Rexroth

ECODRIVE03/DURADRIVE
Drives for General Automation with Fieldbus Interfaces

Firmware Version Notes: FGP 20VRS

SYSTEM200

DOK-DRIVE*-FGP-20VRS**-FV01-EN-P

Rexroth Indramat

Title
ECODRIVE03/DURADRIVE
Drives for General Automation
with Fieldbus Interfaces

Type of Documentation
Firmware Version Notes

Document Typecode
DOK-DRIVE*-FGP-20VRS**-FV01-EN-P

Internal File Reference
Box set: 73-20V-EN
Based on: FGP 20VRS
Document Number: 120-0850-B320-01/EN

Purpose of Documentation
This documentation offers an overview of the functionality of the firmware FWA-DRIVE*-FGP-20VRS and describes the differences between this firmware and its previous version FWA-ECODR3-FGP-03VRS.

In the "Summary" chapter, the texts of the functions and parameters that have been changed or added since the previous version FWA-ECODR3-FGP-03VRS are marked with gray background color.

Record of Revisions

Description	Release Date	Notes
DOK-DRIVE*-FGP-20VRS**-FV01-EN-P	02.2002	First edition

Validity
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Published by
Rexroth Indramat GmbH
Bgm.-Dr.-Nebel-Str. 2 • D-97816 Lohr a. Main
Telephone +49 (0)93 52/40-0 • Tx 68 94 21 • Fax +49 (0)93 52/40-48 85
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Dept. EDF2/EDY (th/mw/hm/bb)

Note
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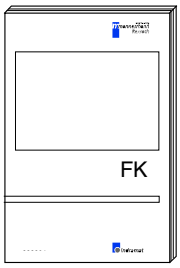
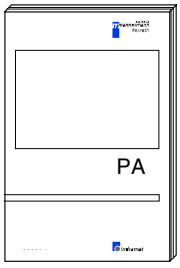
Summary of Documentation - Overview



Functional Description:

Description of all implemented functions
based on SERCOS parameters

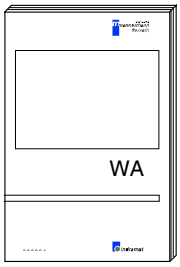
Order designation:
DOK-DRIVE*-FGP-20VRS**-FK01-EN-P



Parameter Description:

Description of all parameters
used in the firmware

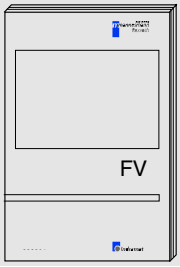
Order designation:
DOK-DRIVE*-FGP-20VRS**-PA01-EN-P



Troubleshooting Guide

- Explanation of the diagnostic states
- How to proceed when eliminating faults

Order designation:
DOK-DRIVE*-FGP-20VRS**-WA01-EN-P



Firmware Version Notes:

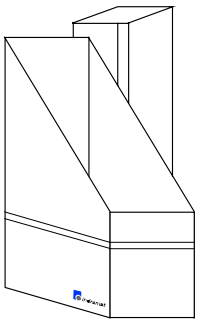
Summary of the functionalities of the new firmware
And of the changes since the previous version
FWA-ECODR03-FGP-03VRS-MS

Order designation:
DOK-DRIVE*-FGP-20VRS**-FV01-EN-P

CD: DRIVEHELP

Collection of Windows help systems which
contain documents on firmware derivates

Order designation:
DOK-GENERL-DRIVEHELP**-GNxx-MS-D0600



Order designation:
DOK-DRIVE*-FGP-20VRS**-7301-EN-P

Notes

Contents

Notes

1 General Information

1.1 Firmware Types

For the ECODRIVE03/DURADRIVE drive families there are three firmware types for different applications:

- **SMT**: Drives for Machine Tool Applications with SERCOS and Parallel Interface
- **SGP**: Drives for General Automation with SERCOS and Parallel Interface
- **FGP**: Drives for General Automation with Field Bus Interfaces

These Version Notes relate to the firmware version:

ECODRIVE03/DURADRIVE

Drives for General Automation
with Field Bus Interfaces

FWA-DRIVE*-FGP-20VRS-MS

Using this documentation it is possible to quickly obtain an overview of the functionalities of this firmware.

In addition, this documentation describes the differences between the firmware version FWA-DRIVE*-FGP-20VRS and the previous version FWA-ECODR3-FGP-03VRS. These differences are marked with gray background color in the "Summary" chapter.

The following drive controllers can be operated with the firmware released:

DKC03.3-040-7-FW	DKC03.3-100-7-FW	DKC03.3-200-7-FW
DKC04.3-040-7-FW	DKC04.3-100-7-FW	DKC04.3-200-7-FW
DKC05.3-040-7-FW	DKC05.3-100-7-FW	DKC05.3-200-7-FW
DKC06.3-040-7-FW	DKC06.3-100-7-FW	DKC06.3-200-7-FW

HDC01.1-A40N-PB01	HDC01.1-A100N-PB01	HDC01.1-A200N-PB01
HDC01.1-A40N-IB01	HDC01.1-A100N-IB01	HDC01.1-A200N-IB01
HDC01.1-A40N-CN01	HDC01.1-A100N-CN01	HDC01.1-A200N-CN01
HDC01.1-A40N-DN01	HDC01.1-A100N-DN01	HDC01.1-A200N-DN01

1.2 Release Notes

The general distribution of the firmware version 20 starts as of the **FWA-DRIVE*-FGP-20V09** firmware release.

This firmware was released on: **01/02/2002**

Note: The commissioning of the drive firmware version **FWA-DRIVE*-FGP-20VRS-MS** requires the DriveTop version **SWA-DTOP***-INB-14VRS-MS-C1,44-COPY** (or higher).

1.3 Drive Controllers

With the SMT, SGP and FGP (all 20VRS) firmware types it is possible to operate all drive controllers of the ECODRIVE03/DURADRIVE ranges. The differences between the devices are due to different current ratings and different device concepts (interfaces, supported motor types and measuring systems).

Interfaces

Apart from a serial interface, there are the following master communication interfaces available:

Master communication interface	FWA	ECODRIVE03	DURADRIVE
SERCOS	SMT, SGP (all 20VRS)	DKC22.3-xxx-7-FW	HDC01.1-AxxxN-SE02
Analog	SMT, SGP (all 20VRS)	DKC21.3-xxx-7-FW	no
Parallel	SMT, SGP (all 20VRS)	DKC21.3-xxx-7-FW	no
INTERBUS	FGP20VRS	DKC04.3-xxx-7-FW	HDC01.1-AxxxN-IB01
PROFIBUS	FGP20VRS	DKC03.3-xxx-7-FW	HDC01.1-AxxxN-PB01
CANopen	FGP20VRS	DKC05.3-xxx-7-FW	HDC01.1-AxxxN-CN01
DeviceNet	FGP20VRS	DKC06.3-xxx-7-FW	HDC01.1-AxxxN-DN01

Fig. 1-1: Master communication interfaces

1.4 Overview of Operating Modes

Operating mode	FWA	ECODRIVE03	DURADRIVE
torque/force control	SMT, SGP, FGP (all 20VRS)	yes	only possible via MCM (e.g. SERCOS)
velocity control	SMT, SGP, FGP (all 20VRS)	yes	only possible via MCM (e.g. SERCOS)
position control	SMT, SGP, FGP (all 20VRS)	yes	yes
drive-internal interpolation	SMT, SGP, FGP (all 20VRS)	yes	yes
drive-controlled positioning	SMT, SGP, FGP (all 20VRS)	yes	yes
jogging	SMT, SGP, FGP (all 20VRS)	yes	only possible via MCM (e.g. SERCOS)
positioning block mode	SMT, SGP, FGP (all 20VRS)	yes	only possible via MCM (e.g. SERCOS)
synchronous operating modes with virtual master axis	SGP, FGP (all 20VRS)	yes	yes
synchronous operating modes with real master axis	SGP, FGP (all 20VRS)	yes	yes

Fig. 1-2: Operating modes (MCM: master communication module)

2 Replacing the Firmware

2.1 Notes on How to Replace the Firmware

When replacing the firmware, please observe the following:

1. The drive controller must be on.
2. The current parameters must be saved.
3. The drive controller must be in phase 2.
4. The baud rate must be set to 9600
   (the value ’0’ must be set in the parameter **P-0-4021, Baud rate RS-232/485**).

Note: Do not switch off the 24V control voltage while replacing the firmware!

2.2 Firmware Replacement Procedure

The following description applies to the firmware replacement with Dolfi V1.05 or newer (SWA-DOL*PC-INB-01V05-MS-C1.44-COPY, part number 279804).

1. Call Dolfi.
2. Input the following under **Options**:

   Tab page **Interface**

   - Under **COM Port** select interface to PC.
   - Set ’9600’ under **Baud rate Connect**.
   - Set baud rate for download under **Baudrate download** (recommended setting: ’115200’).

   Tab page **Address**

   - Enter the address set at switches S2 and S3 on the drive controller.

   Tab page **Language**

   - Select language.
3. Press **Connect** button.

Press **Transmit** button.

- The Windows standard dialog for opening a file opens.

5. Select *.ibf file for update and open file.

- The headers of the programmed modules are read. (You can view the headers that have been read by selecting the tab page **Header**.)

6. Press **Send** button.

- If "Module – All" has been selected, the complete *.ibf file is sequentially programmed without query (an ECODRIVE03/DURADRIVE firmware normally contains three firmware modules). If "Module – Single" has been selected, you will have to press **Send** again after each programmed firmware module.

7. With successful update press **Disconnect** button.

- The drive firmware is started.

8. Exit Dolfi.

- Should the number of parameters to be buffered have changed, "PL" appears on the display (in case errors are pending, then clear these first). If you now press the S1 key, all buffered parameters are reset to their default values. During this time, "C8 Load default parameters" appears on the display.
- If the "C8 Load default parameters" command has been started or the motor type replaced, "UL" appears on the display during the transition check from phase 3 to phase 4. Now press the S1 key or start the "Clear error" command. The controller default values are then loaded to the drive controller from the motor feedback data memory.

9. Load desired parameter file.

3 Summary FWA-DRIVE*-FGP-20VRS-MS

3.1 Master Communication Interfaces

FWA-DRIVE*-FGP-20VRS-MS can be used for the following devices:

- DKC03.3/HDC01.1-A***N-PB01
  (ECODRIVE03/DURADRIVE with PROFIBUS-DP)
- DKC04.3/HDC01.1-A***N-IB01
  (ECODRIVE03/DURADRIVE with INTERBUS-S)
- DKC05.3/HDC01.1-A***N-CN01
  (ECODRIVE03/DURADRIVE with CANopen)
- DKC06.3/HDC01.1-A***N-DN01
  (ECODRIVE03/DURADRIVE with DeviceNet)

The following profiles are supported in the above-mentioned devices:

- I/O mode (functions compatible with the DKC03.1)
- velocity control
- Drive-internal interpolation (functional extension by introducing the target position)
- Freely configurable mode (with configurable multiplex channel and freely configurable signal control and status word)

Note: The "Cyclic position control" profile is **only** supported by the devices with INTERBUS-S or CANopen!

Note: For commissioning you can also use the analog interface.

INTERBUS-S

General features:

- Protocol: INTERBUS-S according to DIN 19258
- Connection to remote bus
- Length of cyclic channel: max. 16 byte
- Parameter transmission via PCP
- Electrical isolation of the interface

Firmware-specific features:

- Mapping of all drive parameters to field bus objects
- Commissioning via INTERBUS without PC by the possibility of bus reconfiguration

PROFIBUS-DP

General features:

- Protocol: PROFIBUS-DP according to DIN EN 50170/2
- Baud rates: 9.6 kbps to 12 Mbps
- Length of cyclic channel: 28 byte max.
  (with 12-byte parameter channel)
- Electrical isolation of the interface

Firmware-specific features:

- Acyclic transmission of parameters in the cyclic channel
- Mapping of all drive parameters to field bus objects
- Commissioning via PROFIBUS without PC by supporting the "SetParam" service for bus initialization
- Synchronous command value acceptance is possible
- PROFIDRIVE V3 parameter channel

CANopen

General features:

- Protocol: CANopen according to CiA DS301
- Baud rates: 10 kbps to 1 Mbps
- Length of cyclic channel: max. 16 byte
- Utilization of the Predefined Connection Set
- Parameter transmission via SDO
- Electrical isolation of the interface

Firmware-specific features:

- Mapping of all drive parameters to field bus objects
- 16-bit format for position data or velocity data is possible

DeviceNet

General features:

- Protocol: DeviceNet Specification, Release 2.0
- Baud rates: 125, 250 and 500 kbps
- Length of cyclic channel: max. 16 byte
- Parameter transmission via Explicit Messages
- Utilization of the Predefined Master/Slave Connection Set
- Electrical isolation of the interface
- Pluggable 5-Pin Open Style Connector

Firmware-specific features:

- Mapping of all drive parameters to field bus objects (classes and instances)

3.2 Basic Operating Modes

Torque/Force Control

Note: With DURADRIVE it is impossible to preset analog command values.

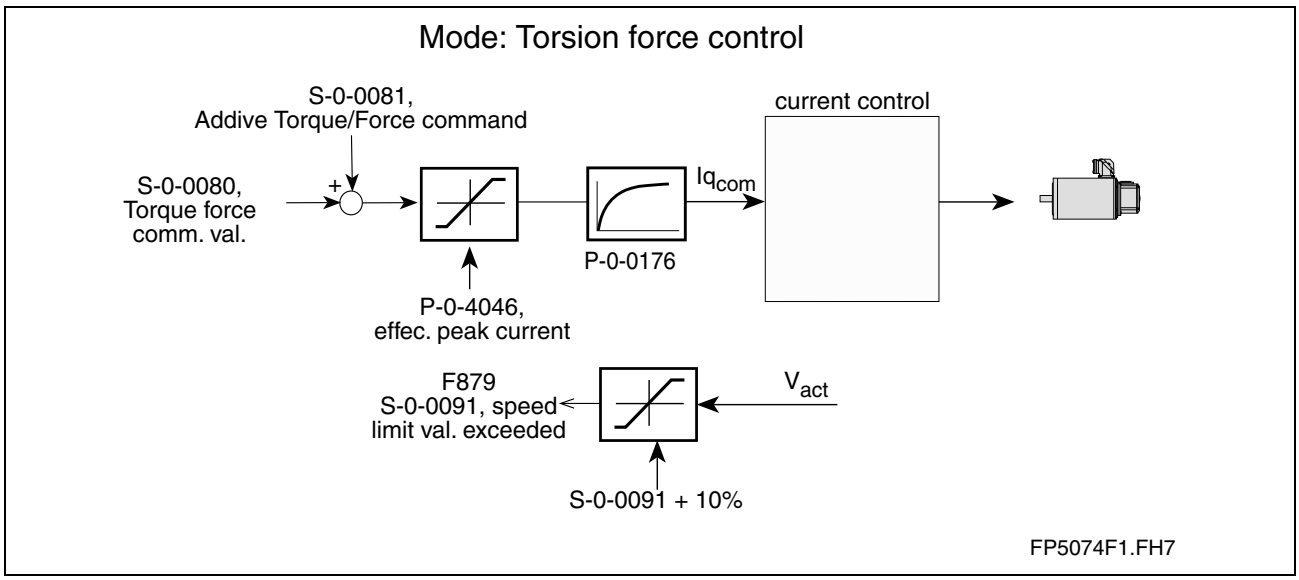


Fig. 3-1: Block diagram: torque/force control

- Torque/force control with regard to the command value preset in parameter **S-0-0080, Torque/Force command** and an additive torque command value in parameter **S-0-0081, Additive Torque/Force command**
- Limiting the preset command value to the limit value that can be parameterized
- Filtering the command value by means of parameter **P-0-0176, Torque/Force command smoothing time constant**
- Monitoring the actual velocity for exceeding parameter **S-0-0091, Bipolar velocity limit value**

Velocity Control

Note: With DURADRIVE it is impossible to preset analog command values.

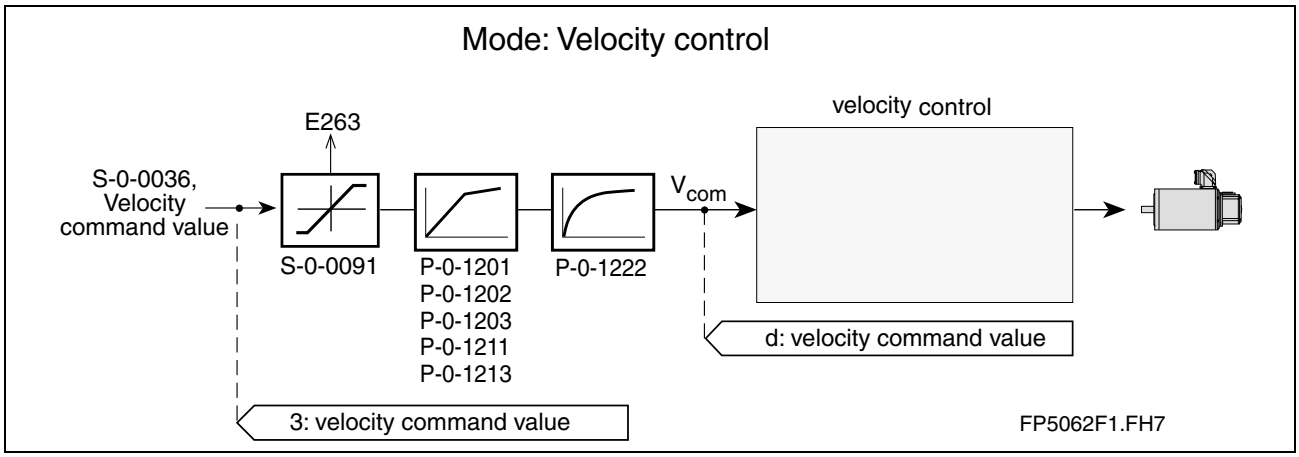


Fig. 3-2: Block diagram: velocity control

- Separately adjustable two-stage acceleration and deceleration limit of the preset velocity command value (parameter **P-0-1211, Deceleration ramp 1** and **P-0-1213, Deceleration ramp 2**); switching from ramp 1 to ramp 2 is done at selectable velocity
- Smoothing the preset command value using a low-pass filter that can be set
- Smoothing the variable using a low-pass filter that can be set
- Filtering a resonance frequency of the variable using a rejection filter with rejection frequency and bandwidth that can be set
- Limiting the variable to a limit value that can be set

Position Control

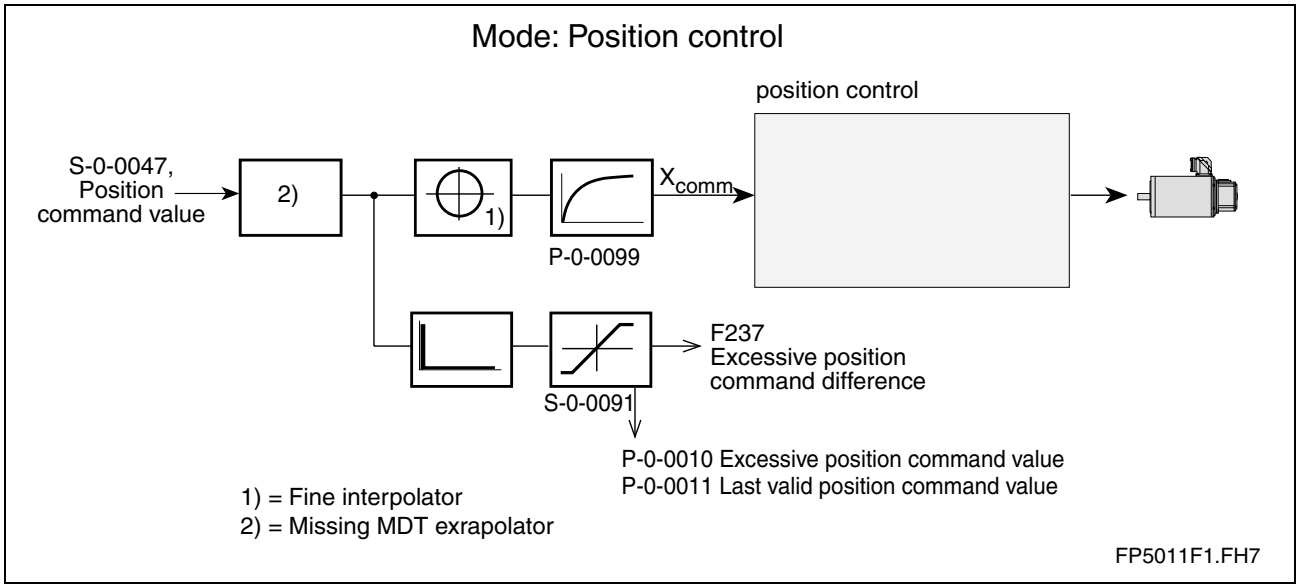


Fig. 3-3: Block diagram: position control

- Position control with regard to **S-0-0047, Position command value**
- Monitoring the position command value difference for exceeding parameter **S-0-0091, Bipolar velocity limit value**
- Fine interpolation of the command value specified in the NC cycle pulse to 1 ms
- Interpolator can be switched from linear to cubic by means of parameter **P-0-0187, Position command processing mode**, bit 0 (default is linear fine interpolator)
- Smoothing the fine interpolated position command values using a low-pass filter that can be set, parameter **P-0-0099, Position command smoothing time constant**
- Position control with regard to actual position value encoder 1 (motor encoder) or actual position value encoder 2 [external (load-side) encoder]
- Dynamic synchronization when changing the operating mode

Drive-Internal Interpolation

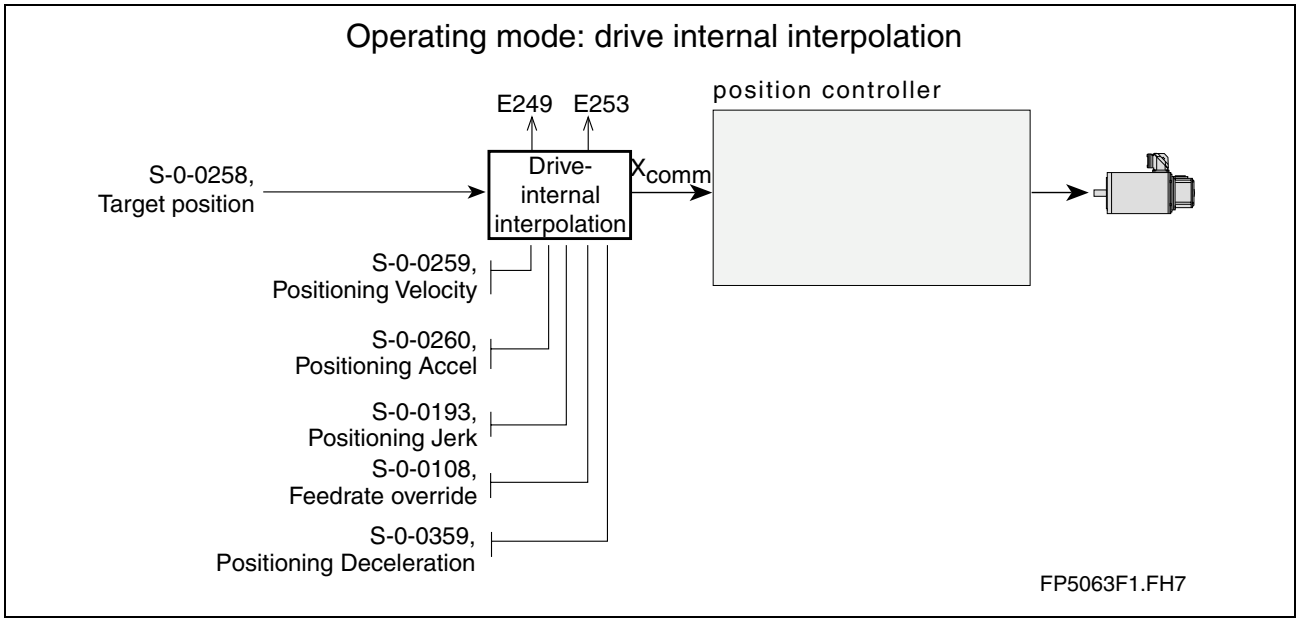


Fig. 3-4: Block diagram: drive-internal interpolation

- Drive-internal generation of a position command value profile to travel to a preset target position (S-0-0258) while maintaining the positioning velocity (S-0-0259) and positioning acceleration (S-0-0260) or positioning deceleration (S-0-0359) that can be set; can be set separately
- Jerk limitation of the generated position command value
- Evaluation of the positioning velocity with feedrate override
- Monitoring the positioning velocity for exceeding parameter **S-0-0091, Bipolar velocity limit value**
- Monitoring the target position for maintaining position limit values
- Command value mode in the modulo format can be set
- Acceleration feedforward (S-0-0348) can be set
- Position control with regard to actual position value encoder 1 (motor encoder) or actual position value encoder 2 [external (load-side) encoder]

Drive-Controlled Positioning

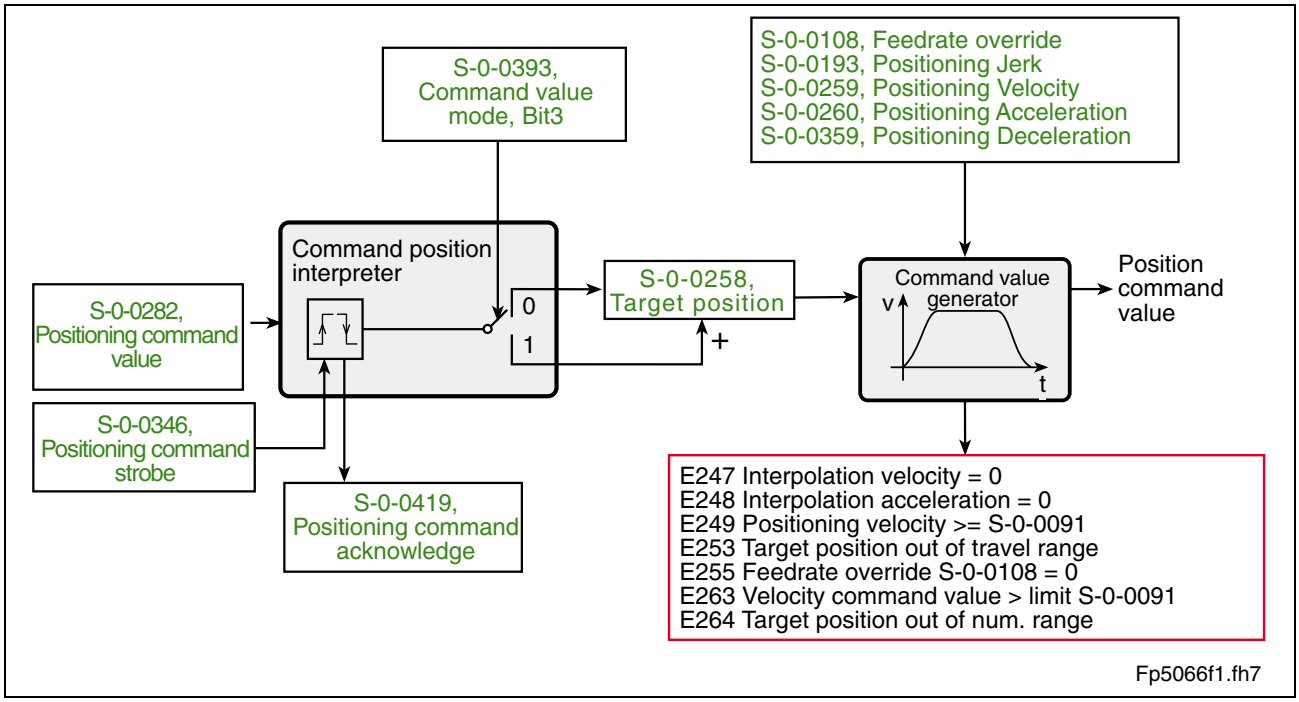


Fig. 3-5: Block diagram: drive-controlled positioning

- Drive-internal generation of a position command value profile to travel to a target position (S-0-0258) preset by means of a positioning command value (S-0-0282) while maintaining the positioning velocity (S-0-0259) and positioning acceleration (S-0-0260) or positioning deceleration (S-0-0359) that can be set; can be set separately
- Control of acceptance of the positioning command value via toggle bit (S-0-0346, bit 0)
- Jerk limitation of the generated position command value
- Evaluation of the positioning velocity with feedrate override
- Monitoring the positioning velocity for exceeding parameter **S-0-0091, Bipolar velocity limit value**
- Monitoring the target position for maintaining position limit values
- Command value mode in the modulo format can be set
- Acceleration feedforward (S-0-0348) can be set
- Position control with regard to actual position value encoder 1 (motor encoder) or actual position value encoder 2 [external (load-side) encoder]
- Generation of the target position from preset positioning command value (absolute or relative positioning)
- Acceleration and deceleration ramps can be set separately

Note: If the positioning command value is accepted, the drive data are written to parameter **S-0-0258, Target position**. The axis is positioned in its target position. If the control unit data are written directly to parameter **S-0-0258, Target position**, this operating mode is compatible with the operating mode "Drive-internal interpolation".

Positioning Block Mode

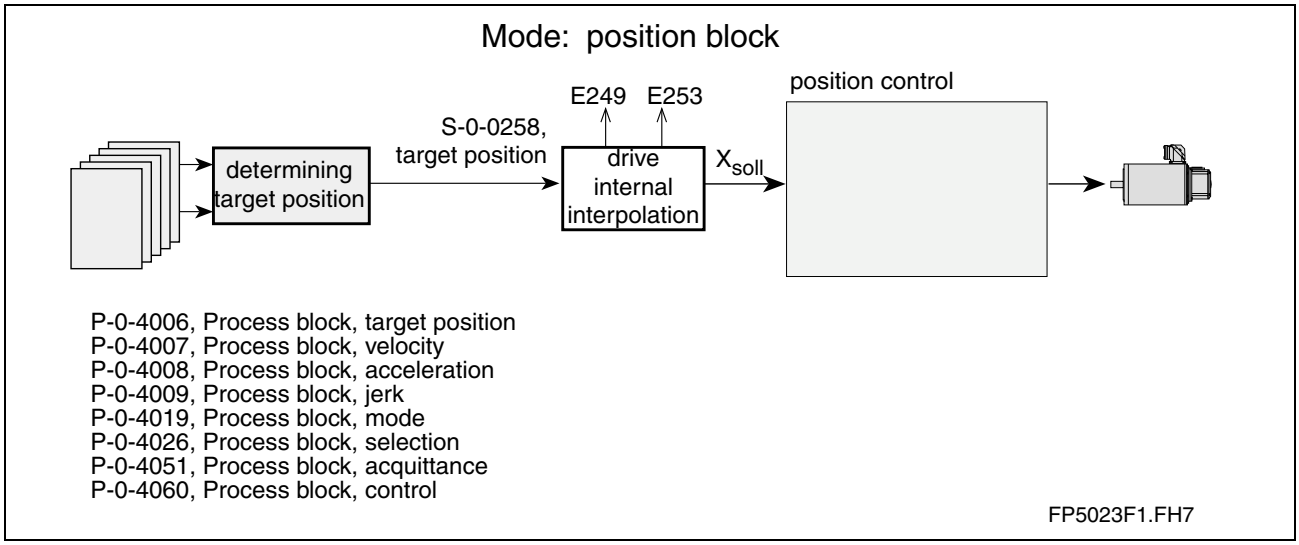


Fig. 3-6: Block diagram: positioning block mode

- Positioning block preselection via parameter **P-0-4026, Process block selection**
- Different modes can be set separately for each positioning block:
  - absolute
  - relative without residual path storage
  - relative with residual path storage
  - infinite travel in positive/negative direction
- Following block mode with position switching or switching signal-dependent switching
- Following block mode with position switching in modes "block transition with old positioning speed", "block transition with new positioning speed" and "block transition with intermediate stop"
- Monitoring the positioning velocity for exceeding the velocity limit value (S-0-0091)
- Monitoring the target position for maintaining position limit values
- Acceleration feedforward can be set
- Position control with regard to actual position value encoder 1 (motor encoder) or actual position value encoder 2 [external (load-side) encoder]
- Acceleration and deceleration can be parameterized separately for each process block. The maximum delay is fixed in parameter **P-0-4063, Process block deceleration**.
- For processing the next process block with block advance by a switch signal the active cam edge can be selected. The effective edge is fixed in parameter **P-0-4019, Process block mode**.
  - **bit 9** = 0: positive edge
    = 1: negative edge

Jogging

- The operating mode "jogging" (positive and negative) is configured via parameter **P-0-4056, Jog inputs**.
- The drive generates the position command value profile while maintaining
- **P-0-4030, Jog velocity**,
- **S-0-0260, Positioning Acceleration**,
- **S-0-0359, Positioning Deceleration** and
- **S-0-0193, Positioning Jerk** for travelling in one direction.
- With active position limit values and a measuring system that has been homed, the drive runs to position limit value minus the positioning window and warning **E831 position limit value while jogging** is generated.

Velocity Synchronization with Virtual Master Axis

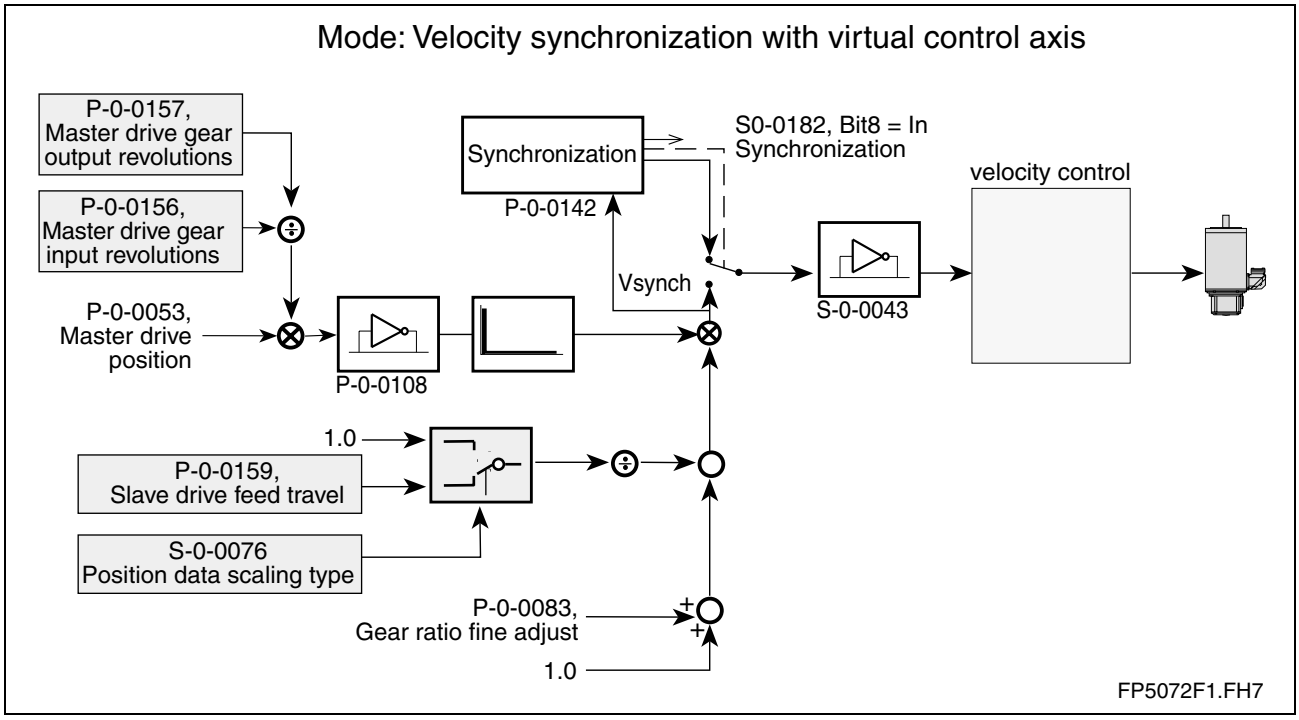


Fig. 3-7: Block diagram: velocity synchronization with virtual master axis

- Velocity control with regard to velocity command values calculated by drive from master axis positions and the electronic gear ratio. It is possible to dynamically change the electronic gear ratio (fine adjustment) and the master axis gear (P-0-0156/P-0-0157).
- Drive-controlled acceleration with synchronization acceleration to the velocity command value when this operating mode has been activated
- Status message "IN-Synchronization" with active and non-active operating mode
- Extrapolation of master axis position with simple MDT failures
- Rotary or translatory output of electronic gearbox as dependent on the position scaling selected
- Determining the master axis position range by means of parameter **P-0-0750, Master axis revolutions per master axis cycle**
- It is possible to limit the change of the velocity command value by the synchronization acceleration

Phase Synchronization with Virtual Master Axis

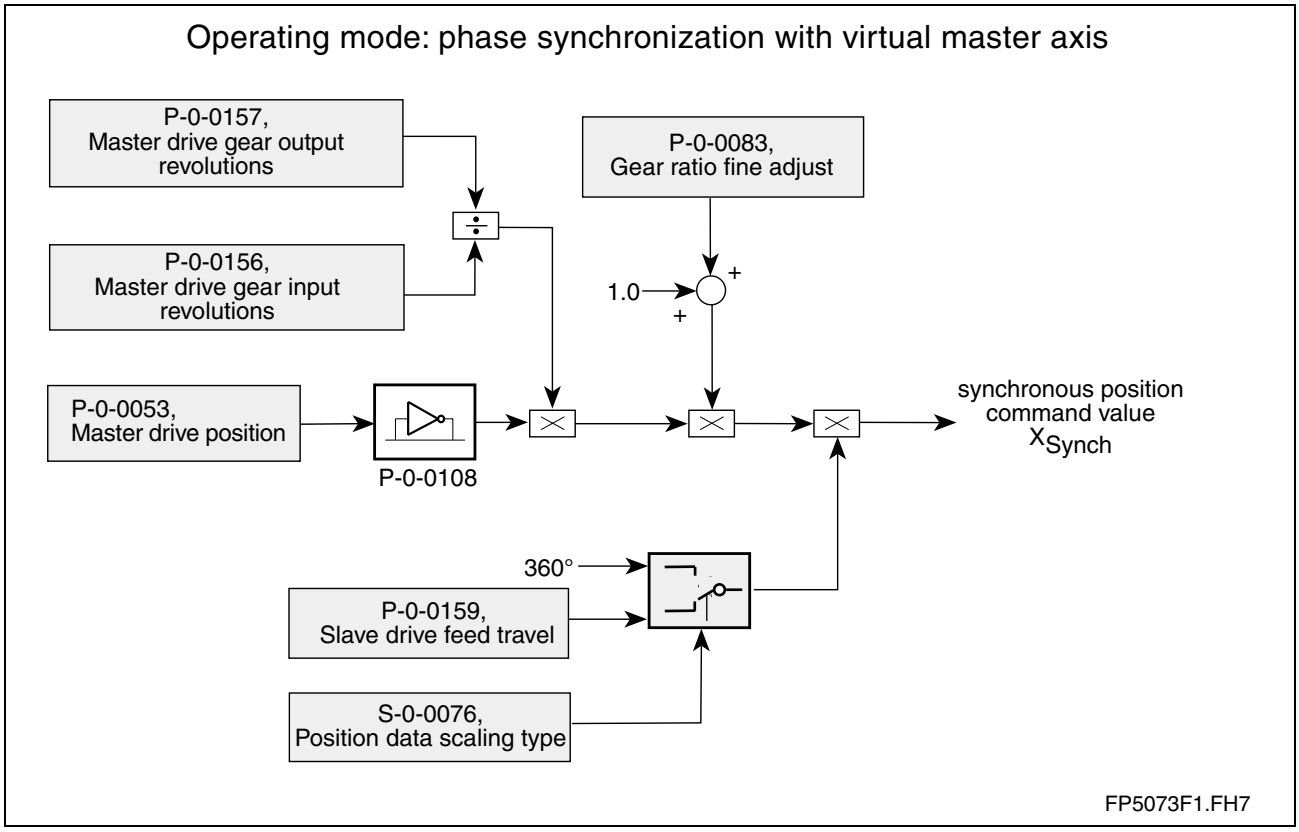


Fig. 3-8: Block diagram: phase synchronization with virtual master axis

- Position control with regard to position command values calculated by the drive from the master axis position, the master axis gear and a gear fine adjustment. It is possible to dynamically change the master axis gear (P-0-0156/P-0-0157).
- Fine interpolation of the master axis positions specified in the NC cycle pulse
- In the "phase synchronization" mode of operation, the parameter **S-0-0103, Modulo value** is always set to a fixed value of 360° (corresponding to one load revolution).
- Determining the master axis position range by means of parameter **P-0-0750, Master axis revolutions per master axis cycle**
- Drive-controlled synchronization to the sum of the position command value plus the additive position command value with the synchronization acceleration, velocity and direction being maintained. The synchronous position command value always is a position in the command value cycle. There are various modes for synchronization:
  - Synchronization in the command value cycle
  - Synchronization in a part of the command value cycle
  - Synchronization in the modulo range
  - Status message: "Synchronization completed"
- Absolute and relative synchronization is possible which also allows relative processing of parameter **S-0-0048, Position command value additional**

- Changes of parameter **S-0-0048, Position command value additional** are either smoothed using a filter or positioned by means of the synchronization acceleration and velocity
- Generation of parameter **P-0-0034, Position command additional actual value** as the difference between actual position value and calculated position command value
- Status message "IN-Synchronization" with active and non-active operating mode
- Extrapolation of master axis position with simple MDT failures
- Rotary or translatory output of electronic gearbox as dependent on the position scaling selected

Electronic Cam Shaft with Virtual Master Axis

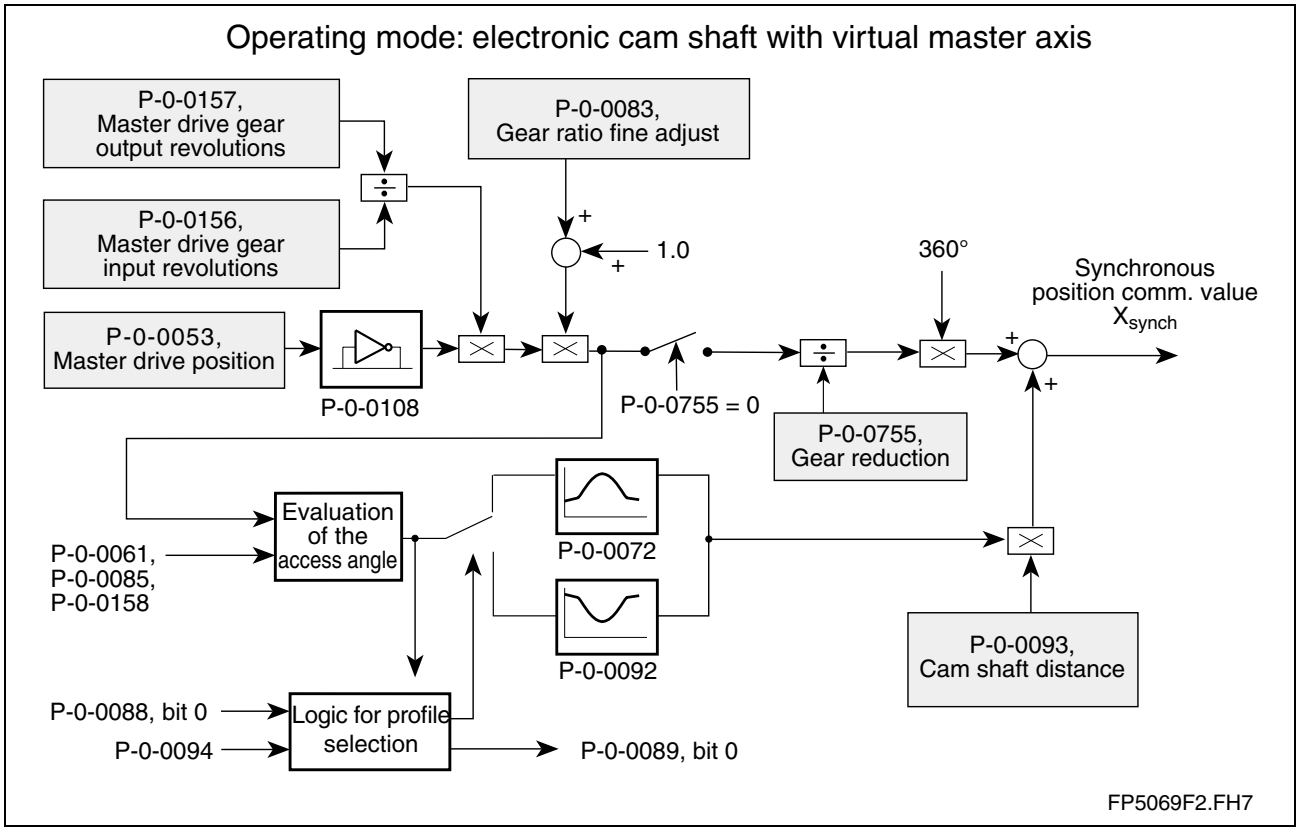


Fig. 3-9: Block diagram: electronic cam shaft with virtual master axis

- Position control with regard to position command values calculated by the drive from the master axis position, the master axis gear, a gear fine adjustment, a cam shaft profile and the cam shaft distance. The master axis position as per master axis gear (P-0-0156/P-0-0157) serves as the profile access angle for the cam shaft profiles.
- In the "electronic cam shafts" mode of operation, parameter **S-0-0103, Modulo value**, with the respective cam shaft profile, is freely selectable.
- Drive-controlled synchronization to the sum of the position command value plus the additive position command value with the synchronization acceleration, velocity and direction being maintained. The synchronous position command value always is a position in the command value cycle. There are various modes for synchronization:
  - Synchronization in the command value cycle
  - Synchronization in a part of the command value cycle
  - Synchronization in the modulo range
  - Status message: "Synchronization completed"
- Absolute and relative synchronization is possible
- Absolute and relative synchronization is possible which also allows relative processing of parameter **S-0-0048, Position command value additional**
- Change velocity can be set for **P-0-0061, Angle offset begin of profile**
- Extrapolation of master axis position with simple MDT failures

- Fine interpolation of the master axis positions specified in the NC cycle pulse
- Fine interpolation of the cam shaft profile values
- Two cam shaft profiles with possibility of switching at specified angle
- Change in cam shaft distance only becomes effective at parameterized angle
- Offset for profile access angle can be set
- Lag-error dependent advance of the profile access angle for lag error compensation can be set
- Drive-controlled synchronization to the sum of the position command value plus the additive position command value with the synchronization acceleration, velocity and direction being maintained; status message: "Synchronization completed"
- Changes of parameter **S-0-0048, Position command value additional** are either smoothed using a filter or positioned by means of the synchronization acceleration and velocity
- Generation of parameter **P-0-0034, Position command additional actual value** as the difference between actual position value and calculated position command value
- Status message "IN-Synchronization" with active and non-active operating mode
- Acceleration feedforward can be set
- Separation of constant movement and the movement resulting from the cam shaft (cross cutter function)
- It is possible to simultaneously switch the master axis gear and the distance value

Velocity Synchronization with Real Master Axis

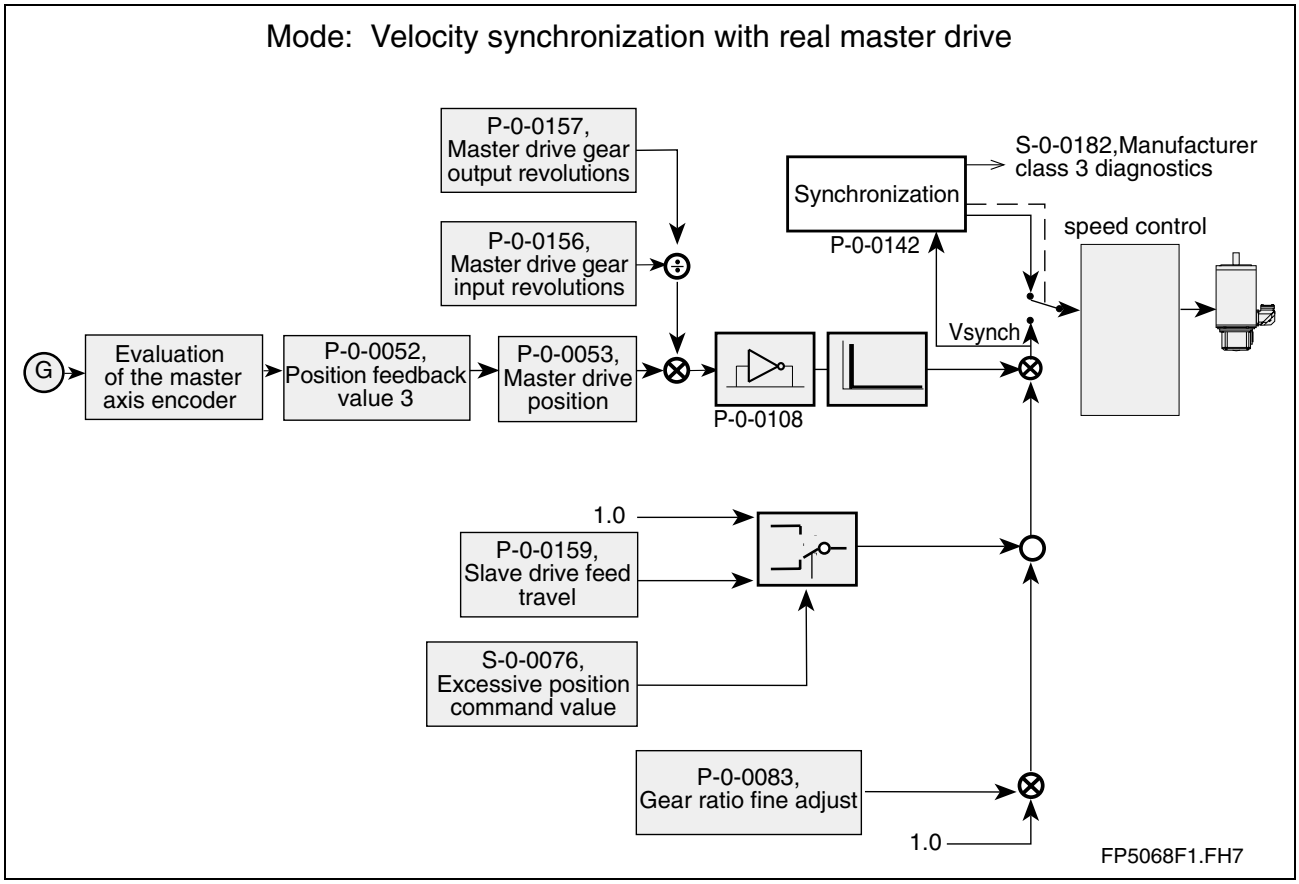


Fig. 3-10: Block diagram: velocity synchronization with real master axis

- The position of the master axis encoder (**P-0-0052, Position feedback value 3**) is directly used as the master axis command value (**P-0-0053, Master drive position**).
- Velocity control with regard to velocity command values calculated by the drive from the master axis positions, the master axis gear and a gear fine adjustment. It is possible to dynamically change the electronic gear ratio (fine adjustment) and the master axis gear (P-0-0156/P-0-0157).
- The master axis position range is determined by means of parameter **P-0-0750, Master axis revolutions per master axis cycle**. The master axis encoder range must equal parameter **P-0-0750, Master axis revolutions per master axis cycle**.
- Drive-controlled acceleration with synchronization acceleration to the velocity command value when this operating mode has been activated
- Optional limitation of the maximum command velocity change to the value of the synchronization acceleration
- Status message "IN-Synchronization" with active and non-active operating mode
- Rotary or translatory output of electronic gearbox as dependent on the position scaling selected

Notes on master axis encoder evaluation:

- Setting absolute measurement for master axis encoder

The "Set absolute measurement" command can also be applied to the master axis encoder. Parameter **S-0-0147, Homing parameter** determines the encoder to be set. Parameter **S-0-0054, Reference distance 2** determines the reference value of the master axis encoder.

- Range of the master axis encoder

The modulo range of the master axis encoder can be expanded to n * 2^{20} revolutions. The value is defined in parameter **P-0-0765, Range of master encoder**.

- Absolute value monitoring of the master axis encoder

On switching to the operating mode (phase 4) the position of the master axis encoder is checked. If this position differs by more than the value defined in parameter **P-0-0766, Master encoder, monitoring window**, the error **F276 Absolute encoder out of allowed window** will be generated.

- Filtering the actual position value 3

For filtering the actual position value 3 a moving average filter with time constants of 0, 2, 4 and 8 ms is available. The phase shift caused by averaging is compensated.

Phase Synchronization with Real Master Axis

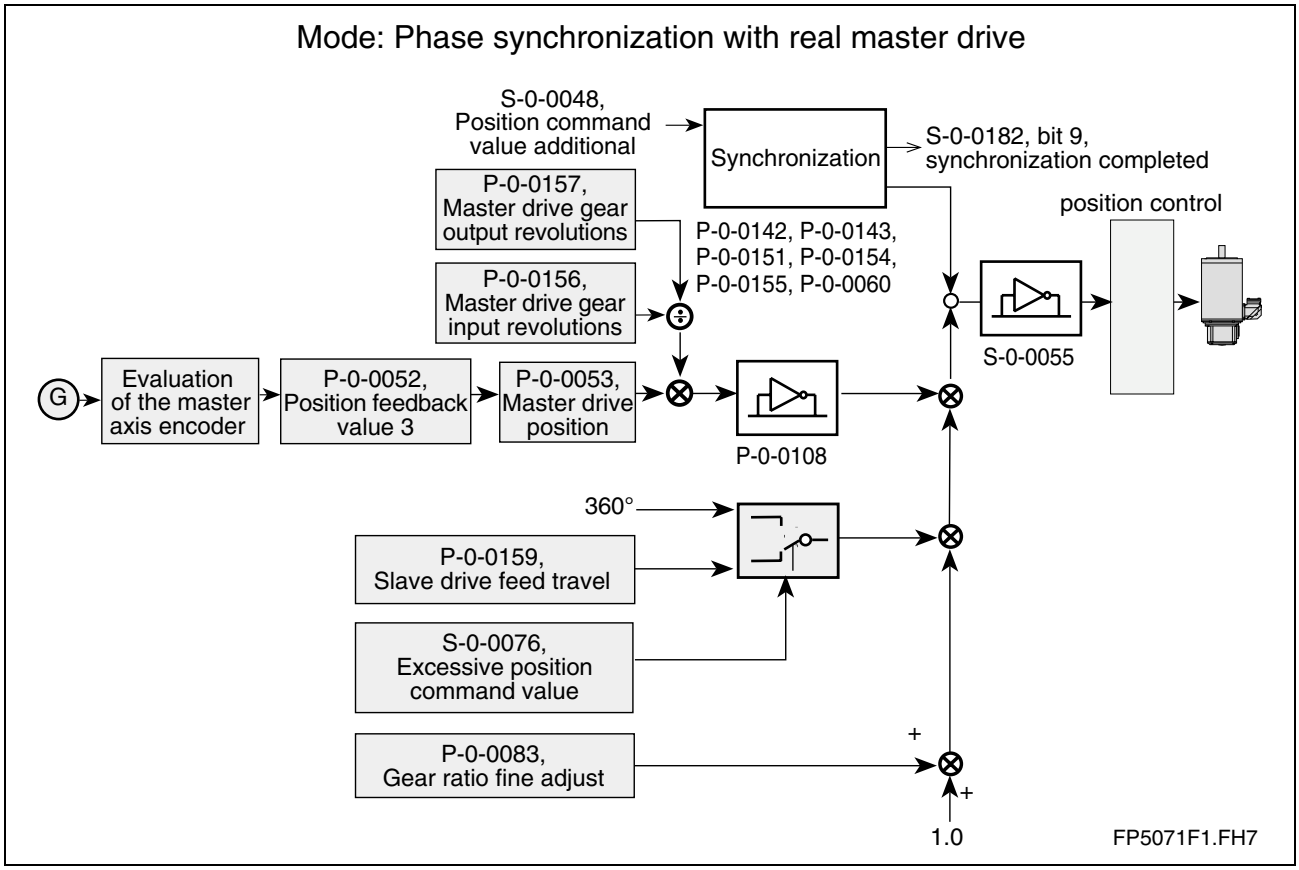


Fig. 3-11: Block diagram: phase synchronization with real master axis

- The position of the master axis encoder (**P-0-0052, Position feedback value 3**) is directly used as the master axis command value (**P-0-0053, Master drive position**).
- Compensation of the filter run time and the processing dead time
- Position control with regard to position command values calculated by the drive from the master axis position, the master axis gear, a gear fine adjustment and the electronic gear ratio. It is possible to dynamically change the master axis gear (P-0-0156/P-0-0157).
- The master axis position range is determined by means of parameter **P-0-0750, Master axis revolutions per master axis cycle**. The master axis encoder range must equal the parameter containing the number of master axis revolutions per master axis cycle
- Drive-controlled synchronization to the sum of the position command value plus the additive position command value with the synchronization acceleration, velocity and direction being maintained. The synchronous position command value always is a position in the command value cycle. There are various modes for synchronization:
  - Synchronization in the command value cycle
  - Synchronization in a part of the command value cycle
  - Synchronization in the modulo range
  - Status message: "Synchronization completed"
- Absolute and relative synchronization is possible

- Absolute and relative synchronization is possible which also allows relative processing of parameter **S-0-0048, Position command value additional**
- Changes of parameter **S-0-0048, Position command value additional** are either smoothed using a filter or positioned by means of the synchronization acceleration and velocity
- Generation of parameter **P-0-0034, Position command additional actual value** as the difference between actual position value and calculated position command value
- Status message "IN-Synchronization" with active and non-active operating mode
- Rotary or translatory output of electronic gearbox as dependent on the position scaling selected

Notes on master axis encoder evaluation:

- Setting absolute measurement for master axis encoder

The "Set absolute measurement" command can also be applied to the master axis encoder. Parameter **S-0-0147, Homing parameter** determines the encoder to be set. Parameter **S-0-0054, Reference distance 2** determines the reference value of the master axis encoder.

- Range of the master axis encoder

The modulo range of the master axis encoder can be expanded to n * 2^{20} revolutions. The value is defined in parameter **P-0-0765, Range of master encoder**.

- Absolute value monitoring of the master axis encoder

On switching to the operating mode (phase 4) the position of the master axis encoder is checked. If this position differs by more than the value defined in parameter **P-0-0766, Master encoder, monitoring window**, the error **F276 Absolute encoder out of allowed window** will be generated.

- Filtering the actual position value 3

For filtering the actual position value 3 a moving average filter with time constants of 0, 2, 4 and 8 ms is available. The phase shift caused by averaging is compensated.

Electronic Cam Shaft with Real Master Axis

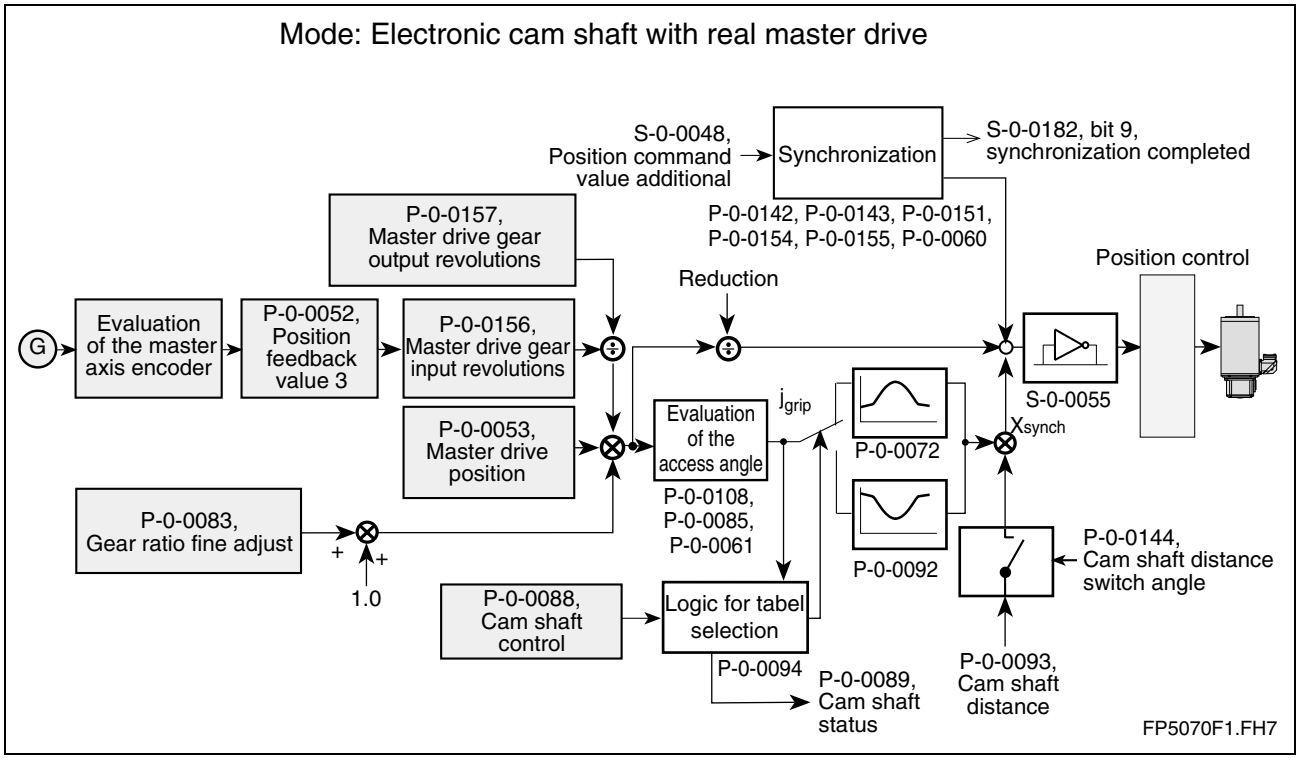


Fig. 3-12: Block diagram: electronic cam shaft with real master axis

- The position of the master axis encoder (**P-0-0052, Position feedback value 3**) is directly used as the master axis command value (**P-0-0053, Master drive position**).
- Compensation of the filter run time and the processing dead time
- Position control with regard to position command values calculated by the drive from the master axis position, the master axis gear, a gear fine adjustment, a cam shaft profile and the cam shaft distance. The master axis position as per master axis gear (P-0-0156/P-0-0157) serves as the profile access angle for the cam shaft profiles.
- The master axis position range is determined by means of parameter **P-0-0750, Master axis revolutions per master axis cycle**. The master axis encoder range must equal parameter **P-0-0750, Master axis revolutions per master axis cycle**.
- Drive-controlled synchronization to the sum of the position command value plus the additive position command value with the synchronization acceleration, velocity and direction being maintained. Status message: "Synchronization completed". The synchronous position command value always is a position in the command value cycle. There are various modes for synchronization:
  - Synchronization in the command value cycle
  - Synchronization in a part of the command value cycle
  - Synchronization in the modulo range
  - Status message: "Synchronization completed"
- Absolute and relative synchronization is possible
- Change velocity can be set for **P-0-0061, Angle offset begin of profile**
- Fine interpolation of the cam shaft profile values

- Two cam shaft profiles with possibility of switching at specified angle
- Change in cam shaft distance only becomes effective at parameterized angle
- Offset for profile access angle can be set
- Lag-error dependent advance of the profile access angle for lag error compensation can be set
- Changes of parameter **S-0-0048, Position command value additional** are either smoothed using a filter or positioned by means of the synchronization acceleration and velocity
- Generation of the position command additional actual value as the difference between actual position value and calculated position command value
- Status message "IN-Synchronization" with active and non-active operating mode
- Acceleration feedforward can be set
- Separation of constant movement and the movement resulting from the cam shaft (cross cutter function)
- It is possible to simultaneously switch the master axis gear and the distance value

Notes on master axis encoder evaluation:

- Setting absolute measurement for master axis encoder

The "Set absolute measurement" command can also be applied to the master axis encoder. Parameter **S-0-0147, Homing parameter** determines the encoder to be set. Parameter **S-0-0054, Reference distance 2** determines the reference value of the master axis encoder.

- Range of the master axis encoder

The modulo range of the master axis encoder can be expanded to n * 2^{20} revolutions. The value is defined in parameter **P-0-0765, Range of master encoder**.

- Absolute value monitoring of the master axis encoder

On switching to the operating mode (phase 4) the position of the master axis encoder is checked. If this position differs by more than the value defined in parameter **P-0-0766, Master encoder, monitoring window**, the error **F276 Absolute encoder out of allowed window** will be generated.

- Filtering the actual position value 3

For filtering the actual position value 3 a moving average filter with time constants of 0, 2, 4 and 8 ms is available. The phase shift caused by averaging is compensated.

3.3 Controller Structure

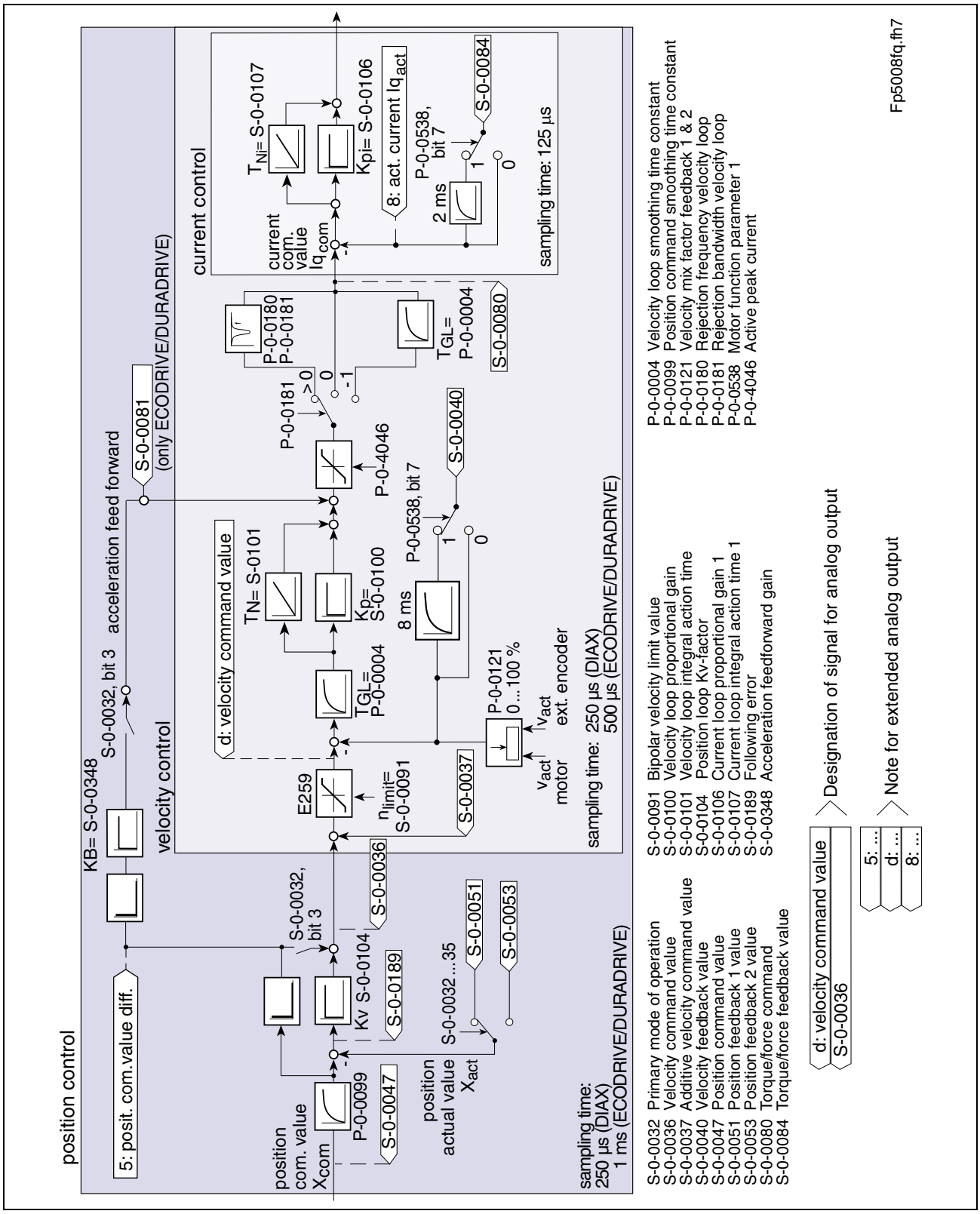


Fig. 3-13: Controller structure FWA-DRIVE*-FGP-20VRS

Note: The controller parameters can be set either manually or by an automated motion cycle (parameter **P-0-0162, D900 Command Automatic control loop adjust**).

3.4 Motor Types

The following motor types can be operated with the firmware:

- MKD
- 2AD
- 1MB
- LAF
- MKE
- MBS (rotary synchronous kit motor)
- MHD
- ADF
- MBW
- LAR
- LSF (linear synchronous kit motor)

- Motor encoder on load side with rotary asynchronous motors
- Field weakening also with synchronous motors
- Automatic commutation setting with synchronous motors with incremental motor measuring systems after initial switching on of drive enable after switching into operating mode; correction of the commutation offset when overrunning the reference mark (only incremental measuring systems) with parameter **P-0-0507, Optimized commutation offset**
- Standstill or nominal current standardized to cooling type; new parameter **P-0-0640, Cooling type**
- Support of third-party motors with temperature sensor KTY84

Motor Holding Brake

Features:

- Self-holding and self-releasing brake
- Brake delay time can be set
- Servo and main spindle brake can be selected
- Brake can be released by the user via parameter **P-0-0542, B100 Command Release motor holding brake**
- Holding brake monitor: "brake check" command via command start or automatically after drive enable applied
- Parameter **P-0-0539, Brake status** allows digital brake activation

3.5 Measuring Systems

Motor Encoder

Note: As standard, the motor encoders are already mounted at delivery of the motors. The motor encoder type can only be selected with kit motors.

The following motor encoders are supported:

P-0-0074	Interface connector	Measuring system
1	X4	digital servo feedback or resolver
2	X8	incremental encoder with 1V sine signals (from Heidenhain)
5	X8	incremental encoder with square-wave signals (from Heidenhain)
8	X8	encoder with EnDat interface
9	X8	gearwheel encoder with $1V_{pp}$ signals
10	X4	resolver encoder without feedback data memory
11	X4+X8	resolver without feedback data memory + incremental encoder with sine signals
12	X4+X8	Hall encoder + square-wave encoder
14	X4+X8	Hall encoder + sine encoder

Fig. 3-14: Measuring systems: connectors

Optional Measuring System

Evaluation as second load-side control encoder or load-side motor encoder is possible (depends on P-0-0185):

P-0-0185	Functions of encoder 2
0	optional control encoder
1	master axis encoder
2	load-side motor encoder
3	measuring wheel encoder
5	relative master axis encoder

Fig. 3-15: Functions of encoder 2

P-0-0075	Interface connector	Measuring system
1	X4	digital servo feedback
2	X8	incremental encoder with 1V sine signals (signal specification of Heidenhain)
5	X8	incremental encoder with square-wave signals (signal specification of Heidenhain)
8	X8	encoder with EnDat interface
9	X8	gearwheel encoder with $1V_{pp}$ signals

Fig. 3-16: Measuring systems: connectors

- Can be evaluated as an absolute measuring system
- Monitoring of the actual position value of the external encoder for plausibility in terms of the actual position value of the motor encoder

Optional Encoder as Master Axis Encoder

The following real master axis encoders can be evaluated:

Type	P-0-0075, Feedback 2 type	Note
GDS/GDM	1	cyclically absolute
Measuring system from Heidenhain with EnDat interface	8	cyclically absolute
incremental encoder with 1V sine signals (signal specification of Heidenhain)	2	incremental
incremental encoder with TTL signals	5	incremental

Absolute master axis encoder

Parameter **P-0-0765, Range of master encoder** determines the absolute range of the master axis encoder. The parameter **P-0-0765, Range of master encoder** contains a factor of 2^{20} so that the following is applicable:

- Modulo range of master axis encoder = master axis encoder range x 2^{20}
- The master axis encoder is evaluated/displayed in this range.

The absolute (see below) master axis encoder is set by means of parameter **P-0-0012, C300 Command Set absolute measurement**. The position of the master axis encoder (P-0-0052) is set to the value of the parameter **S-0-0054, Reference distance 2**.

Incremental master axis encoder

Incremental encoders can also be used as master axis encoders. Depending on the parameter **P-0-0185, Function of encoder 2**, incremental encoders are evaluated in relative form only or, after the zero pulse of the encoder has been detected, in absolute form.

The actual position value 3 can be offset using the parameter **P-0-0087, Offset position feedback value 3**. The actual position value 3 can be filtered by means of a moving average filter with compensation of the filter runtime. Parameter **P-0-0186, Position feedback value 3, smoothing time** determines the time constant.

Note: Only binary resolutions can be used as a master axis encoder!

Absolute Measuring Systems

Absolute measuring systems are those encoders with an absolute range of at least one encoder revolution. This includes the measuring systems:

- Single-/multi-turn HSF
- Single-/multi-turn resolver
- Single-/multi-turn encoder with EnDat interface
- Absolute linear scales with EnDat interface

These measuring systems are only treated as absolute encoders, if their **absolute range exceeds or equals half the travel range or the entire travel range**.

The absolute encoder function can be switched off.

If position data are displayed in modulo format, it is possible to evaluate both motor and optional encoder as absolute encoders. Absolute encoder monitoring is also possible in both cases.

Establishing the Position Reference for Actual Values

It is possible to evaluate single-turn encoders and multi-turn encoders as absolute or non-absolute measuring systems. To be selected in the relevant "position encoder type" parameter.

Depending on the selection, the position reference is established by means of parameter **P-0-0012, C300 Command Set absolute measurement** or by means of parameter **S-0-0148, C600 Drive controlled homing procedure command**.

- **C300 Command Set absolute measurement:**
  - Initializing the actual position value of an absolute measuring system with regard to a preset value related to the machine zero point, with the help of an **initiator** (switch cam)
  - Initializing the actual position value of an absolute measuring system with regard to a preset value related to the machine zero point, with the help of a **command**
  - Executing the command either for the actual position value of the motor encoder or the external encoder
  - Setting absolute measurement without drive enable
  - Setting absolute measurement with drive enable followed by "Drive-controlled homing"
  - Setting absolute measurement with drive enable followed by deactivation of drive enable
  - Absolute measurement can be set via the home switch input (for systems with slip)
  - Setting absolute measurement for a master axis encoder

- **C600 Drive controlled homing procedure command:**
  - While maintaining a reference velocity and acceleration to be parameterized, the drive generates position command values in order to automatically execute a drive motion which is intended to establish a reference for the actual position value with regard to the machine zero point.
  - Executing the command either for the actual position value of the motor encoder or the external encoder
  - Executing command with evaluation of a reference mark and/or a home switch or switching the actual position value without axis motion
  - Executing the command with selectable travel direction to reference point
  - Evaluation of encoders with distance-coded reference marks is possible

3.6 Physical Values Display Formats

- Freely definable LSB valence for the following data transmitted between drive and control unit:
  - position data: degrees, mm, inch
  - velocity data: r.p.m., m/min, inch/min, r/s, m/s, inch/s
  - acceleration data: rad/s², m/s², inch/s²
- Choice of data reference to motor shaft or load
- Choice between translatory and rotary scaling
- Choice between preferred scaling and parameter scaling
- Parameterizable divisor for the modulo value that can be used with "Spindle positioning"

3.7 Error Reactions

- **Variable error reaction** as dependent on error class and selected best possible deceleration
- Selectable settings for **best possible deceleration**:
  - velocity command value reset
  - torque command value reset
  - velocity command value to zero with command value ramp and filter
  - Additional error reactions by means of DISC drive macros; these allow, for example, absolute or relative return motion.
- **Power off on error** can be set
- If the setting "no power off on error" has been selected, the BB1 contact is closed immediately after control voltage is switched on.
- Deceleration of the drive via an emergency stop input (**E-Stop**) with drive reaction to be selected:
  - emergency stop as drive error with error class "non-fatal"
  - emergency stop as drive error with error class "travel range"
  - emergency stop as fatal warning

3.8 General Functions

Comprehensive Diagnostic System

- Diagnosis parameter in plain text, as diagnosis number and as error number
- List of diagnosis numbers
- Hard wired collective messages
- Freely configurable signal status word
- Error memory with operating hours counter to store the drive errors that occurred

Parameterization

- Basic parameter set can be activated for defined setting of the drive parameters to default values
- Customer password protection; selection of password-protected parameters can be set

Language Selection

By means of parameter **S-0-0265, Language selection**, you can select the language of parameter names and units, as well as diagnostic texts.

The following languages have been implemented:

German

English

French

Spanish

Italian

Drive Halt

The drive stops automatically, considering acceleration and jerk limit values.

The following limit values are used:

Previous operating state	Parameters used
no position control operating mode	P-0-1211, Deceleration ramp 1 P-0-1213, Deceleration ramp 2 P-0-1202, Final speed of ramp 1
position control with drive-internal interpolation (positioning block mode, drive-internal interpolation, drive-controlled positioning)	previous positioning deceleration and jerk limits remain active
position control without drive-internal interpolation	S-0-0138, Bipolar acceleration limit value S-0-0349, Jerk limit bipolar

Fig. 3-17: Acceleration and jerk with "Drive halt"

Analog Inputs

- 2 channels with maximum input voltage range of ± 10 V
- 12-bit A/D converter
- Input of drive parameter data via scaling that can be set

Analog Output

- 2 channels with maximum output voltage range of ± 10 V
- 8-bit D/A converter
- Output of drive parameter data via scaling that can be set
- Pre-set drive-internal signals and any bits and bytes of data memory can be output

Oscilloscope Function

- 2 channels with 512 values each
- Preset signals can be used
- Time resolution: 500 µs to 100 ms (time pattern: 500 µs)
- Trigger threshold that can be set for position, velocity and torque/force data
- Drive-internal signals can be triggered and recorded
- Extension of measuring signals to be selected (e. g. S-0-0036, P-0-0053, ...)

Probe Function

- 2 probe inputs with a resolution of 1 µs
- Possible measuring signals:
  - actual position value encoder 1 or actual position value encoder 2 (if external encoder available)
  - master axis position or actual position value 3 (master axis encoder evaluation)
  - relative internal time (internal counter) with a resolution of 1 µs and a recording width of 32 bit
- Determining measured value differences
- Measured value signals can be triggered with regard to positive or negative edges
- Expectation window for probe inputs: It is possible to define a range within which probe edges are generally accepted.
- Continuous measurement: After a measurement, the edge evaluation of the probes is automatically activated again.
- To detect any overflow during the progressing measurement, a probe counter is included in bit 8 to 15 of the corresponding "Probe latched" parameter. This counter is incremented whenever a probe is detected. If the maximum value of 2^8-1 (255) is reached, the counter flows over and is reset to 0!
- Failure monitor for probe events: If there does not occur any probe event within the expectation window specified, the counter is incremented in the parameter **P-0-0224, Probe, number of marker failures**. The counter is cleared as soon as a probe event occurs within the expectation window.
- The measuring signal is selected by entering the ID number of the signal in parameter **P-0-0200, Signal select probe 1** or parameter **P-0-0201, Signal select probe 2**. The parameter **P-0-0225, Probe, IDN list signal selection** lists specifies the ID numbers of the possible probe signals.
- Extended control parameter to activate expectation windows, failure monitoring function and time measurement:
  - The probe event can be limited to a predefined position window. The "Probe with expectation window" function is activated in parameter **P-0-0226, Probe, extended control word**.
  - In conjunction with the expectation window it is also possible to monitor the failure of a probe event. This "Mark failure monitoring function" can also be activated in parameter **P-0-0226, Probe, extended control word**.
  - The time measurement for probe 1 is switched on via parameter **P-0-0226, Probe, extended control word**, too. For probe 2 there isn't any time measurement function.
- The following parameters were reprogrammed and now are 16-bit counters:
  - **S-0-0409, Probe 1 positive latched**
  - **S-0-0410, Probe 1 negative latched**
  - **S-0-0411, Probe 2 positive latched**
  - **S-0-0412, Probe 2 negative latched**
- During continuous measurement the counter value is increased with every valid probe event.

Detecting the Marker Position

Parameter **P-0-0014, D500 Command determine marker position** allows

- checking the faultless detection of the reference mark of an incremental measuring system or
- determining the position of the reference mark in case the homing procedure is carried out by the control unit. In this case this information is used to switch the coordinate system in the control unit.

The home switch is not evaluated in this parameter.

Measuring Wheel Mode

The "measuring wheel mode" function is used with material feed axes (e. g. in sheet-metal machining). By means of a measuring wheel encoder mounted to the material, highly precise material machining is ensured even if some slip occurs between the driving motor and the material itself.

In parameter **S-0-0386, Active Position value** it is always the active actual position value that is displayed; i.e. when the "Measuring wheel mode" command is active and the drive is in a position-controlled operating mode, the actual position value 2 is provided in parameter S-0-0386 (otherwise actual position value 1).

The position difference monitor is activated with parameter **S-0-0391, Monitoring window feedback 2**. If the position difference monitor has been activated (S-0-0391 unequal zero), the position difference is cleared after every measuring wheel revolution (or after 500 mm in the case of linear scaling).

When using a measuring wheel encoder the monitoring window is to be set to the slip that is allowed per measuring wheel revolution. In the case of rotary scaling, the parameter **S-0-0391, Monitoring window feedback 2** refers to the measuring wheel circumference, in the case of linear scaling it refers to 500 mm.

Parking Axis

The parameter **S-0-0139, D700 Command Parking axis** allows uncoupling an axis. This may, for example, be necessary if an axis is temporarily brought to a standstill. The start of this command causes all monitoring functions of the measuring system and of the control loops to be switched off.

The command may only be started without drive enable. If the command is activated with drive enable applied, then the drive generates a command error.

After starting the command

- the measuring system monitors,
- the control loop monitors and
- the temperature monitors

are deactivated.

The measuring system initializations are conducted at the end of the command. This means all initializations as with command **S-0-0128, C200 Communication phase 4 transition check** are conducted. The 7-segment display reads "PA".

This drive no longer accepts the drive enable.

Backup Working Memory Procedure

By means of parameter **S-0-0264, B300 Backup working memory procedure command**, all cyclically configured data can be stored in the NOVRAM if required (all data that are not cyclically configured are already stored in the NOVRAM during the writing process).

Programmable Limit Switch

- 16 dynamic position switch points with one switch-on and switch-off position each
- Parameterizable lead time for each position switch point
- Effective direction of the threshold position switch that can be parameterized, i.e. the threshold position switch only takes effect with the corresponding velocity of the selected reference value.
- Reference position:
  - **S-0-0051, Position feedback 1 value**
  - **S-0-0053, Position feedback 2 value**
  - **P-0-0053, Master drive position**
  - **P-0-0052, Position feedback value 3**
  - **P-0-0434, Internal Position command value**
- Correlation in the "DriveTop" commissioning software with positioning block target positions

Incremental Encoder Emulation (TTL format)

- **S-0-0051, Position feedback 1 value**,
- **S-0-0053, Position feedback 2 value**,
- **P-0-0434, Internal Position command value**,
- **P-0-0053, Master drive position** and
- **P-0-0052, Position feedback value 3**

can be emulated.

The number of lines in the case of emulation can be set as follows:

S-0-0076, Position data scaling type	Unit of parameter P-0-0502, Encoder emulation, resolution
rotary position scaling	lines/encoder revolution
linear position scaling	lines/mm or lines/inch

Fig. 3-18: Setting of the number of lines with incremental encoder emulation

- Zero pulse output also with linear motors and relative encoders (if homed)
- Number of lines with emulation of master axis position can be set in lines/master axis revolution
- Zero pulse can be offset by writing data to parameter **P-0-0503, Marker pulse offset**
- Dead time compensation

Absolute Encoder Emulation (SSI format))

- **S-0-0051, Position feedback 1 value**,
- **S-0-0053, Position feedback 2 value**,
- **P-0-0434, Internal Position command value**,
- **P-0-0053, Master drive position** and
- **P-0-0052, Position feedback value 3**

can be emulated.

The number of lines in the case of emulation can be set as follows:

Motor	**Unit of parameter P-0-0502, Encoder emulation, resolution**
rotary motor	bits/motor revolution
linear motor	bits/mm or bits/inch

Fig. 3-19: Setting of the number of lines with absolute encoder emulation

- With the emulation of the values displayed in the parameters S-0-0051, S-0-0053 and S-0-0047, also the emulated actual position values are offset by parameter **P-0-0012, C300 Command Set absolute measurement**.
- Possible display range: 0 to 4096 revolutions

Automatic Controller Setting

By means of parameter **P-0-0162, D900 Command Automatic control loop adjust**, the velocity and position control loop can be set automatically.

By inputting a travel distance, the command can also be used for modulo axes.

Automatic Commutation Setting

When the controller enable signal is switched on, **P-0-0508, Commutation offset** is determined by means of the automatic commutation setting. With this parameter it is possible to move the drive. When the command **S-0-0148, C600 Drive controlled homing procedure command** is started, the drive moves to the reference point of the machine. When passing the reference mark of the encoder, the drive switches to the value defined in parameter **P-0-0507, Optimized commutation offset**.

The value of parameter **P-0-0507, Optimized commutation offset** has to be determined with the initial commissioning procedure.

Digital Inputs/Outputs

In conjunction with the EMD modules it is possible to evaluate freely configurable digital inputs and outputs. The assignment of the inputs to parameters is realized with parameter **P-0-0125, Assignment digital input -> IDN**. Parameters are assigned to outputs by parameter **P-0-0124, Assignment IDN -> Digital output**.

Master Axis of Master Axis Encoder

Operating mode: Synchronous operating mode with "real master axis"

Functional principle:

The master axis position of the slave axis is generated with the actual position value 3 as the command value. The master axis generator is not required for this purpose.

If several drives, which realize the master axis connection via EcoX, follow a real master axis encoder, the master axis generator has to be activated in the master drive.

Pertinent parameters:

- **P-0-0052, Position feedback value 3**
- **P-0-0761, Master axis position for slave axis**
- **P-0-0762, Master axis generator, signal selection list**
- **P-0-0763, Master axis generator, signal selection**
- **P-0-0768, Master axis generator, status**

Parameter **P-0-0052, Position feedback value 3** has to be configured in parameter **P-0-0763, Master axis generator, signal selection**.

The master axis generator generates **P-0-0761, Master axis position for slave axis** from the actual position value 3, plus a linear set-up time to compensate for the EcoX transmission time.

P-0-0761, Master axis position for slave axis has a fixed resolution of 2^{20} increments per revolution. The modulo value is determined by the useable range of the master axis encoder.

Master Axis of Master Drive

Operating mode: Any in the master; synchronous operating mode with "real master axis" in the slaves

Functional principle:

The master axis position of the slave axis is generated with the position command value, the actual position value 1 and the actual position value 2.

The master axis position of the slave axis (P-0-0761) is transferred to the slave drives via the EcoX bus. With the slave drives (EcoX slave), the value is written to parameter **P-0-0053, Master drive position**. If the slave drives are in a synchronous operating mode with "virtual master axis", these drives follow the master drive.

Pertinent parameters

- **S-0-0051, Position feedback 1 value**
- **S-0-0053, Position feedback 2 value**
- **P-0-0434, Internal Position command value**
- **P-0-0761, Master axis position for slave axis**
- **P-0-0762, Master axis generator, signal selection list**
- **P-0-0763, Master axis generator, signal selection**
- **P-0-0768, Master axis generator, status**

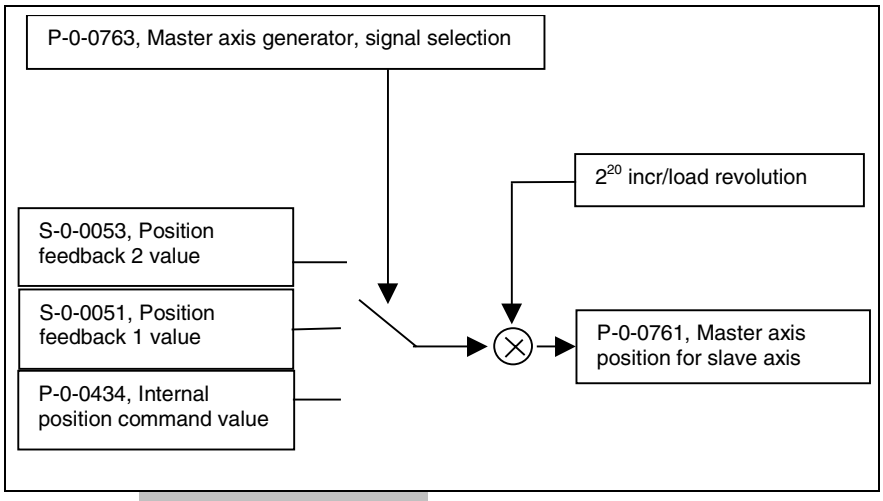


Fig. 3-20: Master axis of master drive

The list of assignable parameters contains all the parameters that can serve as the input values for the master axis generator. The parameter number that generates the input value for the master axis has to be entered in parameter **P-0-0763, Master axis generator, signal selection**.

Virtual Master Axis Generator

Operating mode: Synchronous operating mode with "virtual master axis"

Functional principle:

In the case of a virtual master axis generator, the master axis position is not derived from the position of an encoder or real drive, but determined by means of calculation. When the enable signal is set, the virtual master axis generator integrates the acceleration limit value until the velocity limit value has been reached. The current velocity is integrated, the result is the master axis position for the slave axis (P-0-0761). When the enable signal has been cleared, the velocity is decelerated to zero with the delay limit value.

Pertinent parameters:

- **P-0-0760, Master axis generator, command word**
- **P-0-0761, Master axis position for slave axis**
- **P-0-0765, Range of master encoder**
- **P-0-0768, Master axis generator, status**
- **P-0-0770 Master axis generator, velocity limit**
- **P-0-0771, Master axis generator, acceleration limit**
- **P-0-0772 Master axis generator, deceleration**
- **P-0-0773, Master axis generator, preset position**

3.9 EcoX – Expansion Interface for Digital Drives

Overview

EcoX is the name of an expansion interface for digital drives. It is a serial, cyclic bus that allows the following functions:

- synchronization of drives and I/O modules
- connection of up to 2 modules with 16 digital inputs and outputs each per drive controller
- transmission of a command value to other drive controllers

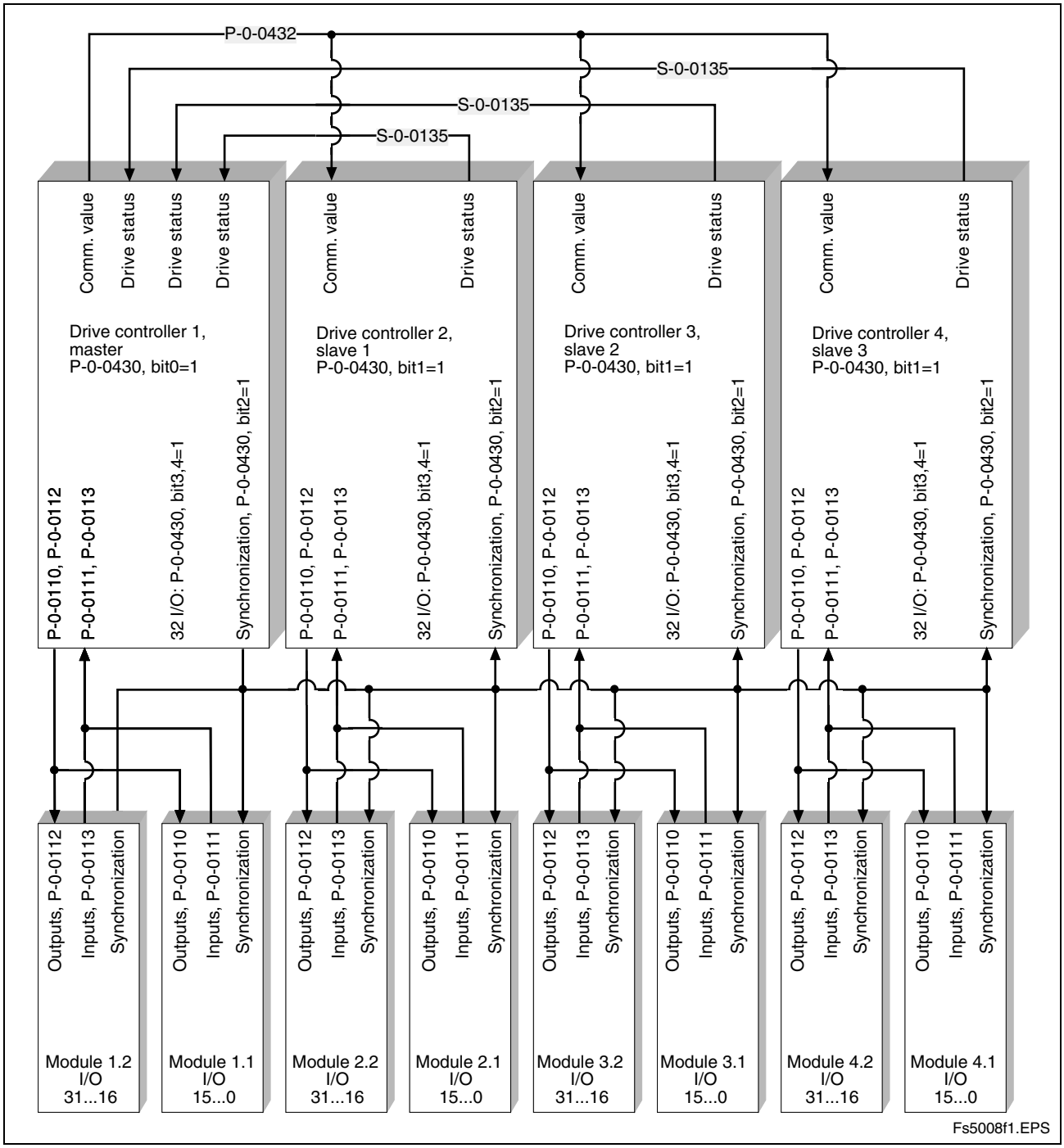


Fig. 3-21: Possible structure of an EcoX bus

Command Value Linkage

Command value linkage of up to 20 drives. The parameter to be transmitted is specified in parameter **P-0-0432, EcoX command value, configuration**.

The following parameters can be transmitted:

- **S-0-0036, Velocity command value**
- **S-0-0040, Velocity feedback value**
- **S-0-0080, Torque/Force command**
- **S-0-0084, Torque/force feedback value**
- **P-0-0434, Internal Position command value**
- **P-0-0761, Master axis position for slave axis**

- Position command value linkage to operate Gantry axes: The master drive can be used in the positioning mode. The generated position command value is transmitted to the slave drive. The slave drive is operated in cyclic position control.
- Torque linkage: Master-slave operation of several drives. The torque command value (S-0-0080) is transmitted. The slave drive is operated in torque control.
- Speed command value linkage: The speed command value of the motor axis is transmitted to the slave. The slave drive is operated in velocity control.

I/O Extension

It is possible to activate one (16 inputs, 16 outputs) or two (32 inputs, 32 outputs) Indramat I/O modules per drive. Use parameter **P-0-0430, EcoX configuration** for selection.

The input data are written to parameters

- **P-0-0111, Parallel input 2 a**nd
- **P-0-0113, Parallel input 3**.

The outputs are written by the parameters

- **P-0-0110, Parallel output 2 a**nd
- **P-0-0112, Parallel output 3**.

The input parameter can be assigned to any parameter which can be configured in the MDT. Any parameter which can be configured in the AT can be written to the output parameter. The cycle time of the I/O modules depends on the number of controllers at the bus, but is independent of whether 16 or 32 I/Os have been connected.

As a matter of principle, the following applies:

- cycle time = 1 ms * (master + number of slaves)
- input/output delay = 1 ms

3.10 DISC Drive Macros

By means of program libraries available in the commissioning tool (e. g. DriveTop) or in the higher-level control unit, function macros can be loaded to the drive. Special functions that are not "hard wired" in the drive firmware are integrated in the standard firmware by means of DISC drive macros.

The following functional extensions have already been realized with DISC drive macros:

- More variable error reactions (relative and absolute return motion)
- Quick stop when signal at probe input
- Extension of existing operating modes (positioning block mode with delay time, ...)
- Automatic drive reactions when an event occurs
- Higher-level process controllers (register controllers, ...)
- Quick stop when signal at digital input
- Relative limit switch

4 New Fields of Application

EcoX

Gantry Axis

A Gantry axis can be realized by linking a min. of 2 axes via the EcoX digital expansion interface. This allows using the Gantry axis function for "non-SERCOS drives", too.

Linkage of Several Axes (Master Axis Interconnection)

From the position selected via parameter **P-0-0763, Master axis generator, signal selection**, the master axis generates a master axis position for slave axes. The following slaves synchronize to this position.

Master-Slave Solution

Advantageous solution can be realized, because, owing to the synchronization via EcoX, there won't be any quantization effects and beat effects.

DISC Drive Macros

More Variable Error Reactions

DISC drive macros allow defining any error reaction, e.g. relative return motion.

Additional Axis-Specific Monitoring Functions

In addition, the DISC functionality allows you defining your own monitoring functions, e.g. current or torque monitors.

Technology Functions

The manufacturer offers a certain number of predefined technology functions that significantly enhance the functional range of the drive. At present, the following technology functions are made available:

- "flying shears"
- register controller
- In-Feed

Automatic (Event-Controlled) Drive Reactions

It is also possible to interrupt the active operating mode (e.g. cam mode or phase synchronization), in order to carry out, after a selectable event, a drive reaction that has been programmed in the DISC macro.

Extension of Existing Operating Modes

It is also possible to extend existing operating modes or make them more flexible. There are, for example, the following options:

- positioning block mode with delay time
- relative limit switch
- "Teach_In" function for positioning block mode
- force control

Master Axis Generator

Stand-Alone Drive for Cam Function

By means of the virtual master axis generator it is now possible for the drive to travel any curve shape (e.g. sine curve). This allows predefining any jerk curve (e.g. "AntiSwapp curves").

Linkage of Several Axes (Master Axis Interconnection)

The master axis position required for linking several axes can be generated by means of the master axis generator in a drive called "master axis". The reference position for generating the master axis position is selected by means of the parameter **P-0-0763, Master axis generator, signal selection**.

Real Master Axis Linkage

Real master axis linkage is the basic interconnection of axes via EcoX, the master axis position being generated by a real master axis encoder.

Measuring Wheel Mode

The "measuring wheel mode" function is used with material feed axes (e. g. in sheet-metal machining). By means of a measuring wheel encoder mounted to the material, highly precise material machining is ensured even if some slip occurs between the driving motor and the material itself.

5 Functional Changes with Regard to the Previous Version

Incompatible Functional Changes

Basic Functionality

Inversion of Control Bits 3 and 5 in the Field Bus Status Word

Up to now, bit 3 and bit 5 in parameter **P-0-4078, Field bus status word** have always been inverted in the freely expandable I/O mode (P-0-4084 = 0xFF82). As of the FGP20VRS firmware these two bits are no longer inverted and are therefore transmitted in the way that you would expect due to the configuration in parameter **S-0-0144, Signal status word**.

Optional Functions

SSI Emulation

The output format (resp. the display range) was changed from ± 2048 revolutions to 0...4096 revolutions, because it is this kind of display that is generally used in the world of control systems.

Functions No Longer Available

As Regards "Relative Drive-Internal Interpolation"

This operating mode does no longer exist. This functionality can be performed completely and compatibly by the operating mode "Drive-controlled positioning".

As Regards "Error Reactions"

The error reaction "Return motion" can no longer be configured in parameter **P-0-0119, Best possible deceleration**. The corresponding function is provided by a DISC drive macro.

As Regards "Probe Function"

Signal selection in parameter **S-0-0169, Probe control parameter** is no longer available.

The quick stop function via probe 1 is no longer available. This functionality can be realized by means of a DISC drive macro.

Deleted Parameters

S-0-0236, Master drive 1 revs.

S-0-0237, Slave drive 1 revs.

S-0-0269, Parameter buffer mode

P-0-0096, Distance to move in error situation

New Parameters

S-0-0000, Dummy parameter

S-0-0264, B300 Backup working memory procedure command

S-0-0376, Max. actual velocity difference in percent

S-0-0377, Maximum actual velocity difference

S-0-0398, IDN list of configurable data in the signal status word

P-0-0110, Parallel output 2

P-0-0111, Parallel input 2

P-0-0112, Parallel output 3

P-0-0113, Parallel input 3

P-0-0125, Assignment digital input -> IDN

P-0-0224, Probe, number of marker failures

P-0-0225 Probe, IDN list signal selection

P-0-0226, Probe, extended control word

P-0-0350, DISC - Control word

P-0-0351, DISC - Status word

P-0-0352, DISC - Program Logic task

P-0-0353, DISC - Program Drive task

P-0-0354 DISC - Program Event task

P-0-0355, DISC - Register Logic task

P-0-0356, DISC - Register Drive task

P-0-0354 DISC - Program Event task

P-0-0358, DISC – Event condition

P-0-0430, EcoX Configuration

P-0-0431, EcoX command, IDN list of configurable parameters in master

P-0-0432, EcoX command value, configuration

P-0-0433, EcoX command, IDN list of configurable parameters in slave

P-0-0434, Internal Position command value

P-0-0435, List of configurable data dig. Input Inputs

P-0-0436, List of configurable data dig. Output Outputs

P-0-0437, List of EcoX slave drives

P-0-0507, Optimized commutation offset

P-0-0603, Position switch, control word

P-0-0750, Master axis revolutions per master axis cycle

P-0-0751, Synchronization divisions per command cycle slave axis
P-0-0752, Load revolutions per actual value cycle slave axis
P-0-0753, Position actual value in actual value cycle
P-0-0754, Command value cycle
P-0-0755, Gear reduction
P-0-0760, Master axis generator, command word
P-0-0761, Master axis position for slave axis
P-0-0762, Master axis generator, signal selection list
P-0-0763, Master axis generator, signal selection
P-0-0764, Master axis Velocity
P-0-0765, Range of master encoder
P-0-0766, Master encoder, monitoring window
P-0-0768, Master axis generator, status
P-0-0770, Master axis generator, velocity limit
P-0-0771, Master axis generator, acceleration limit
P-0-0772, Master axis generator, deceleration
P-0-0773, Master axis generator, preset position
P-7-4014, Motor type

Modified Parameters

S-0-0084, Torque/Force feedback value

- If required, the value displayed in the parameter can be filtered with T = 2 ms (activated with parameter P-0-0538, bit 7)

S-0-0169, Probe control parameter

- Bit 4 is no longer available, selection by means of parameter **P-0-0200, Signal select probe 1** or parameter **P-0-0201, Signal select probe 2**
- Bit 7 quick stop is no longer available

S-0-0399, IDN list of configurable data in the signal control word

- Selection list was extended

P-0-0117, NC reaction on error

- Bit 2: immediate reaction of the event task (DISC drive macro)

P-0-0119, Best possible deceleration

- Return motion impossible

P-0-0155, Synchronization mode

- Bits 2 to 4: synchronization range
- Bit 5: acceleration limit in the case of velocity synchronization

P-0-0200, Signal select probe 1

- Input of an IDN required; time measurement via bit in parameter **P-0-0226, Probe, extended control word**

P-0-0201, Signal select probe 2

- Input of an IDN required; time measurement only possible with channel 1

P-0-0538, Motor function parameter 1

- Bits 4 and 5: automatic commutation setting
- Bit 13: When the torque limit value is reached, the best possible deceleration is immediately initiated.

The following parameters are incremented as soon as a valid probe event occurs:

- **S-0-0409, Probe 1 positive latched**
- **S-0-0410, Probe 1 negative latched**
- **S-0-0411, Probe 2 positive latched**
- **S-0-0412, Probe 2 negative latched**

Further bits were added to the following parameters:

- **P-0-0538, Motor function parameter 1**
- **S-0-0135, Drive status word**
- **S-0-0147, Homing parameter**
- **S-0-0169, Probe control parameter**
- **S-0-0393, Command value mode**

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7.1 Helpdesk

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- per Fax: **+49 (0) 9352 40 49 41**
- per e-Mail: **service@indramat.de**

Our service helpdesk at our headquarters in Lohr am Main, Germany can assist you in all kinds of inquiries. Contact us

- by phone: **+49 (0) 9352 40 50 60**
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- by fax: **+49 (0) 9352 40 49 41**
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7.2 Service-Hotline

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After helpdesk hours, contact our service department directly at

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7.3 Internet

Unter **www.indramat.de** finden Sie ergänzende Hinweise zu Service, Reparatur und Training sowie die **aktuellen** Adressen *) unserer auf den folgenden Seiten aufgeführten Vertriebs- und Servicebüros.

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1. detaillierte Beschreibung der Störung und der Umstände.
2. Angaben auf dem Typenschild der betreffenden Produkte, insbesondere Typenschlüssel und Seriennummern.
3. Tel.-/Faxnummern und e-Mail-Adresse, unter denen Sie für Rückfragen zu erreichen sind.

For quick and efficient help, please have the following information ready:

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2. Information on the type plate of the affected products, especially type codes and serial numbers.
3. Your phone/fax numbers and e-mail address, so we can contact you in case of questions.

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