sec. 2.3).
- If possible, always use the same types of drive for synchronous operation.
- Always use the same motors and the same gear units for multiple-column hoists.
- If drives of the same type are working in a synchronised arrangement (e.g. multiple-column hoist), the drive with the highest load share during operation should be selected as the master.
- In a group configuration (1 master and x equal slaves), it is possible to connect up to 5 slave inverters to one master binary output.
- Slave reaction to power off/power on if the master remains on-circuit:
  If the master is stationary when the power supply system is switched on and the power to the slave is switched off and on again, the slave is in the operational status "NO ENABLE".
  If the master is moving when the power system is switched on and the power to the slave is switched off, the master enters fault mode "EXTERNAL TERMINAL" (F26 with MOVIDRIVE® or F27 with MOVITRAC® 31C). If the power to the slave is switched back on, the slave may enter fault mode "LAG ERROR" (F42) depending on the set lag error limit (P512).
- Connection of motor encoder to X15 → MOVIDRIVE® Operating Instructions
  For MDV: Number of pulses of X14 is identical to the motor encoder on X15.
  For MDS: Number of pulses of X14 is always 1024 pulses per revolution.
- The following encoders with RS-422 signal characteristics are possible on X41 and X42:
  - RS-422, 5V-TTL, tracks A, $\overline{A}$, B, $\overline{B}$, C, $\overline{C}$;
  - Maximum permitted input frequency of the resolver inputs is 200 kHz;
- If synchronous encoders are used the travel ratios (incr./mm) of the motor encoder and the synchronous encoder should be in the range of 0.1 ... 10.
- Mount synchronous encoder positive-locked (= slip-free) onto the driven machine part.
- The master is the external incremental encoder: use an incremental encoder with the highest possible resolution, however a maximum of 200 kHz.
- Parameter Change direction of rotation 1 (P350):
  When the synchronous operation control is active, the parameter setting **must** be P350 = NO. If the master and slave are to operate in opposite directions, then the connection order of the A/A and B/B encoder tracks on the X14 master output and the X42 slave input must be swapped over in each pair (→ Fig. 8).

### 2.3 Synchronous Operation with Open-circuit Monitoring of the Encoder Connection

Fault-free transmission of the incremental encoder signals is necessary to guarantee permanent synchronous operation of the master and slave drive. To do this, open-circuit monitoring of the connection from master X14 (incremental encoder simulation) to slave X42 (master encoder input) is necessary. The functions of "MOTOR STANDSTILL" and "DRS MASTER STOPPED" as well as "/EXT. FAULT" and "/FAULT" are available for this purpose.

The only occasion when no encoder pulses are transmitted to the slave are when the master is at a standstill. Consequently, the slave is informed of this status by means of a binary connection. However, if the master signals **no standstill** and the slave counts **no encoder pulses**, this indicates an **open circuit** or a **defect in the master encoder.** The slave then switches off and signals its status to the master by means of an additional connection.

**Required connections (→ Sec. 3.2, Fig. 9):**

- Program the binary output of the master to the "MOTOR STANDSTILL" function. This output is connected to a binary input on the slave which is programmed to the "DRS MASTER STOPPED" function.
- Program the binary input of the master to the "/EXT. FAULT" function. This input is connected to a binary output on the slave which is programmed to the "/FAULT" function.

### 2.4 Synchronous Start/Stop

The following **mixed operation** is possible with MOVIDRIVE® synchronous operation.

- The dynamic characteristics of the master are less than or equal to the slave.
- The master is an incremental encoder.

**In both areas of application, it must be possible to start/stop the master and slave(s) synchronously. In the case of hoist applications, for example, this is the precondition for correct operation. Combinations in which the master is more dynamic than the slave are, therefore, not permissible.**

| Mixed mode | Master | Slave |
|---|---|---|
| **The dynamic characteristics of the master are less than or equal to the slave** | MC31, MDV, MDS | MDS |
| | MC31, MDV | MDV |
| **The master is an incremental encoder** | Incremental encoder | MDV, MDS |

**The master is an incremental encoder:**

- Brake function OFF:
  No controller inhibit (DIØØ "/CONTROLLER INHIBIT" = "1") and no ENABLE (DIØ3 = "0")
  → Slave stopped subject to speed control at speed 0;
  No controller inhibit (DIØØ "/CONTROLLER INHIBIT" = "1") and ENABLE (DIØ3 = "1")
  → Slave synchronises on the master.
- Brake function ON:
  If the master and slave are both at speed 0, the slave brake is activated.

The following table clarifies the settings and/or wire connections in the aforementioned master/slave combinations with regard to synchronous starting/stopping **and** active open-circuit monitoring master/slave:

| Master | Slave | Master parameters | Slave parameters | Remarks |
|---|---|---|---|---|
| **MC31** | MDV: VFC+nREG or CFC | Open-circuit monitoring: FEA terminal (e.g. X8.63) = "ROTATING FIELD OFF" Synchronous start/stop: X3.62 = "ROTATING FIELD ON" | Open-circuit monitoring: DI terminal = "DRS MASTER STOPPED" Synchronous start/stop: DI terminal = "DRS SLAVE START" Brake function "ON" | Master: Incremental enc. + FEN required, FEA required for open-circuit monitoring Slave: permanent enable |
| **MDV: (→ Fig. 9, ①)** | MDV | Open-circuit monitoring: DOØ1 = "MOTOR STANDSTILL" Synchronous start/stop: DOØ2 = "OUTPUT STAGE ENABLE" Brake function "ON" | Open-circuit monitoring: DI terminal = "DRS MASTER STOPPED" Synchronous start/stop: DI terminal = "DRS SLAVE START" Brake function "ON" | Slave: permanent enable Binary output DOØ2 on master no longer available |
| **MDV: (→ Fig. 9, ②)** | MDS | Open-circuit monitoring: DOØ1 = "MOTOR STANDSTILL" Synchronous start/stop: DBØØ "BRAKE" Brake function "ON" | Open-circuit monitoring: DI terminal = "DRS MASTER STOPPED" Synchronous start/stop: DI terminal = "DRS SLAVE START" Brake function "ON" | Slave: permanent enable Binary output DOØ2 on master still available |
| **MDS** | MDS | Open-circuit monitoring: DOØ1 = "MOTOR STANDSTILL" Synchronous start/stop: DBØØ "BRAKE" Brake function "ON" | Open-circuit monitoring: DI terminal = "DRS MASTER STOPPED" Synchronous start/stop: DI terminal = "DRS SLAVE START" Brake function "ON" | Slave: permanent enable Binary output DOØ2 on master still available |

**Important:**

The "DRS SLAVE START" slave terminal must always be programmed and wired up as well when the brake function is switched on. This also applies if the master is only an incremental encoder, in which case an external control has to specify the "DRS SLAVE START" signal.

The position is maintained subject to position control when the brake function is switched off and the "DRS SLAVE START" signal is withdrawn or if the stop range (P510) is entered.

## 2.5 Synchronous Operation with Sync. Encoder

In all applications involving friction-locked power transmission between the motor shaft and the machine, in which case slip is to be expected, it is necessary for position measurement to take place using an additional incremental encoder. This incremental encoder is mounted in a positive-locked connection to the driven machine part (it is fitted to a section of the machine) and is referred to as a sync. encoder below. It is required in order to register the current position of the slave (G3). Furthermore, the encoder mounted on the motor shaft is required in order to register the current speed (G2) of the drive.
The higher the encoder position resolution (the number of pulses counted per travel distance unit)

- the more accurately the slave can follow the master,
- the more rigidly the synchronous operation control can be set (larger P-factor),
- the smaller the angle deviation during acceleration and deceleration.

Due to the calculation accuracy of the synchronous encoder, the travel resolution ratios (incr./mm) of the motor encoders and the synchronous encoders should, however, lie in the range of 0.1...10. If the ratio lies outside this range, then it may be possible in many cases to achieve a more favorable ratio with a different encoder.

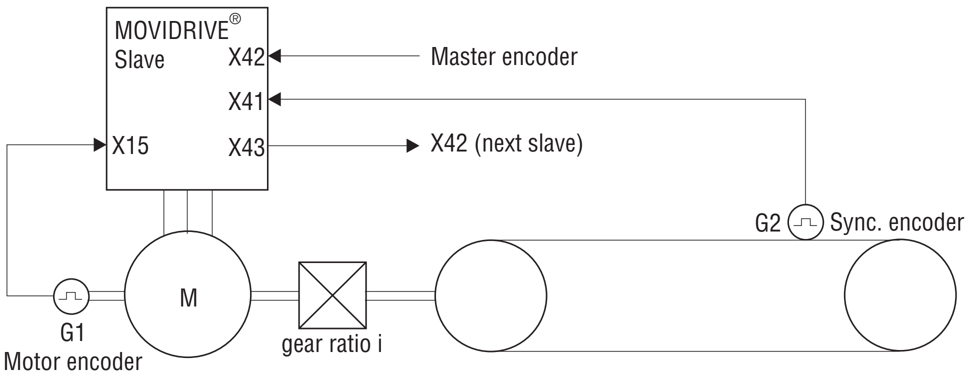



*Fig. 6: Synchronous operation with sync. encoder, equal or chain*

**Setting the master/slave gear factor:** → Sec. 4.4.3

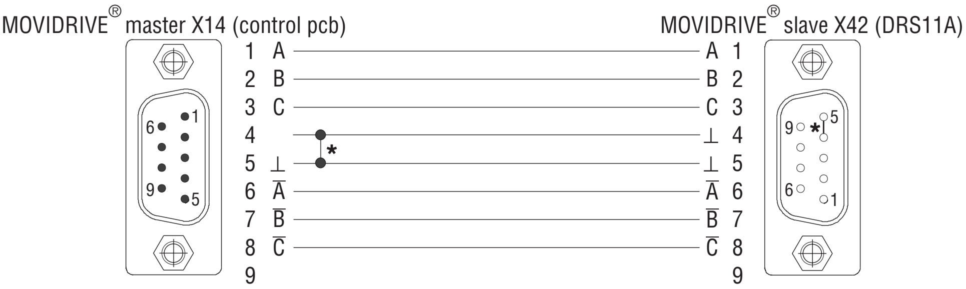
**Setting the slave encoder / slave sync. encoder factor:** It is possible to have a mechanical ratio between the incremental encoder for picking up the motor speed (G2) and the incremental encoder for position measurement (G3). This ratio is set using P231 (slave resolver factor) / P232 (slave sync. encoder factor).

- Equal:
  The sync. encoder master signal on X42 is passed on to other slaves via X43. All the slaves, therefore, receive the identical master encoder signal.
- Chain:
  The corresponding sync. encoder slave signal on X41 is passed on to the next slaves in each case via X43. The sync. encoder signal, therefore, becomes the master encoder signal of the following slave.

# 3 Installation

## 3.1 Installation Instructions

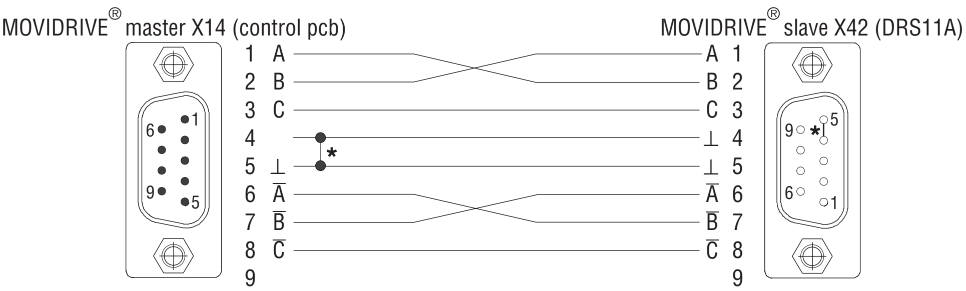
- The maximum permitted cable lengths are:
  - Between the master inverter and the slave inverters: 10 m
  - Between the inverters and the corresponding incremental encoders (MDV) / resolvers (MDS): 100 m
- Connection cables of the incremental encoders (motor and sync. encoder) and all cables "incremental encoder simulation", "input master encoder" and "output incremental encoder":
  Use shielded cables with twisted conductor pairs (A and $\overline{A}$, B and $\overline{B}$, C and $\overline{C}$)
  (wiring of incremental encoder/resolver → MOVIDRIVE® operating instructions).
- Enable instruction on slave inverter for synchronous operation mode:
  DIØØ (X13:1) = "1" (/controller inhibit), DIØ3 (X13:4) = "1" (enable) and
  DIØ1 (X13:2) = "1" (right) or DIØ2 (X13:3) = "1" (left).
  **Important:** The sense of rotation of the slave is determined by the sense of rotation information in the setpoint pulses from the master to the slave in synchronous mode.
- If the master and slave drives have to operate with the same sense of rotation:
  CW rotation of master = CW rotation of slave; the connection sequence on the "Incremental encoder simulation" master output and the "Master encoder" slave input is identical.




* In version 13 and higher, terminals X42:4-X42:5 are jumpered in the factory, jumper X14:4-X14:5 is then no longer required.

*Fig. 7: Master-slave connection with the same sense of rotation*

- If the master and slave have to operate with opposing senses of rotation (e.g. drive shafts of geared motors with the same number of gear stages are facing one another):
  Swap over the connection sequence of the tracks A/$\overline{A}$ and B/$\overline{B}$ in pairs on the "Incremental encoder simulation" master output and the "Master resolver" slave input.

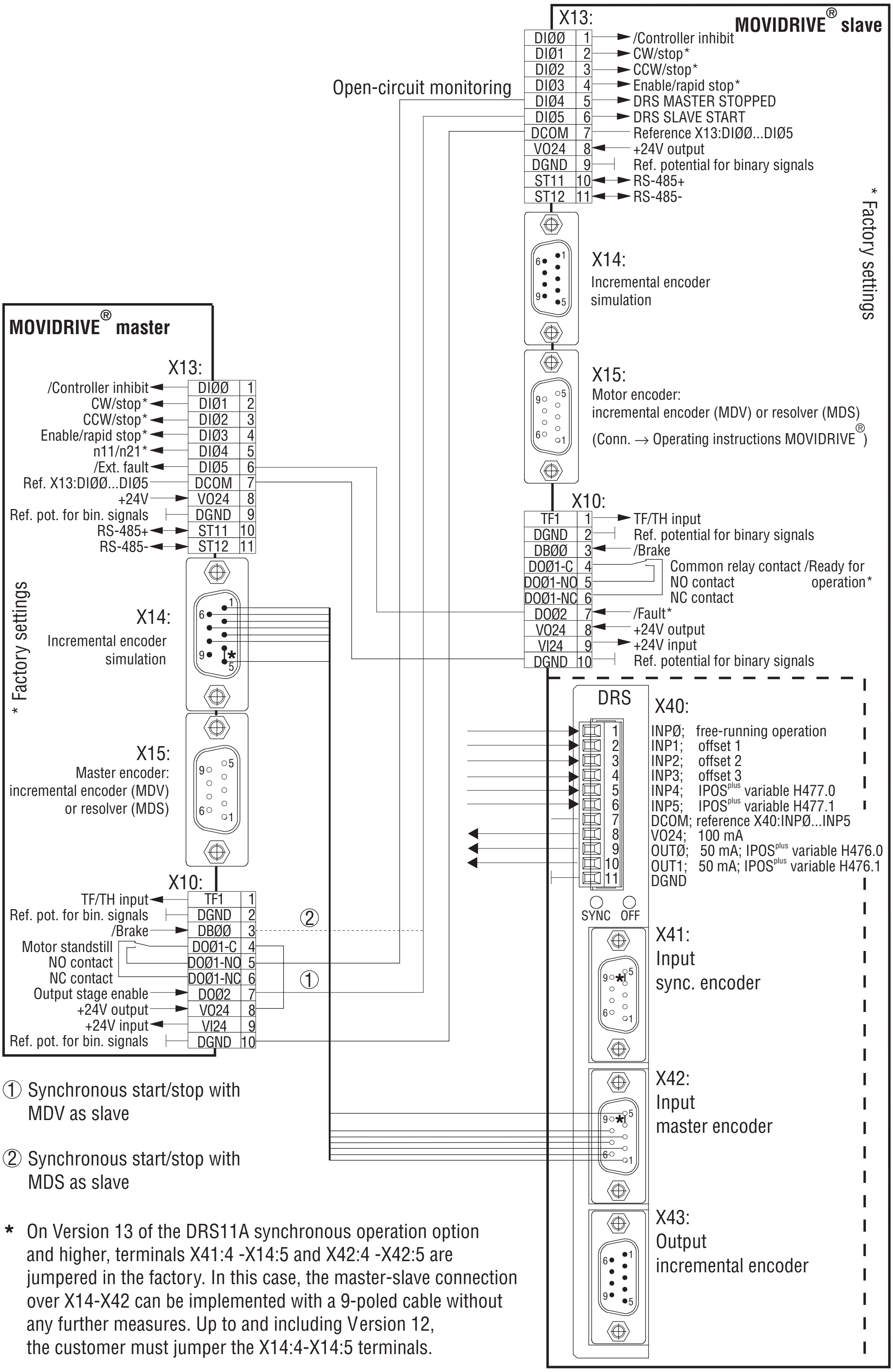



* In version 13 and higher, terminals X42:4-X42:5 are jumpered in the factory, jumper X14:4-X14:5 is then no longer required.

*Fig. 8: Master-slave connection with opposing senses of rotation*

- On version 13 of the DRS11A synchronous operation option and higher, terminals X41:4-X41:5 and X42:4-X42:5 are jumpered in the factory. In this case, the master-slave connection over X14-X42 can be implemented with a 9-poled cable without any further measures. SEW offers a prefabricated cable for this connection. Up to and including Version 12, the customer must jumper the X14:4-X14:5 terminals.

## 3.2 MOVIDRIVE® Master - MOVIDRIVE® Slave Connection




① Synchronous start/stop with MDV as slave

② Synchronous start/stop with MDS as slave

* On Version 13 of the DRS11A synchronous operation option and higher, terminals X41:4 -X14:5 and X42:4 -X42:5 are jumpered in the factory. In this case, the master-slave connection over X14-X42 can be implemented with a 9-poled cable without any further measures. Up to and including Version 12, the customer must jumper the X14:4-X14:5 terminals.

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*Fig. 9: MOVIDRIVE® master - MOVIDRIVE® slave connection*

## 3.3 MOVITRAC® 31C Master - MOVIDRIVE® Slave Connection

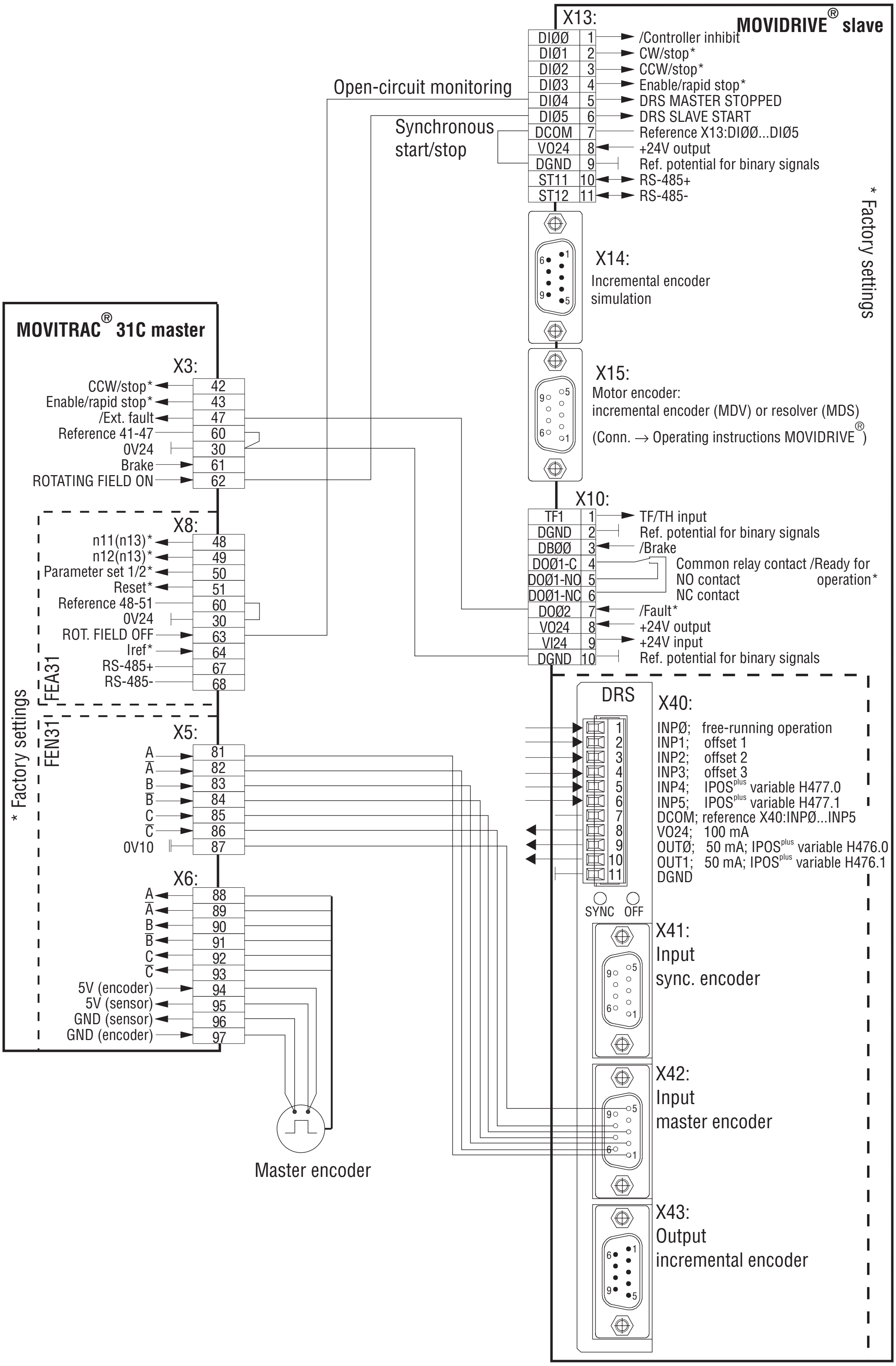


*Fig. 10: MOVITRAC® 31C master - MOVIDRIVE® slave connection*

## 3.4 Incremental Encoder Master - MOVIDRIVE® Slave Connection

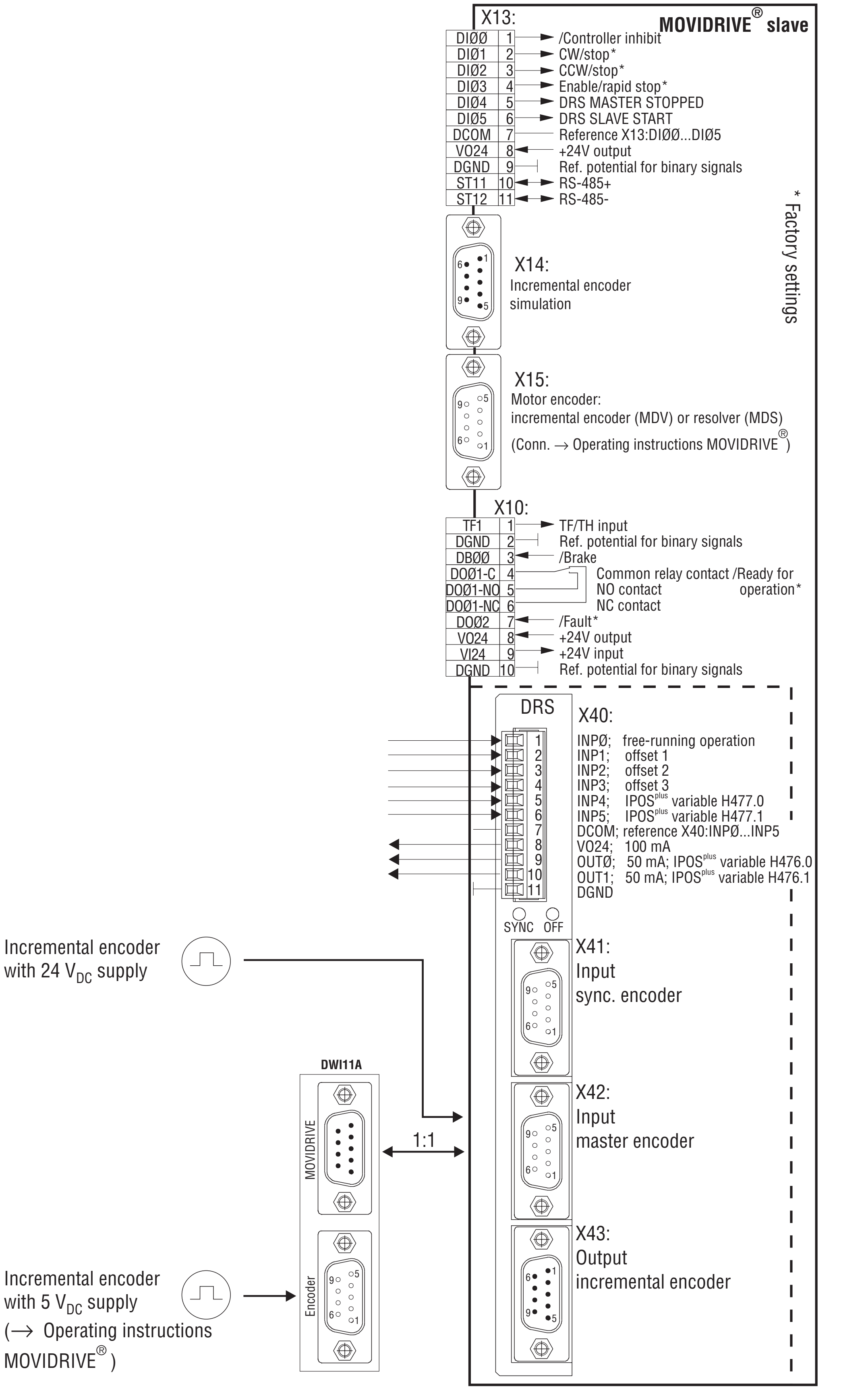


*Fig. 11: Incremental encoder master - MOVIDRIVE® slave connection*

## 3.5 Functional Description of the "DRS11A Synchronous Operation Option" Terminals

| Terminal | | Function | |
|---|---|---|---|
| **X40:** | 1 | INØ: Free-running operation | "0" signal = synchronous operation<br>"1" signal = free-running operation |
| | 2 | IN1: Offset 1 | "0" signal = no Offset, with "1" signal on IN1, IN2 or IN3 the offset 1, 2 or 3 (P225, P226 or P227 becomes effective. The offset values cannot be mixed. When IN1, IN2 and IN3 simultaneously receive a "1" signal, then IN1 is effective. |
| | 3 | IN2: Offset 2 | |
| | 4 | IN3: Offset 3 | |
| | 5 | IN4: IPOS$^{plus}$ variable H477.0 | The signal level of IN4 and IN5 can be read with the IPOS$^{plus}$ H477 variables. |
| | 6 | IN5: IPOS$^{plus}$ variable H477.1 | |
| | 7 | DCOM | Reference potential for X40:1...X40:6 |
| | 8 | VO24 | Voltage output +24 V, max. 100 mA |
| | 9 | OUTØ: IPOS$^{plus}$ variable H478.0 | The signal level of OUTØ and OUT1 can be read and set with the IPOS$^{plus}$ H477 variables. |
| | 10 | OUT1: IPOS$^{plus}$ variable H478.1 | |
| | 11 | DGND | Reference potential for binary signals |
| **X41:/X42:** | 1 | Signal track A | Incremental encoder input sync. encoder (X41:)<br>or master encoder (X42:)<br>Use only a 5 V.TTL encoder with RS-422 signal characteristics. Encoders with $24V_{DC}$ voltage supply can be directly supplied over X41:9 or X42:9. For encoders with 5 $V_{DC}$ supply, the "DWI11A 5V encoder supply option" must be connected bewteen the X41/X42 and the encoder.<br>The track sequence A $\rightarrow$ B means CW motor rotation looking onto the end of the motor output shaft i.e. A is ahead of B. |
| | 2 | Signal track B | |
| | 3 | Signal track C | |
| | 4 | Reference potential DGND* | |
| | 5 | Reference potential DGND | |
| | 6 | Signal track $\overline{A}$ | |
| | 7 | Signal track $\overline{B}$ | |
| | 8 | Signal track $\overline{C}$ | |
| | 9 | VO24 | 24 V power supply for resolver, max. 180 mA |
| **X43:** | 1 | Signal track A | Incremental encoder output<br>When P230 "sync. encoder = OFF" or "EQUAL RANKING" then pulse no. as on encoder connection X42.<br>Where P230 "sync. encoder = CHAIN", then pulse no. as on encoder connection X41. |
| | 2 | Signal track B | |
| | 3 | Signal track C | |
| | 4 | N.C. | |
| | 5 | Reference potential DGND | |
| | 6 | Signal track $\overline{A}$ | |
| | 7 | Signal track $\overline{B}$ | |
| | 8 | Signal track $\overline{C}$ | |
| | 9 | N.C. | - |

* On Version 13 of the DRS11A synchronous operation option and higher, terminals X41:4 -X14:5 and X42:4 -X42:5 are jumpered in the factory.

**IMPORTANT:**

The INØ ... IN3 binary inputs and OUT ...OUT3 binary outputs are fixed assigned to the above functions and cannot be programmed.

# 4 Startup

## 4.1 Introduction

The following example describes the startup procedure for the synchronous operation of a two-column hoist.

Both drives are fitted with **identical** gear units with the **identical** ratio. The rated power values of the motor and the inverters are identical. In both drives, CW rotation of the motor means an upward movement of the hoist. This means that the prefabricated Master-Slave cable from SEW (part no. 814 344 7) can be used for the Master X14 - Slave X42 connection.

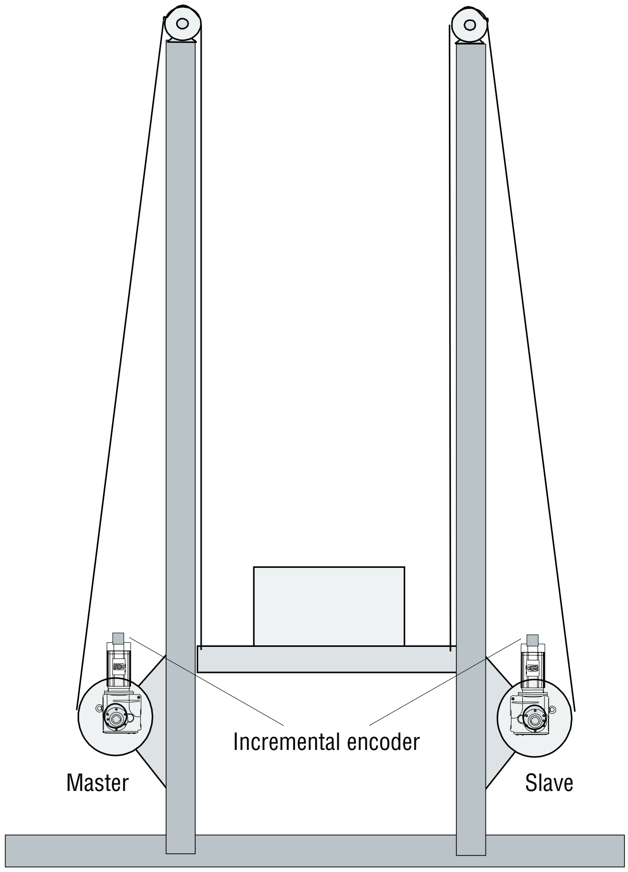


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*Fig. 12: Two-column hoist*

**Master drive:** AC asynchronous motor with mounted incremental encoder type EV1R and brake

**Master inverter:** MOVIDRIVE® MDV60A; VFC-n-CTRL (CFC) operating mode
No option card

**Slave drive:** AC asynchronous motor with mounted incremental encoder type EV1R and brake

**Slave inverter:** MOVIDRIVE® MDV60A; VFC-n-CTRL&SYNC (CFC&SYNC)
With synchronous operation card type DRS11A option

**IMPORTANT:**

If a MOVIDRIVE® MDS60A with permanent-field synchronous motor (DFY motor) is used instead of a MOVIDRIVE® MDV60A with AC asynchronous motor (D/DT/DV or CT/CV motor), the operating mode SERVO is set on the master, and SERVO&SYNC on the slave. Otherwise, the startup procedure is the same as for the MOVIDRIVE® MDV.

## 4.2 Summary of Startup Procedure

The following diagram shows the procedure:

**Preliminary Work**
- Check wiring, terminal assignments and safety cut-outs.
- **Disconnect drives from machine!**
- Carry out speed controlled start up of master and slave separately.
- Program binary inputs and outputs according to application.
- Activate master and slave and test speed-control operation.

→ Sec. 4.3

↓

**Testing the Encoder Signals**
- Cancel angle of deviation between master and slave with "DRS SET ZEROPOINT".
- Set operating mode P700 on the slave to synchronous operation.
  In MDV: VFC-n-CTRL.&SYNC or CFC&SYNC.
  In MDS: SERVO&SYNC.
- Block slave (/CONTROLLER INHIBIT DIØØ = "0") and turn master.
- SYNC LED (green) should light up. If not, check the encoder connection of master and slave.

→ Sec. 4.4.1

↓

**Synchronous Operation of Master and Slave**
- Cancel angle of deviation between master and slave with "DRS SET ZEROPOINT".
- Enable slave and start master drive. The slave follows the master.

→ Sec. 4.4.2

↓

**Setting the Synchronous Operation Parameters**
- Set master gear ratio factor (P221) and slave gear ratio factor (P222) according to the gear unit ratios.

→ Sec. 4.4.3

↓

**Synchronous Operation of Master and Slave in Mounted Drives**
- Mount and align drives.
- Cancel angle of deviation between master and slave with "DRS SET ZEROPOINT".
- Enable drives.
- Check wether the angle of deviation is within the permissible range during acceleration (→ MX_SCOPE or green SYNC LED).
- Optimize P-gain (P220).

→ Sec. 4.5

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*Fig. 13: Structure of startup*

### 4.3 Preliminary Work

Make sure that

- the wiring,
- the terminal assignments
- and the safety cut-outs

have been implemented correctly in accordance with the application.

**Disconnect the drives from the machine so both drives can be mechanically operated independently of one another. This prevents the system being damaged due to unexpected movements during the startup of the synchronous operation.**

- Start up the master and slave drive **separately** in accordance with the information given in the MOVIDRIVE® manual in VFC-n CONTROL or CFC mode (→ P700).
- Program the terminal wiring of the master and slave in accordance with your application.
- Activate and test the speed-controlled operation of both drives.

### 4.4 Activating Synchronous Operation

#### 4.4.1 Testing the Encoder Signals

- Cancel any angle deviation which may be present (green SYNC LED is lit up) between the master and slave:
  - Program a binary input of the slave inverter to the "Set DRS zero point" function. The signal is "1" active.
  - Switch this binary input "0"→"1"→"0", the green SYNC LED goes out.
- Activate the synchronous operation control of the **slaves** by setting the operating mode (P700) to VFC&SYNC or CFC&SYNC. Initially leave all parameters of the synchronous operation controller at their factory settings.
- Block the **slave** using DI00 = "0" (controller inhibit).
- Move the master drive **only** and observe the green SYNC LED on the DRS11A at the same time. The LED must come on after the master has moved a short distance.

  Check the resolver connection between the master and the slave if the green LED does **not** light up. **In this case, the slave does not recieve any travel information from the master.**

#### 4.4.2 Synchronous Operation of Both Drives when Dismounted

- Cancel the angle deviation (green SYNC LED is lit up) between the master and slave:
  - Program a binary input of the slave inverter to the "Set DRS zero point" function. The signal is "1" active.
  - Switch this binary input "0"→"1"→"0", the green SYNC LED goes out.
- The slave can then be enabled by means of:
  - DIØØ = 1 (no controller inhibit)
  - DIØ1 = 1 (CW rotation)
  - DIØ3 = 1 (enable)
  - X40.1 = 0 (no free-running operation)
- Now set the master in motion and the slave drive follows.

### 4.4.3 Setting the Synchronous Operation Parameters

- Parameter input of the master and slave gear factors (P221 and P222).
  - P221 and P222 can be left at the factory setting of 1 when **identical gear units** are used with **identical ratio** and **identical reduction ratio.**
  - In any other configuration, it is necessary to determine P221 and P222 in accordance with the following formula:

$$\frac{P221}{P222} = \frac{A_M \bullet i_M}{A_S \bullet i_S} \bullet \frac{iv_M}{iv_S} \bullet \frac{U_S}{U_M}$$

$A_M$, $A_S$ → Resolution of the master and slave encoders
$i_M$, $i_S$ → Gear ratio of the master and slave gear units
$iv_M$, $iv_S$ → Reduction ratio of master and slave
$U_M$, $U_S$ → Circumference of master and slave output elements

- Now enable the master and slave. Both drives should now operate **with synchronous angular rotation.**

## 4.5 Testing Synchronous Operation with Mounted Drives

- Mount both drives onto your machine and line both drives up with each other mechanically.
- Cancel the angle deviation using the "Set DRS zero point" function (→ Sec. 4.4.1).
- Enable both drives in accordance with the connection diagram (→ Sec. 3.2).
- Observe the green SYNC LED on the synchronous operation card during operation. Use this display to determine the current angle deviation between the master and slave.
  - If the green SYNC LED comes on during acceleration and deceleration, the angle deviation is in excess of the tolerance set in parameter P514.
  - The precise angle deviation can be recorded and determined using the MX_SCOPE software.
- Now optimize the P-gain of the synchronous operation control (P220) as follows:
  - Apply the maximum operating load to the system.
  - Increase P220 in small steps of 1 - 2. Whilst doing this, observe the control characteristics of the slave.
  - Increase P220 until the slave drive develops a tendency towards oscillation.
  - Next reduce P220 by 15 % and take this result as the value for P220.

  Further optimization can be performed using the MX_SCOPE software.
- Adapt the parameters for monitoring the synchronous operation control so it meets your requirements.

## 4.6 Examples for the Calculation of P221 and P222

### 4.6.1 Example 1

This example will demonstrate the operation of two chain conveyors in synchronous operation. This is a positive-locked application with varying gear ratios. A synchronous encoder is not necessary, as in positive-locked applications the position data can be calculated from the signal of the motor encoder.

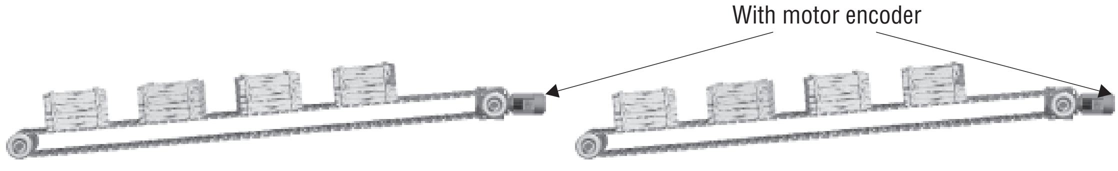


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*Fig. 14: Two chain conveyors*

**Calculation is aimed to establish the relationship of the position resolution between master and slave.**

**Calculation data:**

**Master:**
K87 DT100 L4 BM ES1 (with motor encoder)

Gear ratios:

$$i_M = 36.52 = \frac{40 \bullet 33 \bullet 83}{25 \bullet 8 \bullet 15}$$

**Slave:**
KA67 DT100 LS4 BM ES1 (with motor encoder)

Gear ratios:

$$i_S = 48.77 = \frac{47 \bullet 33 \bullet 81}{23 \bullet 8 \bullet 14}$$

You can ascertain the number of gearing teeth from your SEW sales office.

Resolution of incremental encoder:

$$A_M = 1024 \bullet \frac{\text{Incr.}}{\text{Rev.}} \bullet 4 = 4096 \bullet \frac{\text{Incr.}}{\text{Rev.}}$$

Resolution of incremental encoder:

$$A_S = 1024 \bullet \frac{\text{Incr.}}{\text{Rev.}} \bullet 4 = 4096 \bullet \frac{\text{Incr.}}{\text{Rev.}}$$

The incremental encoders provide 1024 pulses per revolution. The encoder impulses are quadrupled in the inverter.

Sprocket pinion (reduction):

$$\text{Module } m_M = 5$$
$$\text{No. of teeth } Z_M = 15$$
$$U_M = m_M \bullet Z_M$$

Sprocket pinion (reduction):

$$\text{Module } m_S = 4$$
$$\text{No. of teeth } Z_S = 20$$
$$U_S = m_S \bullet Z_S$$

$$\text{Position res. master} \left[\frac{\text{Incr.}}{\text{mm}}\right] = \frac{A_M \bullet i_M}{\pi \bullet m_M \bullet Z_M}$$

$$\text{Position res. slave} \left[\frac{\text{Incr.}}{\text{mm}}\right] = \frac{A_S \bullet i_S}{\pi \bullet m_S \bullet Z_S}$$

**Calculation:**

$$\frac{P221}{P222} = \frac{\dfrac{A_M \bullet i_M}{\pi \bullet m_M \bullet Z_M}}{\dfrac{A_S \bullet i_S}{\pi \bullet m_S \bullet Z_S}} = \frac{A_M \bullet i_M}{A_S \bullet i_S} \bullet \frac{m_S \bullet Z_S}{m_M \bullet Z_M}$$

$$\frac{P221}{P222} = \frac{4096 \bullet \dfrac{40 \bullet 33 \bullet 83}{25 \bullet 8 \bullet 15}}{4096 \bullet \dfrac{47 \bullet 33 \bullet 81}{23 \bullet 8 \bullet 14}} \bullet \frac{4 \bullet 20}{5 \bullet 15} = \frac{85523200}{107071875}$$

$$\frac{P221}{P222} = \frac{3420928}{4282875}$$

The parameter values for this example are; P222 = 3420928 and P222 = 4282875.

### 4.6.2 Example 2, Synchronous Encoder Application

This example will demonstrate the operation of two belt conveyors in synchronous operation. This is a force-locked application with identical gear ratios. In force-locked applications, the position data cannot be accurately calculated from the signal of the motor encoder, for this reason a master encoder is necessary on the first belt and a synchronous encoder on the second belt. The motor encoder and the synchronous encoders have different resolutions.

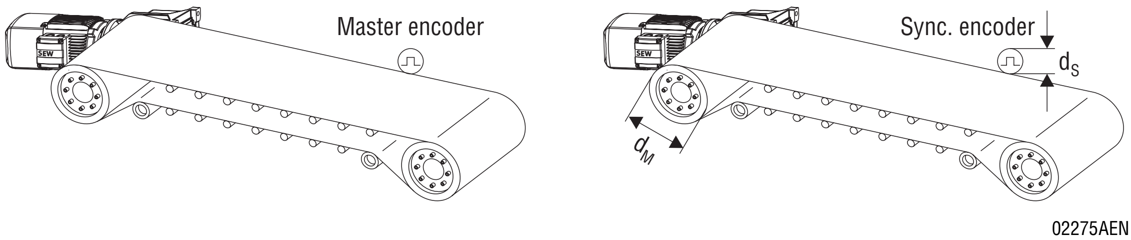



*Bild 15: Two belt conveyors*

For the recognition of the synchronous encoder, P230 must be set to "Synchronous Encoder = EQUAL-RANKING" or "CHAIN". The synchronous encoder is evaluated for the control of the slave drive. The slave motor encoder therefore is of no consequence for synchronous operation control, but is, however, necessary for speed control of the slave drive.
The master encoder and the synchronous encoder are both mounted directly onto the belt. They are identical encoders with identical gear units. The diameter of the belt pulleys is identical and, consequently, also the position resolutions (incr./mm) of the master encoder and the synchronous encoder. Parameters P221 and P222 must both be set to 1.
In the application with the synchronous encoder, the position resolutions of the slave motor encoder and the synchronous encoder must be adapted to each other. This can be done with parameters P231 "Slave encoder factor" and P231 "Slave synchronous encoder factor".

**Slave motor encoder: K47 DT100 L4 BM ES1**

Gear ratio:

$$i_M = 7.36 = \frac{38 \bullet 27 \bullet 69}{23 \bullet 19 \bullet 22}$$

Resolution incremental encoder (motor encoder):

$$A_M = 1024 \bullet \frac{\text{Incr.}}{\text{Rev.}} \bullet 4 = 4096 \bullet \frac{\text{Incr.}}{\text{Rev.}}$$

Belt pulley of conveyor:

$$d_M = 200 \text{ mm}$$

$$U_M = \pi \bullet d_M$$

$$\text{Pos. resol. slave motor encoder} \left[\frac{\text{Incr.}}{\text{mm}}\right] = \frac{A_M \bullet i_M}{\pi \bullet d_M}$$

**Synchronous encoder:**

Reduction:

$$i_{V\_S} = 2$$

Resolution incremental encoder (sync. encoder):

$$A_S = 2048 \bullet \frac{\text{Incr.}}{\text{Rev.}} \bullet 4 = 8192 \bullet \frac{\text{Incr.}}{\text{Rev.}}$$

Belt pulley of synchronous encoder:

$$d_S = 150 \text{ mm}$$

$$U_S = \pi \bullet d_S$$

$$\text{Pos. resolution sync. encoder} \left[\frac{\text{Incr.}}{\text{mm}}\right] = \frac{A_S \bullet i_{V\_S}}{\pi \bullet d_S}$$

**Calculation:**

$$\frac{P232}{P231} = \frac{\dfrac{A_S \bullet i_{V\_S}}{\pi \bullet d_S}}{\dfrac{A_M \bullet i_M}{\pi \bullet d_M}} = \frac{A_S \bullet i_{V\_S}}{A_M \bullet i_M} \bullet \frac{d_M}{d_S}$$

$$\frac{P232}{P231} = \frac{8192 \bullet 2}{4096 \bullet \dfrac{38 \bullet 27 \bullet 69}{23 \bullet 19 \bullet 22}} \bullet \frac{200}{150} = \frac{769120}{1061910}$$

$$\frac{P232}{P231} = \frac{176}{243}$$

In this example, the parameter values are; P231 = 243 and P232 = 176.

# 5 Parameters

Explanation of the parameters: the factory setting is identified by underlining in each case.

Parameters can only be changed in the INHIBITED inverter status (= output stage at high resistance).

## 5.1 Relationship between Parameter Values and Output Speed

In the case of the adjustable parameters (P224, P225, P226, P227, P510, P511, P512, P514), it is necessary to enter increments which relate to an angle offset (e.g. as a permitted deviation or as an offset) between the master and the slave drive. They refer to the value which the inverter calculates on the basis of the encoder pulses. The **encoder pulses** are **quadrupled** in the inverter.

The number of increments which is to be entered in the parameters is calculated on the basis of the angle offset of the motor according to the following formula; in this case, the angle offset of the motor relates to motor revolutions (e.g. 180° = 0.5 motor revolutions):

**Incremental value to be entered = Motor revolutions x 4 x pulse number of the incremental encoder**

**Example:**

If the "/DRS LAG" message is to be generated in case of a deviation of 5 motor revolutions when incremental encoders are used with the pulse count = 1024 increments/revolution between the master and slave, enter the increment value in P512 "Lag error limit" as follows:

***Counter value to be entered Z = 5 x 4 x 1024 = 20.480***

This value can also be used in relation to the gear unit output shaft:

***Motor revolutions = Gear unit output revolutions x*** $i_{Gear\ unit}$

As well as the motor speed and gear ratio, the reduction also has an influence on the effective output speed at the driving motor; in this case, the motor revolutions should be calculated as follows:

***Motor revolutions = Output revolutions x*** $i_{Gear\ unit}$ ***x*** $i_{Reduction}$

## 5.2 Signalling Functions

The following **operating states** are signalled:

- Optical display on SYNC LED (green) "Counter LED display" (P514):
  The SYNC LED can be used for visualizing the maximum differential between the master and slave occurring at any particular time during startup:
  ON = Angular difference > value of P514
  OFF = Angular difference < value of P514
- Optical display of the operating mode by OFF LED (red) "FREE-RUNNING OPERATION SLAVE":
  ON = Slave is in free-running operation
  OFF = Slave is in synchronous operation
- Status message "DRS SLAVE IN POS":
  - On one of the programmable binary outputs (P60_/P61_)
- Message "/DRS ADV. WARN.":
  - On one of the programmable binary outputs (P60_/P61_)
- Fault message "/DRS LAG":
  - On one of the programmable binary outputs (P60_/P61_)
  - With selectable fault response by the drive (P834)

The following additional parameters are available for synchronous operation.
(Complete parameter list → MOVIDRIVE® manual/operating instructions)

| Par. | Name | Adjustment range<br>**Factory setting** | After startup | Description |
|---|---|---|---|---|
| **22_** | **Synchronous control (only parameter set 1)** | | | |
| 220 | P-gain (DRS) | 1...**10**...200 | | Gain of synchronous operation controller in the slave |
| 221 | Master gear factor | **1**...3,999,999,999 | | Enter gear factors (incl. reduction, driving gear ∅, etc.) |
| 222 | Slave gear factor | **1**...3,999,999,999 | | |
| 223 | Mode selection | **1**/2/3/4/5/6/7/8 | | Select operating mode |
| 224 | Slave counter | -99,999,999...-10 /<br>**10**...99,999,999 inc. | | Angle offset or limit values for modes 3, 4 and 5. |
| 225 | Offset 1 | -32,767...-10 / **10**...32,767 inc. | | Mode 6: Angular differences to which the slave sets itself for the duration of a "1" signal at X40:2...X40:4.<br>Mode 7: Permanent angle offset. |
| 226 | Offset 2 | -32,767...-10 / **10**...32,767 inc. | | |
| 227 | Offset 3 | -32,767...-10 / **10**...32,767 inc. | | |
| **23_** | **Synchronous operation with sync. encoder** | | | |
| 230 | Sync. encoder | **OFF** / EQUAL / CHAIN | | Equal: Master sync. encoder signal is passed on to all slaves in parallel.<br>Chain: Master sync. encoder signal is only passed on to the first slave. The second slave receives the slave sync. encoder signal from the 1st slave, etc. |
| 231 | Slave encoder factor | **1**...1000 | | Ratio between slave encoder and slave sync. encoder |
| 232 | Slave sync. encoder factor | **1**...1000 | | |
| **24_** | **Synchronous operation with catch-up** | | | |
| 240 | Synchr. speed | 0...**1500**...5000 rpm | | |
| 241 | Synchr. ramp | 0...**2**...50 s | | The load inertia moment of the slave determines the synchr. ramp. This is altered by the startup. |
| **51_** | **Synchronous operation monitoring functions** | | | |
| 510 | Position tolerance of slave | 10...**25**...32,768 inc. | | |
| 511 | Adv. warn. lag error | **50**...99,999,999 inc. | | |
| 512 | Lag error limit | 100...**4000**...99,999,999 inc. | | |
| 513 | Lag indication delay | 0...**1**...99 s | | |
| 514 | Counter LED display | 10...**100**...32,768 inc. | | |
| 515 | Delayed position indication | 5...**10**...2000 ms | | |
| 60_<br>61_ | Binary inputs | Can also be selected for DRS<br>- DRS SET ZERO POINT<br>- DRS SLAVE START<br>- DRS TEACH IN<br>- DRS MASTER STOPPED | | → Sec. 3.2 |
| 62_<br>63_ | Binary outputs | - /DRS ADV. WARN.<br>- /DRS LAG<br>- DRS SLAVE IN POS. | | → Sec. 3.2 |
| **83_** | **Responses to faults** | | | |
| 834 | LAG ERROR response | **EM. STOP / FAULT** | | |

The following functions either cannot be activated with the DRS11A or do not have any effect:

- Parameter set changeover;
  No changeover to parameter set 2 can be performed in the VFC-n-CONTROL, CFC and SERVO operating modes in conjunction with synchronous operation.
- P75_ "Master-slave function"; the parameter does not have any effect.

## 5.3 Explanation of the Parameters

**22_ Synchronous operation control (only parameter set 1)**

220 P-gain (DRS)
Adjustment range: 1...10...200
Gain of the synchronous operation controller in the slave. This determines the control characteristics of the slave as a function of the angular differences in respect of the master. The greater the P-gain setting, the faster any angular difference is corrected (although there is also a greater tendency towards oscillation). This should be avoided because it subjects the braking resistor to unnecessary strain resulting from the continuous changing between motor and generator operation.

221/222 Master gear factor / slave gear factor
Adjustment range: 1...3,999,999,999
These settings are only necessary on the slave inverter. These parameters are used for setting the position measurement relationship between the master and the slave. Note that the encoders of the motors can only be used for position measurement of the master and slave provided there is **positive-locked power transmission (no slip).** This relationship results from:

1. Exact gear ratio of the master and slave drive. It is necessary to take account of the ratio of each individual gear stage. These data can be found in the speed diagram of the gearbox.
2. Reduction ratios.

In all applications in which the power transmission between the motor shaft and the machine is **force-locked,** in which case slip is to be expected, it is necessary to measure the position using an **additional encoder.**
This encoder must be mounted in a positive-locked connection to the driven machine part (it is fitted to a section of the machine) and is referred to as a **sync. encoder** below.
With drives of the same type (same ratio i), the value **1** is set for both parameters.

223 Mode selection
Adjustment range: 1/2/3/4/5/6/7/8
The mode selection determines how the slave reacts to a free-running operation signal.
"0" signal at terminal X40:1 (INØ) iniates synchronous operation.
In free-running operation (X40:1 = "1"), the slave does not receive its setpoint from the master. In this case the setpoint source in P100 is effective. Master and slave no longer run in angular synchronization.

| Mode | Function | Description | X40:1 | X40:2… X40:4 | Slave counter (P224) | OFF (red) |
|---|---|---|---|---|---|---|
| **1** | Free-running operation<br>- limited time by X40:1<br>- with new reference point | X40:1 = "1" initiates free-running<br>X40:1 = "0" initiates synchronous operation<br>Slave counter (P224) and internal difference counter are switched off. When free-running ends, the actual position is set as the new reference point to the master. The angular difference arising during free-running is not reduced to zero. | Effective | Not effective | Not effective | ON |
| **2** | Free-running operation<br>- limited time by X40:1 | X40:1 = "1" initiates free-running<br>X40:1 = "0" initiates synchronous operation<br>Slave counter (P224) is not effective and the internal difference counter is effective. When free-running ends, the angular difference arising during free-running is reduced to zero. The slave runs in the previous position, synchronous to the master. | Effective | Not effective | Not effective | On |
| **3** | Free-running operation<br>- limited time by X40:1<br>- with new ref. point | X40:1 = "1" initiates free-running<br>X40:1 = "0" initiates synchronous operation<br>On switch-over to free-running (X40:1 → "1"), the actual slave position is saved in the internal difference counter. When free-running ends, (X40:1 → "1"), the slave synchronizes itself to the saved position with an extra sign-prefixed position offset, set with P224. This results in a new reference point for the slave in relation to the master. | Effective | Not effective | Effective | ON |
| **4** | Free-running operation<br>- limited by value in P224 | A "1" signal to X40:1 (pulse time > 100 ms) initiates start of free-running. Free-running operation ends when the angular difference reaches the value in P224 and the angular difference is reduced to zero. The slave then runs in the previous position, synchronous to the master. | Effective | Not effective | Effective | ON |

| Mode | Function | Description | X40:1 | X40:2… X40:4 | Slave counter (P224) | OFF (red) |
|---|---|---|---|---|---|---|
| **5** | Free-running operation<br>- limited by value in P224<br>- with new ref. point | A "1" signal to X40:1 (pulse time > 100 ms) initiates start of free-running. Free-running operation ends when the angular difference reaches the value in P224. The angular difference is not reduced to zero but the slave enters synchronous operation with this new value and therefore has a new reference point in relation to the master. The sign-prefix for P224 defines whether the new reference point is in the leading or the trailing sense of direction in relation to the master position. | Effective | Not effective | Effective | ON |
| **6** | Synchr. operation<br>- with occasional angle offset (offset) | Slave runs with offset value of P225 in relation to master. | "1" | X40:2="1" | Not effective | ON |
| | | Slave runs with offset value of P226 in relation to master. | "1" | X40:3="1" | | |
| | | Slave runs with offset value of P227 in relation to master. | "1" | X40:4="1" | | |
| **7** | Synchr. operation<br>- with permanent angle offset (phase trimming) | Slave runs with offset value of P225 in relation to master. | "1" | X40:2="1" | Not effective | ON |
| | | Slave runs with offset value of P226 in relation to master. | "1" | X40:3="1" | | |
| | | Slave runs with offset value of P227 in relation to master. | "1" | X40:4="1" | | |
| **8** | Free-running operation<br>- limited time by X40:1<br>- with new ref. point | X40:1 = "1" initiates free-running<br>X40:1 = "0" initiates synchronous operation<br>When free-running operation ends (X40:1 → "0"), the internal difference counter is set to zero and the slave synchronizes itself in the angular position to the master as set in P224. This results in a new reference point for the slave in relation to the master, namely the value in P224. | Effective | Not effective | Effective | ON |

224 Slave counter [inc.]

Adjustment range: -99,999,999...-10 / 10...99,999,999

The angle offset in respect of the master which can be activated in modes 3, 4 and 5 is referred to as the slave counter. In contrast to the offset, this angle offset can be adjusted using the "Teach-in" function. Depending on the mode, it functions as a limit value for free-running operation or specifies a permanent angle offset for the slave in respect of the master, i.e. it specifies a new reference point.

In **mode 3,** the slave counter specifies a new reference point for the slave in respect of the master after free-running operation has been completed. The new reference point is in the positive sense of rotation relative to the master if the sign of the slave counter is positive; if the sign is negative, it is in the negative sense of rotation relative to the master.

In **mode 4,** the slave counter is used as a limit value for the angle offset. The slave automatically runs back to its old reference point in respect of the master in free-running operation after it reaches the entered angular difference (value of P224). This happens irrespective of whether the slave is running ahead of the master with a higher setpoint or running behind the master with a lower setpoint in free-running operation. The polarity of the setpoint and the slave counter must be the same.

In **mode 5,** the slave counter specifies a new reference point for the slave in respect of the master as in mode 3. The new reference point is in the positive sense of rotation relative to the master if the sign of the slave counter is positive; if the sign is negative, it is in the negative sense of rotation relative to the master. The slave automatically synchronizes itself to the master again after reaching the new reference point. This means the slave needs a suitable setpoint in free-running operation.

In **mode 8** the slave counter gives the slave a new reference point to the master as in mode 3. The internal counter for the angle offset is set to zero before the new reference point is set.

The slave counter is entered with a sign:

- Value "without sign" Slave runs ahead of the master; the value is added to the old reference point = Offset in leading sense of rotation.
- Value "-": Slave follows behind the master; the value is subtracted from the old reference point = Offset in trailing sense of rotation.

225 Offset 1 [inc.] (X40:2)

226 Offset 2 [inc.] (X40:3)

227 Offset 3 [inc.] (X40:4)
Adjustment range: -32,767...-10 / 10...32,767 inc.; effective only in mode 6 or mode 7!
For **mode 6** (angle offset at times):
Three separately adjustable angular differences to which the slave sets itself for the duration of the "1" signal at X40:2 / X40:3 / X40:4. This is followed by synchronous operation in the previous position in respect of the master. The offset values cannot be mixed, i.e. if one offset value is active, the others are blocked. If X40:2, X40:3 and X40:4 receive a "1" signal at the same time, X40:2 is in effect.
For **mode 7** (permanent angle offset):
As in mode 6, except that the angle offset is also retained after the "1" signal is withdrawn. If the "1" signal is applied for longer than 3 s, the slave adjusts itself continuously 4 times a second.
For **modes 6 and 7:** Sign of the angle value as in mode 5.

**23_ Synchronous operation with sync. encoder**

In all applications involving friction-locked power transmission between the motor shaft and the machine, in which case slip is to be expected, it is necessary for position measurement to take place using an additional encoder. This encoder must be mounted in a positive-locked connection to the driven machine part (it is fitted to a section of the machine) and is referred to as a sync. encoder. It is used for registering the current position of the slave. Furthermore, the encoder mounted on the motor shaft is required in order to register the current speed of the drive.

230 Sync. encoder

| | |
|---|---|
| OFF | No sync. encoder application. |
| EQUAL | The "sync. encoder master" signal is passed on to the next slave. |
| CHAIN | The "sync. encoder slave" signal is passed on to the next slave. |

231/232 Slave encoder factor / Slave sync. encoder factor
Adjustment range: 1..1000
There is usually a mechanical ratio between both encoders. This ratio has to be set using the parameters.

**24_ Synchronous operation with catch-up**

If the slave is switched from free-running operation to synchronous operation, the current angle offset in respect of the master is reduced depending on the set operating mode. In order to operate this catch-up process in a controlled fashion, it is possible to set parameters for the synchronization speed and the synchronization ramp.

240 Synchr. speed [rpm]
Adjustment range: 0...1500...5500 rpm
This parameter specifies the speed of the catch-up process. In this case, it should be noted that the synchronization speed (catch-up speed) is greater than the maximum operational value for the master speed multiplied by the ratio between the slave gear factor (P222) and the master gear factor (P221).

$$P240 > n_{max\_master} \bullet \frac{P222}{P221}$$

241 Synchr. ramp [s]
Adjustment range: 0...2...50 s
Amount of the acceleration ramp for synchronizing the slave with the master. Enter the value 0 if the slave is to synchronize itself with the master using the maximum possible acceleration.

**51_ Synchronous operation monitoring functions**

510 Position tolerance slave [inc.]
Adjustment range: 10...25...32.768 inc.
Various preconditions must be met in order for the slave to position exactly. The brake of the slave drive is applied when all of the following conditions are met:

- the master is stopped,
- the master is de-energized (= inverter status INHIBITED),
- the slave is stopped and is located within the position window.
  The DRS SLAVE IN POS message can be used as a position message, for example, and be programmed on a binary output (P62_/P63_).

511 Adv. warn. lag error [inc.]
Adjustment range: 50...99.999.999 inc.
An advance warning message is generated if the angle offset exceeds the value set here. This is independent of the operating mode of the slave drive. The DRS ADV. WARN. message can be used as a position message, for example, and be programmed on a binary output (P62_/P63_).

512 Lag error limit [inc.]
Adjustment range: 100...4000...99.999.999 inc.
Fault message F42, "Lag error" is generated if the angle offset exceeds the value set here. This is independent of whether the slave is operating in free-running or synchronous operation. The /DRS LAG message can be programmed as a signal output on a binary output (P62_/P63_).
As well as this message, it is also possible to program how the inverter responds to a fault (→ P834).
The /DRS LAG message is "0" active. In modes 3 and 5, the synchronization point is already at the new cutting position starting from when the free-running operation terminal (X40:1) is actuated. The /DRS ADV. WARN. and /DRS LAG messages therefore already relate to this point and can be used for time-optimised positioning of the saw in the "flying saw" application. In modes 6 and 7, the synchronization point is already at the new angle position starting from when an offset terminal is actuated. The /DRS ADV. WARN. and /DRS LAG messages therefore relate to the new position.

513 Delayed lag message
Adjustment range: 1...99 s [s]
The "Adv. warn. lag error" and "Lag error limit" messages can be suppressed as a fault message or an output on a binary output for an adjustable masking time during the transition from free-running operation to synchronous operation.

514 Counter LED display [inc.]
Adjustment range: 10...100...32.768 inc.
LED V1 (green) lights up to indicate if the angle offset exceeds the value set here. This makes it possible immediately to visualize the maximum differential between the master and slave occurring during operation. This is helpful during startup.

515 Delayed position message [ms]
Adjustment range: 5...10...2000 ms
The binary output message DRS SLAVE IN POS is not generated until the master and slave have been within the "Position tolerance slave" (P510) for the length of time set here.

**60_/61_ Binary inputs**

The programmable binary inputs can be assigned four additional types of signal for synchronous operation.

- DRS SET ZERO PT.
  The internal counter for the angle offset can be zeroed.
  "1" signal = Counter is zeroed.
  "1" → "0" = New reference point for synchronous operation. The function is needed during startup if it is necessary to calibrate the master and slave to one another.
- DRS SLAVE START
  Causes synchronous start of master and slave.
- DRS TEACH IN
  Makes it possible to enter the cutting length (slave counter P224) for the "flying saw" application which can be performed using modes 3 and 5. The possibility of entering the cutting length using the DRS TEACH IN binary signal is available if the inverter is not accessible to the user.
  The following steps are necessary for entering the cutting length:
  - The binary input to which DRS TEACH IN is assigned must receive a "0" signal.
  - Use terminal X40:1 ("1" signal) to switch the drive to free-running operation.
  - Reference points 1 and 2 specify the cutting length.
  - Move to reference point 1.
  - Give a "1" signal on the binary input with DRS TEACH IN.
  - Move to reference point 2.
  - Give a "0" signal on DRS TEACH IN again.
  - Use terminal X40:1 ("0" signal) to switch the drive to synchronous operation.
  - The "teach value" is adopted by the slave counter (P224).

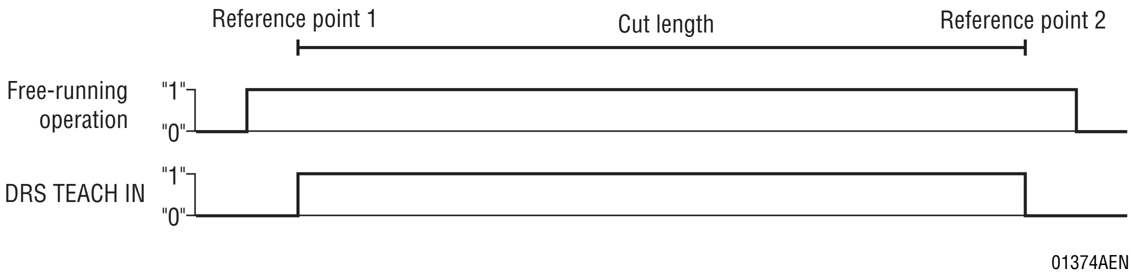



*Fig. 16: DRS TEACH IN function*

**2 variants for moving to the reference points:**

1. Move to the reference points with the saw carriage;
   This method can be used with small cutting lengths. The material to be cut to length is stopped and the saw is moved by the cutting length.
2. Move to the reference points with the material to be cut to length;
   This can be used when the cutting lengths are longer than the area in which the sawing operation takes place. To do this, set the first reference point to the current cutting position after cutting the material to length. Then stop the saw, switch on the material feed, move the material to be cut to length by the required cutting length and set the second reference point.

- DRS MASTER STOPPED
  Permits open-circuit monitoring between the master and slave.
  Open-circuit monitoring is active when the slave binary input is programmed to "DRS MASTER STOPPED". The slave signals fault 48 "HARDWARE DRS" in case of an open circuit (→ Sec. 6).

**62_/63_ Binary outputs**

The programmable binary outputs can be assigned three additional messages for synchronous operation:

- /DRS PRE-WARN. (→ P511) "0"-active
- /DRS LAG (→ P512) "0"-active
- DRS SLAVE IN POS (→ P510) "1"-active

**834 Reaction to LAG ERROR**

It is possible to program the reaction to a fault message generated by exceeding the lag error limit (→ P512):

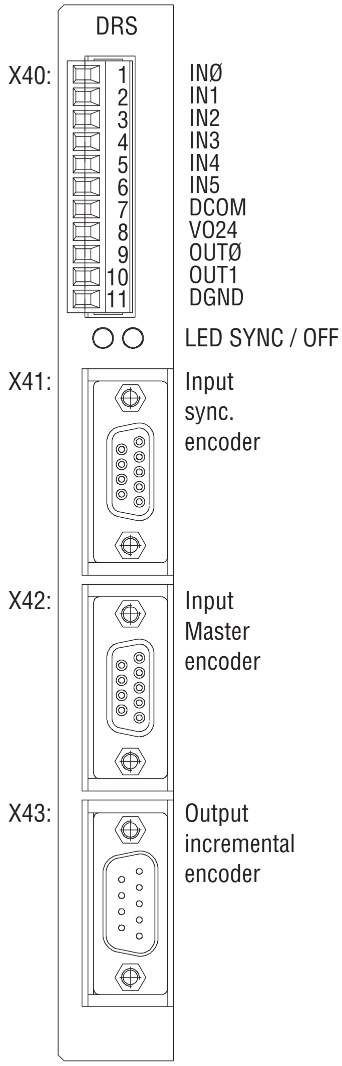
| Reaction | Description |
|---|---|
| NO REACTION | No fault is displayed, nor is there any fault response. The signalled fault is completely ignored. |
| DISPLAY FAULT | The fault is displayed (on the 7-segment display and MX_SHELL); however, the unit does not react in any other respect. Reset can be used for resetting the fault (terminal, RS-485, fieldbus, auto reset). |
| IMMED. STOP/FAULT | The inverter is switched off immediately and a fault message is generated. In this case, the brake is applied immediately and the output stage is inhibited. The ready message is withdrawn and the malfunction output is set, if programmed. A new start is only possible after a fault reset during which the inverter is re-initialized. |
| EMERG. STOP/FAULT | The drive is braked along the set emergency stop ramp. Once the stop speed is reached, the brake is applied and the output stage is inhibited. The fault message is displayed immediately. The ready message is withdrawn and the malfunction output is set, if programmed. A new start is only possible after a fault reset during which the inverter is re-initialized. |
| RAPID STOP/FAULT | The drive is braked along the set rapid stop ramp. Once the stop speed is reached, the brake is applied and the output stage is inhibited. The fault message is displayed immediately. The ready message is withdrawn and the malfunction output is set, if programmed. A new start is only possible after a fault reset during which the inverter is re-initialized. |
| IMMED. STOP/WARN. | The inverter is switched off immediately and a fault message is generated. In this case, the brake is applied immediately and the output stage is inhibited. A malfunction message is activated via the terminal, if programmed. The ready message is not withdrawn. If the fault is corrected by an internal procedure or a fault reset, the drive starts again without re-initialization of the unit. |
| EMERG. STOP/WARN. | The drive is braked along the set emergency stop ramp. Once the stop speed is reached, the brake is applied and the output stage is inhibited. The fault message is displayed immediately. A malfunction message is activated via the terminal, if programmed. The ready message is not withdrawn. If the fault is corrected by an internal procedure or a fault reset, the drive starts again without re-initialization of the unit. |
| RAPID STOP/WARN. | The drive is braked along the set rapid stop ramp. Once the stop speed is reached, the brake is applied and the output stage is inhibited. The fault message is displayed immediately. A malfunction message is activated via the terminal, if programmed. The ready message is not withdrawn. If the fault is corrected by an internal procedure or a fault reset, the drive starts again without re-initialization of the unit. |

# 6 Fault Messages

The following fault messages may occur specifically in synchronous running:
(For the complete list of faults → MOVIDRIVE® manual/operating instructions).

| Fault code | Designation | Possible cause | Response |
|---|---|---|---|
| **14** | Encoder | - Encoder cable or shield not connected correctly<br>- Short circuit or wire break in encoder cable<br>- Encoder defective | Check encoder cable and shield are connected correctly; check for short circuit and wire break |
| **36** | No option | - Option card type not permitted<br>- Setpoint source, control source or operating mode not permitted for this option card | - Use appropriate option card<br>- Set correct setpoint source (P100)<br>- Set correct control source (P101)<br>- Set correct operating mode (P700 or P701) |
| **40** | Boot synchronization | Fault during boot synchronization between inverter system and option card | Fit a new option card if this reoccurs |
| **41** | Watchdog option | Fault during communication between system software and option card software | Contact SEW Service for advice |
| **42** | Lag error | - Polarity of incremental encoder set incorrectly<br>- Acceleration ramps too short<br>- P-portion of positioning control too small<br>- Speed controller parameters set incorrectly<br>- Value for lag error tolerance too low | - Change over polarity of incremental encoder<br>- Extend ramps<br>- Set P-portion to higher value (P220)<br>- Set speed controller parameters again<br>- Set lag error tolerance to higher value<br>- Check wiring of encoder, motor and power system phases<br>- Check mechanical components for freedom of movement; they may be blocked |
| **48** | Hardware DRS | - Encoder signal from master faulty<br>- Hardware required for synchronous running is faulty | - Check encoder wiring<br>- Fit a new synchronous running card |

# 7 Technical Data




01007AEN

*Fig. 17: Front view of DRS11A*

| **Option** | | **Synchronous operation card type DRS11A** |
|---|---|---|
| Part number | | 822 319 X |
| Binary inputs<br><br>Signal level<br><br>Control functions | X40:INØ ...IN5 | $R_i \approx 3.0$ kΩ, PLC compatible<br>$I_E \approx 10$ mA, sampling interval: 5 ms<br>+13 V...+30 V ≙ "1"<br>-3 V...+5 V ≙ "0"<br>The binary inputs are fixed assigned with:<br>INØ = free-running operation<br>IN1 = Offset 1<br>IN2 = Offset 2<br>IN3 = Offset 3<br>IN4 = IPOS$^{plus}$ variable H477.0<br>IN5 = IPOS$^{plus}$ variable H477.1 |
| Reference terminal | X40: DCOM | Reference for binary inputs X40:INØ...IN5 |
| Binary outputs<br><br>Signal level<br><br>Control functions | X40:OUTØ OUT1 | $R_i \approx 100$ Ω, PLC compatible<br>Response time: 5 ms<br>"0" = 0 V, "1" = 24 V<br>**Do not apply external voltage!**<br>The binary outputs are fixed assigned with:<br>OUTØ = IPOS$^{plus}$ variable H476.0<br>OUT1 = IPOS$^{plus}$ variable H476.1 |
| Reference terminal | X40:DGND | Reference potential for binary outputs |
| LEDs | SYNC (green) | ON = Angular difference > value of P514<br>OFF = Angular difference < value of P514 |
| | OFF (red) | ON = Free-running operation<br>OFF = Synchronous operation |
| Input sync. encoder | X41: | TTL level (RS-422), max. 200 kHz<br>24 V, max. 180 mA<br>9-pin sub-D plug female |
| Input master encoder | X42: | TTL level (RS-422), max. 200 kHz<br>24 V, max. 180 mA<br>9-pin sub-D plug female |
| Incremental encoder output | X43: | TTL level (RS-422), 24 V, max. 180 mA<br>9-pin sub-D plug male |
| Permissible cable section | | Single core: 0.20...0.5 mm$^2$ (AWG24...20)<br>Double core: 0.20...0.34 mm$^2$ (AWG24/22) |
| RAM battery | Type<br><br><br>Service life | CR 2430 (25x3 mm), commercial battery, available from specialized retailers, cannot be provided by SEW Spare Parts service.<br>> Ten years, dispose of used batteries in accordance with the applicable waste disposal regulations. |
| Weight | | 0.18 kg (0.4 lb) |

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