AMK

AMKASYN

VARIABLE SPEED DRIVES

AMKASYN

Digital Converter in Modular Construction

Programmable Control PS

Description of Fast Functions SF

Version AZ-PS4 V02.13

0700 Part No.: 25785

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Abbreviations and designations

APSF	User programmable SF (SF)
Ax.y	Binary output: Byte x, Bit y
AZ	AMKASYN central module
AZ-IG	AMKASYN option card for connecting pulse generators
AZ-PSx	AMKASYN option card for implementing the PS functions
BA	Operating mode
BINEA	Binary input/output (SF)
COPY	Copying function (SF)
DFKT	Speed function table (SF)
E/A/M	Input/output/flag
ED	Input double word
EDG	Electronic rotary encoder
EPOS	Extended positioning (SF)
Ex.y	Binary input: Byte x, Bit y
FB	Function block
FGEN	Reference input variable generator (SF)
FIPW	Function interpolator for distance-time functions (SF)
FIPZ	Function interpolator for time functions (SF)
ID	Parameters of the basic system
IMES	Pulse measurement (SF)
KMDFKT	Commanding function
m	Total number of tables (FIPW)
PAA	Process output image
PS	Programmable control
q	Number of start tables (FIPW)
REGL	Control (SF)
RESET	SF commanding code (value = 0)
SAK	Following error compensation
SF	Fast function
SFKMD	SF commanding
SF-ACTIVE	SFKMD status (value = 2)
SF-Nr-Max	Largest possible permitted SF number (currently = 15)
SF-RESET	SFKMD status (value = 0)
SF type-Max	Largest possible permitted SF type number (currently = 9)
START	SF commanding code (value = 1)
STDFKT	Standard functions (SF)
Te	Time of a motion cycle
Tsf	Time grid of the fast functions
V	Speed ratio in connection with SF FGEN
V_n	Speed standardizing factor (speed ratio = V / V_n)
VALUE NEW	SF commanding code (value = 5)
XFIPW	Extended FIPW (SF)
Xme	Master input increments per cycle (FIPW)

1 Introduction

User programs of the AMKASYN programmable control (PS) are processed interpretatively. The command execution time is approx. 10 ...30µs. The program run-through times depend upon the program length. They are a few ms as a rule. Fast command value curves for position or speed profiles cannot be generated directly with these. Also customarily time-equidistant command value interpolation points are required for position command values.

For fast movement functions prefabricated program modules present in machine code, which are called up time-equidistantly by the operating system and e.g. in each case calculate and output directly to the drive a new position command value interpolation point are provided in the AMKASYN PS. In this case the call in the 0.5 ms grid (or multiples of this) is synchronized with the controller calls of the drives. The administration, activation, initialization, parameterizing of the modules is performed by the user program and thus is in the hand of the user. However, the actual function runs autonomously with assigned input/output variables. The computing time of the individual modules is 50-200µs, so that several such modules can be active.

The main applications lie in the motion control of the drives:

- Fast feed (indexing),
- Electronic cams,
- Clocking in/out (also oversynchronously) of electronic gears,
- Fast speed adjustment to external signals,
- Fast binary output depending upon positions (cam switching mechanism),
- PID controller,
- Fast, cyclic user programs, etc.

2 Embedding the fast functions in the PS

2.1 Overview

The "Fast functions" are independent program modules with interfaces to the PS program system and with access to cyclic data holders (command values/feedback values) for the drives.

Commanding the fast functions (cf. documentation: AMK-specific function blocks):

- Selection, initialization by PS (AWL, FB 207)
- Activating, deactivating and parameterizing by PS (AWL, FB 208)
- Cyclic call by operating system, synchronized to cyclic internal data transfer to and from the drives

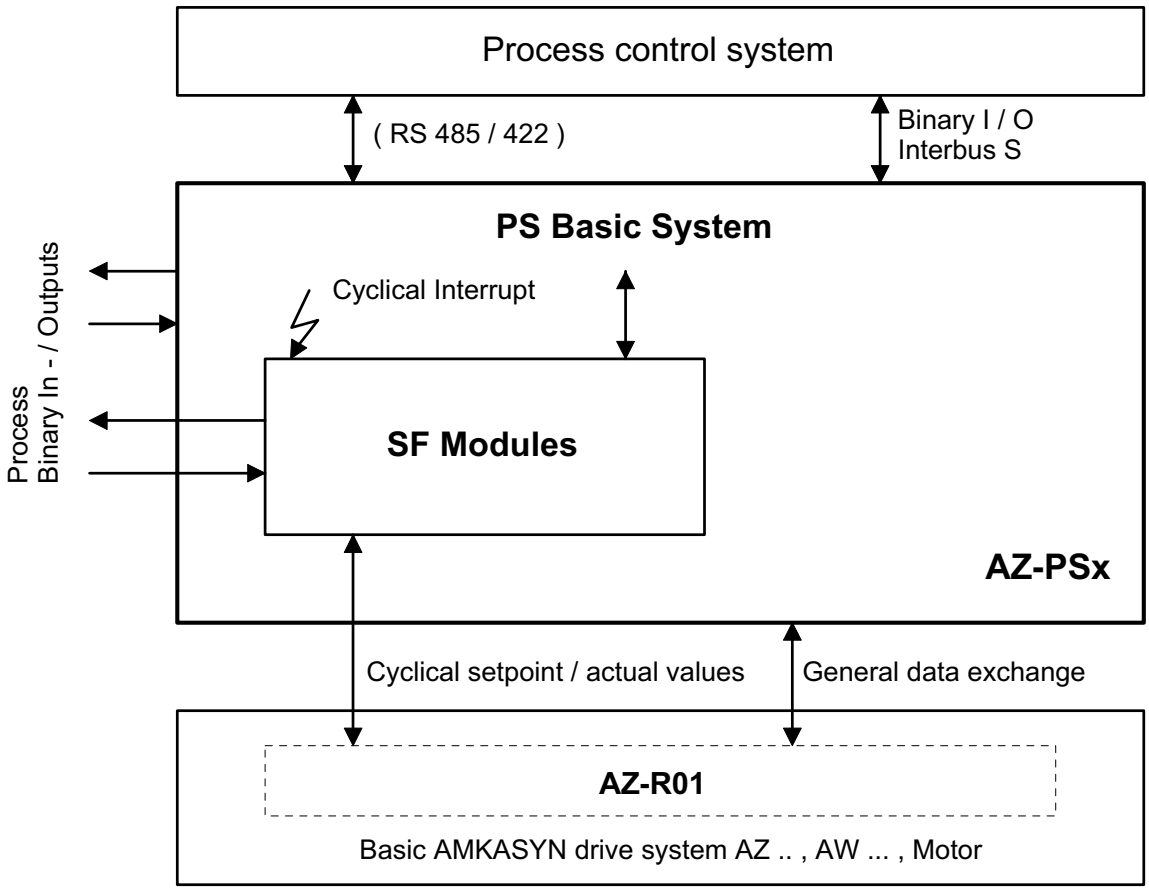
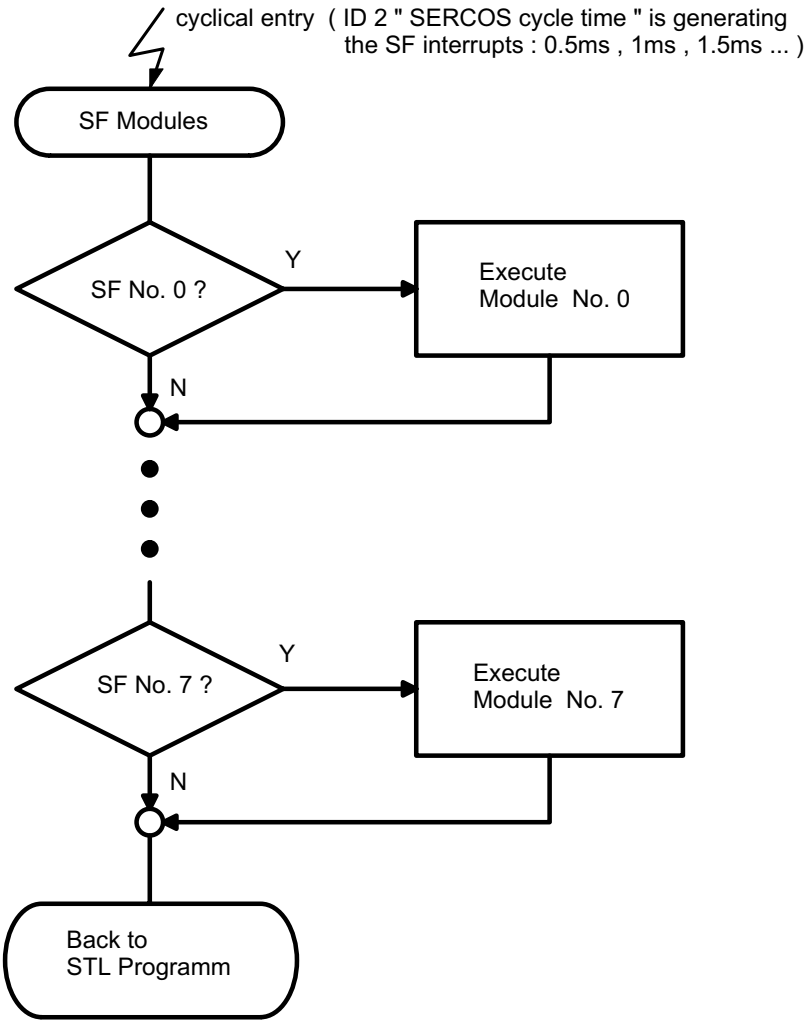


Figure 1: SF module concept

2.2 Cyclic commanding of the SF modules



The SF modules are connected by a branch distributor, which is called in the time cycle of the drive control. A maximum of "SF-Nr-Max + 1" SF modules can run quasi parallel (as from AZ-PS4 system software AZ-PS4 V02.09: SF-Nr-Max = 15 applies). For the consistent supply of the SF modules with process data, these are copied in the time cycle. The time cycle is determined by ID 2 (SERCOS cycle time) of the drive basic system (cf. documentation parameters).

The maximum "SF-Nr-Max + 1" SF modules of different or the same type are selected on initialization by FB 207 and assigned to a processing sequence corresponding to the SF number corresponding to the adjacent figure (cf. documentation: AMK-specific function blocks).

Figure 2: SF integration

2.3 Interfaces to the drives, to the E/A and to the user program

The following figure illustrates the interface structure of fast functions:

- The data holder interface serves for the control cycle-synchronous interfacing of the SF to drive information or the linking of several SF. Typical information is e.g. position feedback / command values, speed feedback / command values, or the information prepared by a SF.
- The binary input/output interfaces facilitate fast reaction to binary input signals or fast output of binary signals (E/A or M area is configurable; cf. documentation: AMK-specific function blocks, FB207). The minimum reaction time in the E/A area is 2ms. Typical information is e.g. the start signal for initiating a table-supported movement (coupling in clock mode) or the output of the movement status (movement input active/inactive).
- The data block interface facilitates the variable input of a larger amount of information. Typical information is e.g. the interpolation points of a table-controlled movement.

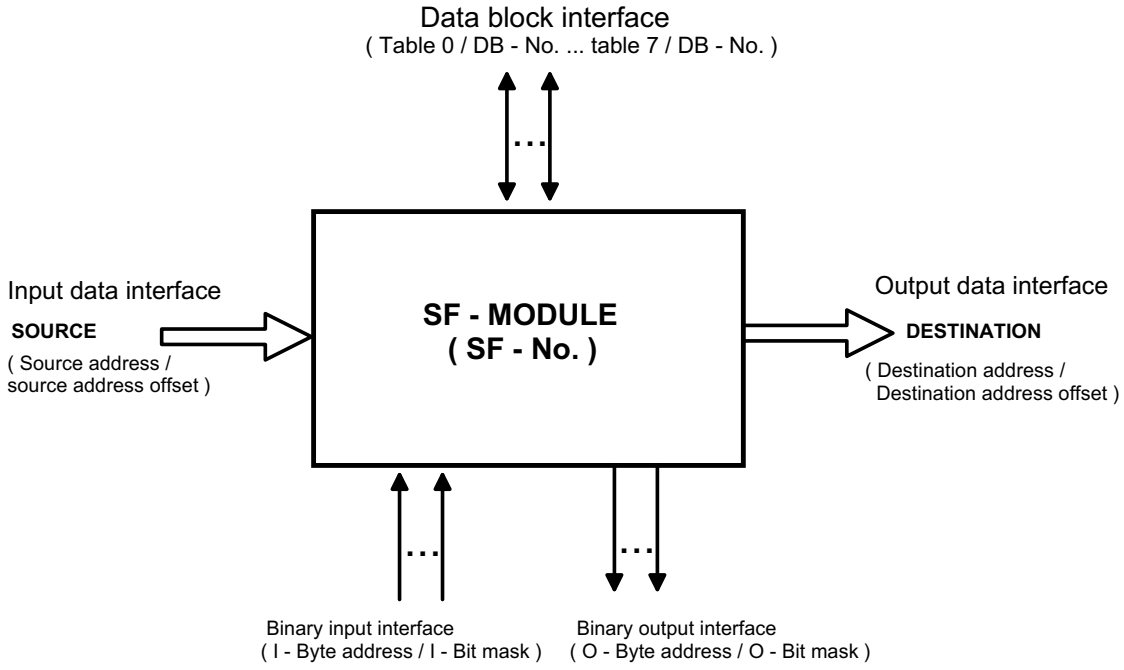


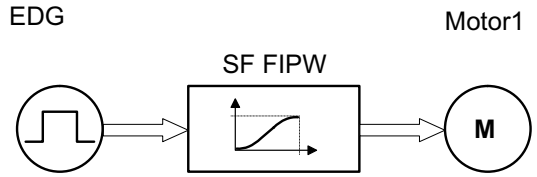
Figure 3: SF module interfaces

The user interface to the fast functions is provided by the function blocks FB 207 and 208 or the data blocks assigned to these FBs. Further the data blocks of the data block interface (cf. Figure 3) can be used.

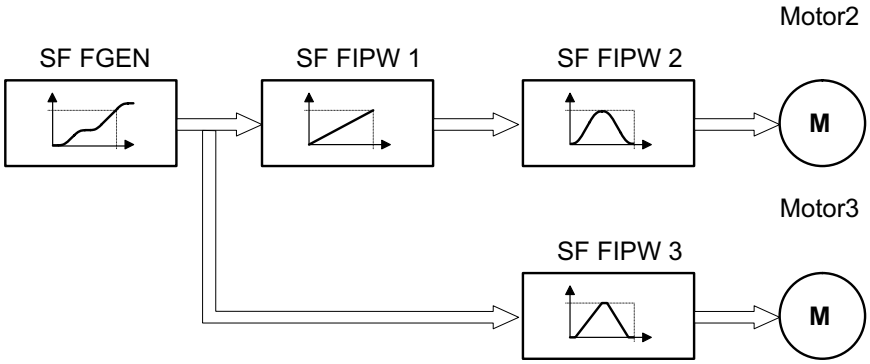
With FB 207 (initializing SF)

- the required SF modules can be selected (cf. Section 2.2), and
- the interfaces can be determined (cf. Figure 3).
- As from software version AZ-PS3 V02.06 it is possible to link fast functions with one another through their data holder interface (cf. documentation: AMK-specific function blocks or Figure 4).
- As from software version AZ-PSx V02.07 it is possible to configure binary inputs/outputs in the flag image (cf. documentation: AMK-specific function blocks, FB207).

Remarks: In the course of the binary input/output interface determination a maximum of 8 bits can be allocated per SF. The bits of a SF have consecutive bit addresses within a byte (e.g. E0.0, E0.1). The byte address and the bit address of the first bit of the SF are determined by SF initialization (FB 207). Output byte addresses occupied by SF are automatically excluded from the process output image updating (PAA) (cf. documentation: PS command set, Section "Displaying bit information in the input image of the PS").



Example 1: Direct source/sink assignment
SF source = Electr. rot. encoder (or motor encoder)
SF sink = Motor 1 position setpoint



Example 2: Linkage of SF sources and sinks
SF source FIPW 1 = SF sink FGEN
SF source FIPW 2 = SF sink FIPW 1
SF source FIPW 3 = SF sink FGEN
SF sink FIPW 2 = Motor 2 position setpoint
SF sink FIPW 3 = Motor 3 position setpoint

EDG Electronic rotary encoder
SF Fast function
FGEN Command variables generator
FIPW Position function interpolator

Figure 4: SF linking

FB 208 (commanding SF) allows

- the control of the SF status (reset, started, ..) and
- the selection of different subfunctions of the relevant SF module

Remarks: Status and error flags (MB 232 and MD 233) are used jointly for all SF. MB 232 and MD 233 contain the status and error information of the commanded

SF only after the SF commanding of the corresponding SF number (cf. documentation: AMK-specific function blocks)!

Remarks: Data holders must be assigned to fast functions SF-specifically. Typical assignments are shown in the course of the description of the individual SF (see following sections). Further it must be observed that the information of data holders can be determined by the configuration parameters ID 32785, 32786 for each drive or by ID 32948 for the central module (AZ). Refer to the "Parameters" documentation for an exact description!

Caution:

- In the course of the following SF descriptions SF binary inputs/outputs are designated with E1, .. , E8 or A1, .. , A8. This numbering corresponds to the locigal order of the SF E/A signals. The physical determination results through the determination of the logical E1/A1 bit, according to the above remarks for FB207!
- Furthermore fast functions are designated corresponding to their SF number, independently of the SF type linked with the SF number by the initialization (SF0 corresponds to the 1st SF processed by the system software and SF15 to the 16th processed SF; cf. Figure 2)!
- Output byte addresses occupied by SF are excluded from updating of the process output image (PAA) (cf. documentation: PS command set, Section "Displaying bit information in the output image of the PS")!
- SF work after a SF commanding "Start" completely autonomously.
  ⇒ A transition of the PS into the error status as well as withdrawal of the "Controller enable" have no direct influence on the processing of the SF (cf. documentation: PS command set, Section "Characteristics of fast functions")!

2.4 SF overview

The following table provides an overview of the currently implemented fast functions (SF):

SF type	Description	
0	COPY – DCOPY – ECOPY – SIDIFF	Copying function – for fast direct copying of source in sink – for fast copying of source information or SFKMD parameters depending upon the SF binary input "E1" – for fast binary display of command/ feedback difference exceeding
1	FIPW	Function interpolator for distance and time functions
2	FIPZ	Function interpolator for time functions
3	STDFKT – VARSYNC – DIGDREH	Standard functions – for fast variation of the synchronous ratio – for fast digital speed command value input
4	DFKT	Speed function table
5	FGEN	Reference input variable generator
6	REGEL	Control
7	IMES	Pulse distance measurement
8	BINEA	Binary input/output
9	XFIPW	Extended function interpolator for distance and time functions
10	APSF	User programmable SF
11	EPOS	Extended positioning
12	NOCK	Cam switching mechanism

Table 1: SF overview

3 Fast functions

3.1 "SF COPY" copying function

SF type = 0

In the scope of "SF COPY" different functions, such as copying source information into an arbitrary sink or the binary display of a configurable command/feedback difference exceeding are combined taking account of the following error compensation on the basis of fast functions.

A distinction is made between the following functions:

SF function number (SFKMD fct)	Short designation	Meaning
1	DCOPY	Fast direct copying of source information
2	ECOPY	Fast copying of source information or SFKMD parameters depending upon SF binary input "E1"
255	SIDIFF	Fast command / feedback difference monitoring taking account of the SF following error compensation

Table 2: Copy functions

3.1.1 General structure and parameters of the DB for SF commanding

The following table provides an overview of the commanding variables used jointly by all functions of SF COPY. A detailed description of the function-dependent parameters is given in the subsequent sections.

SF number (DR0)
- Meaning: SF number under which a SF of the SF type 0 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
- Meaning: Selection of the copy functionality
- Value range: 0: No function selected
  1: Direct copying "DCOPY"
  2: Binary input-depending copying "ECOPY"
  255: Command/actual difference monitoring "SIDIFF"

SFKMD code (DR 1)
- Meaning: SF command code.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): Start SF
  5 (WERTNEU): Supply SF with new parameters

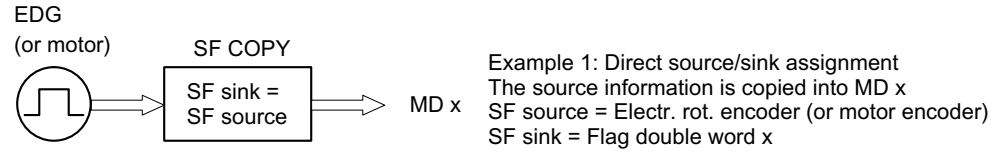
SFKMD-BA (DL 1)
- Meaning: Selection of the SF operating mode.
- Value range: Function-dependent

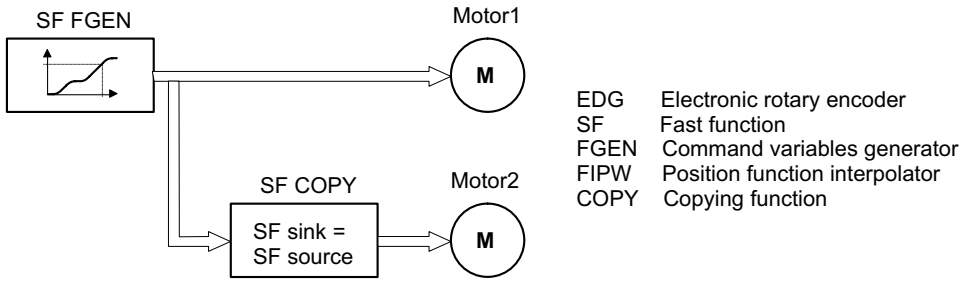
Parameter (DD 2 .. DD 32)
- Meaning: SF commanding parameter.
- Value range: Function-dependent

3.1.2 "SF COPY-DCOPY", SF for direct copying of source information

With this fast function, the source information is copied directly into the sink in the course of the "SFKMD function 1" (DCOPY). In this case a distinction is made between two operating modes as from version AZ-PS4 V02.11 (cf. Section **Fehler! Verweisquelle konnte nicht gefunden werden.**, SFKMD-BA):

- Operating mode 0: Absolute copying of the source values into the sink.
  This operating mode facilitates e.g. the transfer of the pulse generator information into a PS-internal flag double word (cf. Figure 5, Example 1), or the simultaneous supply of several drives with the same command values (cf. Figure 5, Example 2).
- Operating mode 1: Incremental copying.
  In this operating mode the difference between two consecutive source values is summed to a 32-bit variable and copied into the sink. Only the less significant word of the source is evaluated to form the difference. The sink value at the "Start time" of the SF is used as output value for summation of the 32-bit variable (cf. Figure 6).





Example 2: Linkage of SF sources and sinks
Simultaneous supply of two drives

SF source FGEN = not used
SF source COPY = SF sink FGEN
SF sink FGEN = Motor 1 position setpoint
SF sink COPY = Motor 2 position setpoint

Figure 5: Example for the SF COPY-DCOPY

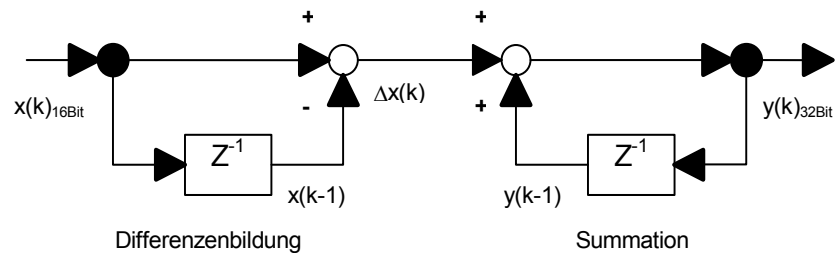


Figure 6: Incremental copying

3.1.2.1 DCOPY-specific user interface

Prerequisites and marginal conditions

Expedient settings of the drive basic system operating mode (cf. documentation: Parameter; ID 32800..32809) in the case of a drive as SF sink (Sink address = 1..8):

BA command value source = 3C (hexadecimal; commanding interface)
Position control without following error compensation (SAK is implemented by the SF if required), synchronous ratio (ID 32892, ID 32893) is effective:
⇒ SF sink = 16-bit command value source
Example: ID 32800 = 3C0004
Position control with fine interpolation (if required):
⇒SF sink = 32-bit command value source
Example: ID 32800 = 3C0404
Speed control with speed ramp (if required):
⇒SF sink = 32-bit command value source
Example: ID 32800 = 3C0043

All sources and sinks possible in the course of SF initialization are allowed
(cf. documentation: AMK-specific function blocks; FB207).

Structure and parameters of the DB for SF commanding

Data	High word		Low word	
double word	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words
Table 3: DCOPY commanding DB

SF number (DR 0)
- Meaning: SF number under which a SF of the SF type 0 was initialized by means of FB 207.
- Value range: 0.. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
- Meaning: SF commanding function; selection of the copying function.
- Value range: 0 No function selected.
  1 Direct copying of the SF source information into the SF sink.

SFKMD code (DR 1)
- Meaning: SF commanding code
- Value range: 0 (RESET): Reset of the SF
  1 (START): Start of the SF

SFKMD-BA (DL 1)
- Meaning: SF commanding operating mode.
- Value range: 0 Absolute copying
  1 Incremental copying

Table 0 .. Table 7 are not used.

3.1.3 "SF COPY-ECOPY", SF for binary input-dependent copying of source information or SFKMD parameters

With this fast function the source information or SFKMD parameter values are copied into the sink in the scope of the "SFKMD function 2" (ECOPY). Switching over between the information to be copied takes place depending upon a binary input (E1). It can be determined with the SFKMD operating mode which values to be copied are assigned to the "E1" signal information (0 and 1). The "E1" signal information is output at the binary output (A1), with output of the value to be copied ("A1" = "E1").

The "SF COPY" (ECOPY) thus facilitates the fast change from SF sink information, depending upon a binary signal (cf. Figure 7).

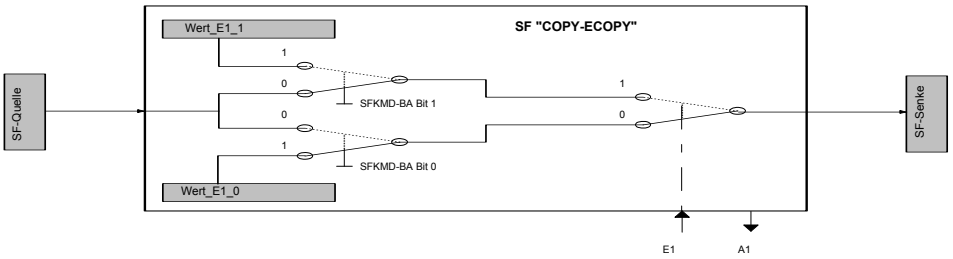


Figure 7: Structure of the SF COPY (ECOPY)

3.1.3.1 ECOPY-specific user interface

Prerequisites and marginal conditions

Expedient settings of the drive basic system operating mode (cf. documentation: Parameter; ID 32800..32809) - in the case of a drive as SF sink (Sink address = 1..8):

- BA command value source = 3C (hexadecimal; commanding interface)
- Position control without following error compensation (SAK is implemented by the SF if required), synchronous ratio (ID 32892, ID 32893) is effective:
  ⇒ SF sink = 16-bit command value source
  Example: ID 32800 = 3C0004
- Position control with fine interpolation (if required):
  ⇒SF sink = 32-bit command value source
  Example: ID 32800 = 3C0404
- Speed control with speed ramp (if required):
  ⇒SF sink = 32-bit command value source
  Example: ID 32800 = 3C0043

Required settings for "Analog channel 1..4 source" or "Analog channel 1..4 end value" (cf. documentation: Parameters; ID 32787..32794) - in the case of an analog output "AA1..4" as SF sink (Sink address = 64; sink offset = 0..3; cf. documentation: AMK-specific function blocks, FB 207):

- AA1: ID 32787 = 32908.0 "Analog channel 1 source"
  ID 32788 = 10000 e.g.: "Analog channel 1 end value"
- AA2: ID 32789 = 32909.0 "Analog channel 2 source"
  ID 32790 = 10000 e.g.: "Analog channel 2 end value"
- AA3: ID 32791 = 32910.0 "Analog channel 3 source"
  ID 32792 = 10000 e.g.: "Analog channel 3 end value"
- AA4: ID 32793 = 32911.0 "Analog channel 4 source"
  ID 32794 = 10000 e.g.: "Analog channel 4 end value"

All sources and sinks possible in the scope of SF initialization (FB 207) are allowed (cf. documentation: AMK-specific function blocks; FB207).

Structure and parameters of the DB for SF commanding

Data	High word		Low word	
double word	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	Value-E1_0			
04	Value-E1_1			
06	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 4: ECOPY commanding DB

SF number (DR 0)

- Meaning: SF number under which a SF of the SF type 0 was initialized by means of FB 207.
- Value range: 0.. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)

- Meaning: SF commanding function; selection of the copying function.
- Value range: 0 No function selected.
  2 Binary input dependent copying "ECOPY"

SFKMD code (DR 1)

- Meaning: SF commanding code
- Value range: 0 (RESET): Reset of the SF
  1 (START): Start of the SF
  5 (WERTNEU): Supply SF with new parameters

SFKMD-BA (DL 1)

- Meaning: SF commanding operating mode.
- Value range: bit-coded
  Bit 0 = 0: For E1 = 0, Copy SF source
  = 1: For E1 = 0, Copy "Value_E1_0" parameter
  Bit 1 = 0: For E1 = 1, Copy SF source
  = 1: For E1 = 1, Copy "Value_E1_1" parameter

Table 0 .. Table 7 are not used.

3.1.3.2 Example

Depending upon M 100.0 ("0" or "1") 5V or 10V should be output optionally at analog output AA1. Acknowledgement is through M 101.0.

Initialization DB of the SF "COPY-ECOPY"

:KB 0	;DR 0	SF type	COPY
:KB 0	;DL 0	SF number	SF0
:KB 3	;DR 1	E/A-M mode	E: M mode; A: M mode
:KB 0	;DL 1	Reserved	
:KB 0	;DR 2	Source address offset	Not used
:KB 0	;DL 2	Source address	Not used
:KB 0	;DR 3	Sink address offset	(x = 1,
:KB 64	;DL 3	Sink address	Analog output AAx)
:KB 1	;DR 4	Input bit mask	M x.0,
:KB 100	;DL 4	Input byte address	with x = 100)
:KB 1	;DR 5	Output bit mask	(M x.0,
:KB 101	;DL 5	Output byte address	with x = 101)
:KB 0	;DR 6	DB number Tab0	Not used
:KB 0	;DL 6	DB number Tab1	Not used
:KB 0	;DR 7	DB number Tab2	Not used
:KB 0	;DL 7	DB number Tab3	Not used
:KB 0	;DR 8	DB number Tab4	Not used
:KB 0	;DL 8	DB number Tab5	Not used
:KB 0	;DR 9	DB number Tab6	Not used
:KB 0	;DL 9	DB number Tab7	Not used

Commanding DB of the SF "COPY-ECOPY"

:KB 0	;DR00	SF number	SF0
:KB 2	;DL00	SFKMD fct	COPY-ECOPY
:KB 1	;DR01	SFKMD code	Start
:KB 0	;DL01	SFKMD-BA	E = 0: Value_E1_0
	;		E = 1: Value_E1_1
:KD 10000	;DD02	Value_E1_0	AA1 = 10V (e.g. = 100% nominal torque)
:KD 5000	;DD04	Value_E1_1	AA1 = 5V (e.g. = 50% nominal torque)
:KD 0	;DD06	Reserved	
	.	.	
:KD 0	;DD32	Reserved	

Required parameters:

AA1:	ID 32787 = 32908.0	"Analog channel 1 source"
	ID 32788 = 10000	"Analog channel 1 end value"

3.1.4 of times "SF COPY-SIDIFF", SF for command/feedback value difference monitoring

In the scope of the "SFKMD function 255" (SIDIFF) the "SF COPY" allows the monitoring of the following error (position command/feedback value difference) of up to 8 drives (AW1..AW8). If the drives are controlled through a "SF FIPW or FIPZ" with following error compensation (cf. documentation: Description of fast functions SF), then the proportion corrected by the following error compensation is automatically deducted from the following error of the position controller (as it appears e.g. with ID 32786 = 32824 in the Config.AW message 32). The considered value thus corresponds to the real offset between command system (e.g. master drive) and feedback system (e.g. slave drive).

Exceeding a (per AW) configurable threshold is indicated in the A/M byte address that can be input by SF initialization (output byte address; cf. documentation: AMK-specific function blocks, FB207). One output bit is formed per configured AW. This bit becomes "1" if the threshold is exceeded, or "0" if the threshold is not reached.

Remarks: Independently of the output bit mask (in the scope of FB207) one bit is assigned to each AW in the following form: AW1,..,AW8 -> A x.0,..,A x.7 or M x.0,..,M x.7.

The corrected position command/feedback value difference can be displayed e.g. in the flag image by means of the SF sink (128, 129; cf. FB 207).

There can be averaging through N command/feedback difference values for smoothing the corrected command/feedback difference by the "mean factor" (cf. Section 3.1.4.1).

For suppressing individual disturbances, or for guaranteeing a minimum display bit duration, a minimum number of times of consecutively exceeding or falling below the threshold in the grid of the SF (SERCOS cycle time) can be input by the "agreements" parameter (cf. Section 3.1.4.1), before the assigned binary signal is set to "1" or "0".

Additional, AW-specific commanding parameters can be agreed in a DB to be agreed on SF initialization. These are per AW:

- The command/feedback difference threshold, from which the assigned binary signal is set = "1".
- The command value divider or command value multiplier (if a synchronous ratio unequal to "1:1" was selected).

3.1.4.1 SIDIFF-specific user interface

Prerequisites and marginal conditions

A SF source is not required.
Currently only the value 128 or 129 is expedient as SF sink in the scope of the FB 207 if imaging the corrected position command/feedback value difference in the flag range is required.

Caution: The SF "COPY-SIDIFF" is based on the not corrected following error of the position controller in the Config.AW message 32. For each drive for which monitoring or binary indication should take place in the scope of the SF "COPY-SIDIFF", "ID 32786 = 32824" must therefore be parameterized necessarily (cf. documentation: Parameters).

Structure and parameters of the DB for SF commanding

Data	High word		Low word	
double word	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	Res. = 0	AW number	Res. = 0	AW mask
04	Res. = 0	Agreements	Res. = 0	Mean factor
06	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 5: SIDIFF commanding DB

SF number (DR 0)
- Meaning: SF number under which a SF of the SF type 0 was initialized by means of FB 207.
- Value range: 0.. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
- Meaning: SF commanding function; selection of the copying function.
- Value range: 0 No function selected.
  255 Binary indication of the position command/feedback difference monitoring.

SFKMD code (DR 1)
- Meaning: SF commanding code
- Value range: 0 (RESET): Reset of the SF
  1 (START): Start of the SF
  5 (WERTNEU): Supply SF with new parameters

SFKMD-BA (DL 1)
- Meaning: SF commanding operating mode.
- Value range: bit-coded:
  - Bit 0 = 0: 32-bit evaluation of the Config.AW message 32
    = 1: 16-bit evaluation of the Config.AW message 32 (to avoid inconsistency)
  - Bit 1 = 0: 32-bit mean value formation in AZ-PS3 module
    = 1: 16-bit mean value formation in AZ-PS3 module (for running time optimization)

AW mask (DR 2)
- Meaning: Bit mask for selecting the AWs to be monitored.
- Value range: bit-oriented:
  Bit 0 = 1: AW 1 selected
  .....
  Bit 7 = 1: AW 8 selected

AW number (DR 3)
- Meaning: AW number for selecting the command/feedback difference display by means of the SF sink.
- Value range: 0: No display
  1..8: Display for AW1..AW8 (in increments)

Mean factor (DR 4)

- Meaning: Factor N for selecting mean value formation over N interpolation points.
- Value range: 0: Default value (N = 10)
  1: N =1 (no mean value formation: shortened running time)
  2..255: N = 2..255 (mean value formation through 2 to 255 interpolation points)

Agreements (DR 5)

- Meaning: Number of agreements Ü. (A binary display = "1" occurs only if the command/feedback difference limit is exceeded consecutively Ü times. A binary display = "0" occurs only if the command/feedback difference limit was not reached consecutively Ü times.)
- Value range: 0: Default value (Ü = 5)
  1..255: Ü = 1..255

Table 0 (extended commanding parameter set)

A data block which contains an extended parameter set for SF "COPY-SIDIFF" can be determined by "DB number Tab0" by means of SF initialization (cf. documentation: AMK-specific function blocks, FB 207). The data words of this DB have the following meaning in this case:

Data double word	High word		Low word	
	High byte	Low byte	High byte	Low byte
00	Reserved = 0		Command/feedback diff. threshold AW1	
02	Command value divider AW1 (according to ID 32892)			
04	Command value multiplier AW1 (according to ID 32893)			
06	Reserved = 0		Command/feedback diff. threshold AW2	
08	Command value divider AW2 (according to ID 32892)			
10	Command value multiplier AW2 (according to ID 32893)			
..	..			
42	Reserved = 0		Command/feedback diff. threshold AW8	
44	Command value divider AW8 (according to ID 32892)			
46	Command value multiplier AW8 (according to ID 32893)			

Total number: 48 data words

Table 6: Extended commanding DB

Command/feedback difference threshold AW1 (DW0)

- Meaning: Threshold above which a binary display = "1" occurs
- Value range: $0..2^{15}-1$
- Unit: Increments

Command value divider AW1 (DD2)

- Meaning: Command value divider AW1 (corresponding to ID 32892; AW1)
- Value range: 0: Default value = 1
  $2^{16}..2^{31}-1$

Command value multiplier AW1 (DD4)

- Meaning: Command value multiplier AW1 (corresponding to ID 32893; AW1)
- Value range: 0: Default value = 1
  $-2^{31}..2^{31}-1$

Command/feedback difference threshold AW8 (DW42)

- Meaning: Threshold above which a binary display = "1" occurs
- Value range: $0..2^{15}-1$
- Unit: Increments

Command value divider AW8 (DD44)

- Meaning: Command value divider AW8 (corresponding to ID 32892; AW8)
- Value range: 0: Default value = 1
  $2^{16}..2^{31}-1$

Command value multiplier AW8 (DD46)

- Meaning: Command value multiplier AW8 (corresponding to ID 32893; AW8)
- Value range: 0: Default value = 1
  $-2^{31}..2^{31}-1$

If no extended commanding DB is created ("DB number Tab0" = 0), a "command/feedback difference threshold" = 100, as well as a "command value divider" = 1 and "command value multiplier" = 1 are assumed for all AWs selected through "AW mask".

Remarks: With a synchronous ratio not equal to 1:1, there is a clearly higher SF cycle time for the AZ-PS3 module.

Table 1 .. Table 7 are not used.

3.1.4.2 Example

Initialization DB of the SF "COPY-SIDIFF"

:KB 0	;DR 0	SF type	COPY
:KB 0	;DL 0	SF number	SF0
:KB 2	;DR 1	E/A-M mode	E: E/A mode; A: M mode
:KB 0	;DL 1	Reserved	
:KB 0	;DR 2	Source address offset	Not used
:KB 0	;DL 2	Source address	Not used
:KB 104	;DR 3	Sink address offset	x = 104
:KB 129	;DL 3	Sink address	Double word flag DD x
:KB 0	;DR 4	Input bit mask	
:KB 0	;DL 4	Input byte address	Not used
:KB 1	;DR 5	Output bit mask	Bit 0
:KB 100	;DL 5	Output byte address	A-Byte: MB 100
:KB 16	;DR 6	DB number Tab0	DB16 (Extended parameter set)
:KB 0	;DL 6	DB number Tab1	Not used
:KB 0	;DR 7	DB number Tab2	Not used
:KB 0	;DL 7	DB number Tab3	Not used
:KB 0	;DR 8	DB number Tab4	Not used
:KB 0	;DL 8	DB number Tab5	Not used
:KB 0	;DR 9	DB number Tab6	Not used
:KB 0	;DL 9	DB number Tab7	Not used

Commanding DB of the SF "COPY-SIDIFF"

:KB 0	;DR00	SF number	SF0
:KB 255	;DL00	SFKMD fct	COPY-SIDIFF
:KB 1	;DR01	SFKMD code	Start
:KB 3	;DL01	SFKMD-BA	16-bit command/feedback difference evaluation;
	;		16-bit mean value formation (PS3)
:KB 3	;DR02	AW mask	Binary display for AW1 and AW2
	;		(Bit x.0 and x.1)
:KB 0	;DL02	Reserved	
:KB 1	;DR03	AW number	Corrected following error display for AW1
:KB 0	;DL03	Reserved	
:KB 100	;DR04	Mean factor	Mean value formation over 100 interpolation points
:KB 0	;DL04	Reserved	
:KB 10	;DR05	Agreements	Binary display as from 10 agreements
:KB 0	;DL05	Reserved	
:KD 0	;DD06	Reserved	
.		.	
:KD 0	;DD32	Reserved	

Extended commanding DB of the SF "COPY-SIDIFF" (DB 16)

:KF 50	;DW00	Command/feedback difference threshold AW1	50 increments
:KF 0	;DW01	Reserved	
:KD 655360	;DD02	Command value divider AW1	655360 :
:KD 1310720	;DD04	Command value multiplier AW1	1310720
:KF 50	;DW06	Command/feedback difference threshold AW2	50 increments
:KF 0	;DW07	Reserved	
:KD 0	;DD08	Command value divider AW2	1 :
:KD 0	;DD10	Command value multiplier AW2	1
...			
:KF 50	;DW42	Command/feedback difference threshold AW8	50 increments
:KF 0	;DW43	Reserved	
:KD 0	;DD44	Command value divider AW8	1 :
:KD 0	;DD46	Command value multiplier AW8	1

AMKASYN parameter settings:

- AW1: ID 32786 = 32824 ⇒ Config.AW message 32 = position control difference
- AW2: ID 32786 = 32824 ⇒ Config.AW message 32 = position control difference

3.2 "SF FIPW" function interpolator for distance and time function

SF type = 1

With this fast function command positions are generated with the aid of the function interpolator for the drives both depending upon the (master) position and upon the time.

3.2.1 Principle of the function interpolator

The function interpolator assigns an output value which corresponds e.g. to a command position to an input variable by reference to a table which contains the interpolation points of the function. The input variable can be in principle any internal or external variable, e.g. a master position or the time t. The table interpolation points are filed in a data block, whereby the 1st table value states the number of the interpolation points + 1 (max. 128). The table values are 32-bit values. There is linear interpolation between the interpolation points.

Caution:
- The absolute amount of the value difference between 2 consecutive table values must be less than 32768!
- Table values of a started SF may not be changed!
- The data blocks (DB) assigned to the SF by the SF initialization (FB 207) may not be deleted (or newly generated)!

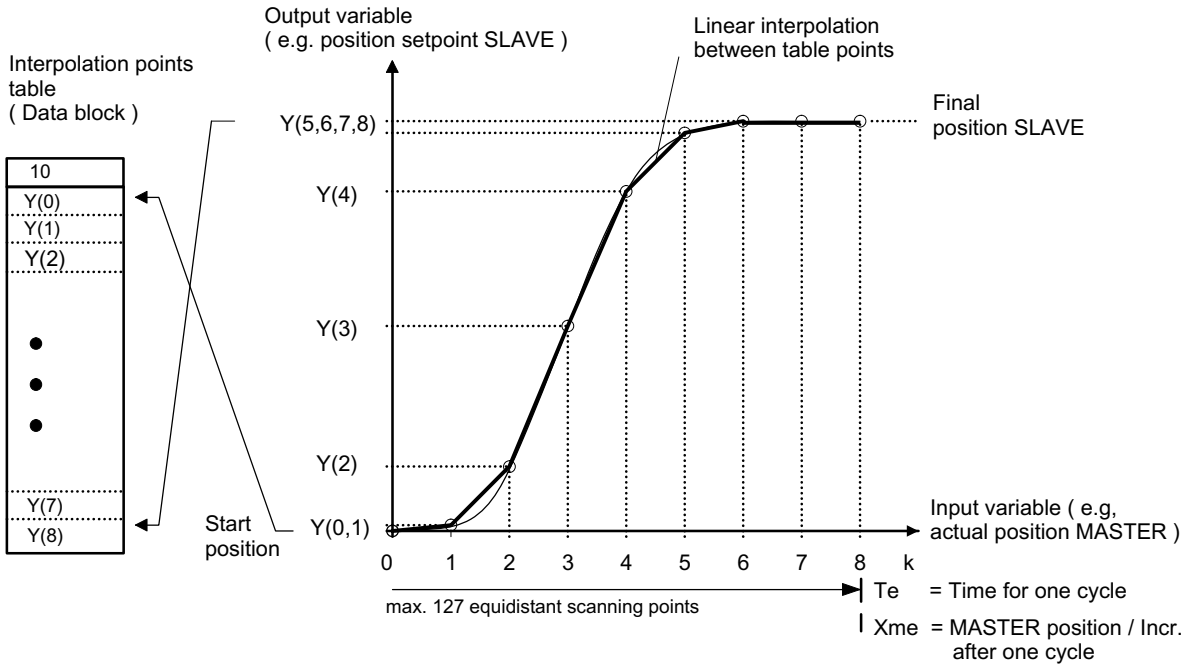


Figure 8: Principle of the function interpolator

The input variable, time (Te=cycle time) or master position (Xme=master cycle end position) is divided up equidistantly and the associated output positions are entered in the table.

Remarks: With regard to the cycle time a distinction must be made between:
- The cycle time Te (it determines the duration of a movement cycle).
- The SF cycle time Tsf (k=1) (time grid in which the SF is called cyclically; it determines the time grid in which e.g. command positions of the movement cycle are output).

The output variable of the function interpolator can be multiplied with a factor K (multiplication factor) and divided with a factor n (division exponent) to the base of 2:

Output variable Y = [interpolated table value] • $K / 2^n$

It must be observed: |Output variable Y| < 2^{31}-1

Remarks: The computing time is reduced with K=1 and n=0, i.e. $K / 2^n = 1$!

3.2.1.1 Time mode application

Fast moving to positions and fast cycle drives, with freely definable movement profile, are supported by fast functions of the SF type 1.

Remarks: The SF FIPZ (SF type 2; cf. Section 3.3) moreover allows the implementation of cycle drives with a movement profile that can be selected through binary input signals.

The input variable of time for the function interpolator is generated internally. The output variable can be forwarded as position command value, e.g. to one of the 8 drives.

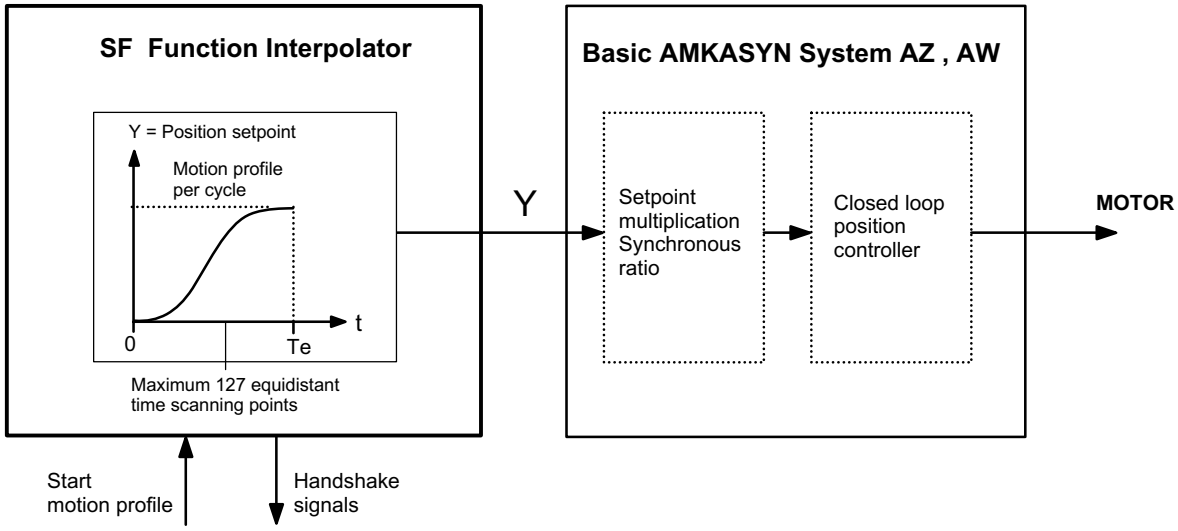


Figure 9: Principle of the function interpolator in the time mode

Depending upon the SF type and if appropriate upon the SFKMD-BA, the function is repeated cyclically or else performed once after a start signal (cf. following sections and figures).

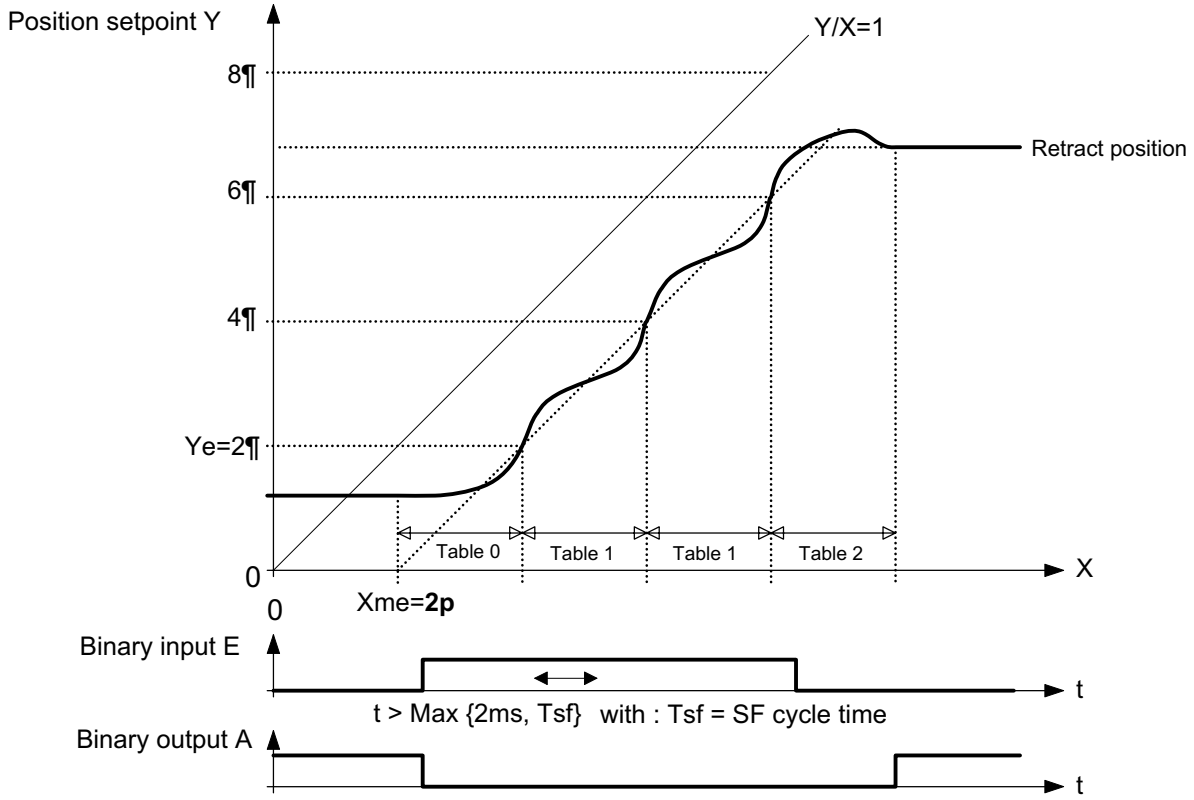


Figure 10: Time function in the clock mode

The movement time Te is determined by the SF commanding parameter "Cycle time" (cf. Section 3.2.2.3); i.e. the time axis is determined independently of the table.

Remarks: The time grid of the command position input (SF cycle time) is determined by the value of ID 2 (SERCOS cycle time). There is a 1 ms grid for instance with ID 2 = 1.

The function environment value Ye is determined by the table end value and the division and multiplication factor. Also there can be further exact multiplication of the output values Y with the synchronous ratio in the drive basic system (cf. documentation: Parameters; ID 32893, ID 32893).

Operating modes (cf. Section 3.2.2.3; SFKMD-BA):

- "Cyclic table processing" (SFKMD-BA=4): Independently of a binary input (from the start of the SF by means of FB 208), Table 0 is processed by this depending upon the time. Processing can be interrupted only by resetting the SF by means of FB 208.
- "Start immediately with auto stop (SFKMD-BA=132)": Controlled through a binary input (logical transition from 0 to 1), Table 0 is processed by this depending upon the time. Processing takes place immediately after detection of the positive input edge and begins with every positive edge at t = 0. Processing ends automatically on output of the last Y value (at t = Te).

- "Clocking in/out with auto stop" (SFKMD-BA=84): Controlled through a binary input (logical transition from 0 to 1), **m** (total number of tables) tables, which are switched over to one after the other, in each case after the time Te, are processed by this depending upon the time. The drive is then stopped ("clocked out"). The function interpolator remains in this condition until the binary input again has a flank change (logical transition from 0 to 1) ("clocking in").

  Remarks: The time t = 0 is determined by means of FB 208 at the start of the SF. The time t also runs on during the "clocked out" state. The time is not reset on "clocking in". Clocking in occurs only within a start window that can be defined around the 0-point (Modulo Te).

- "Clocking in/out" (SFKMD-BA=100): Controlled through a binary input (logical transition from 0 to 1), the program starts with **q** start table(s) which are switched over to one after the other in each case after the time Te. The working table q+1 is then switched over to. With the transition of the binary input to the logical value 0, the drive is stopped ("clocked out") through **r** table(s) (with r = m - q - 1; **m** = total number of tables). The function interpolator remains in this condition until the binary input is logic 1 again ("clocking in").

  Remarks: The time t = 0 is determined by means of FB 208 at the start of the SF. The time t also runs on during the "clocked out" state. The time is not reset on "clocking in". Clocking in or clocking out occurs only within a start window that can be defined around the 0-point (Modulo Te).

3.2.1.2 Distance mode application

The fast function of the SF type 1 supports quickly controllable coupling of drives defined by table values. The minimum reaction time is approx. 2ms.

A master position encoder is the input variable for the function interpolator, e.g. EDG or the internal position feedback value of another drive. The output variable is forwarded as command position, e.g. to a drive.

Remarks: The time grid of the command position input (SF cycle time) is determined by the value of ID 2 (SERCOS cycle time). At ID 2 = 1 there is e.g. an 1ms grid.

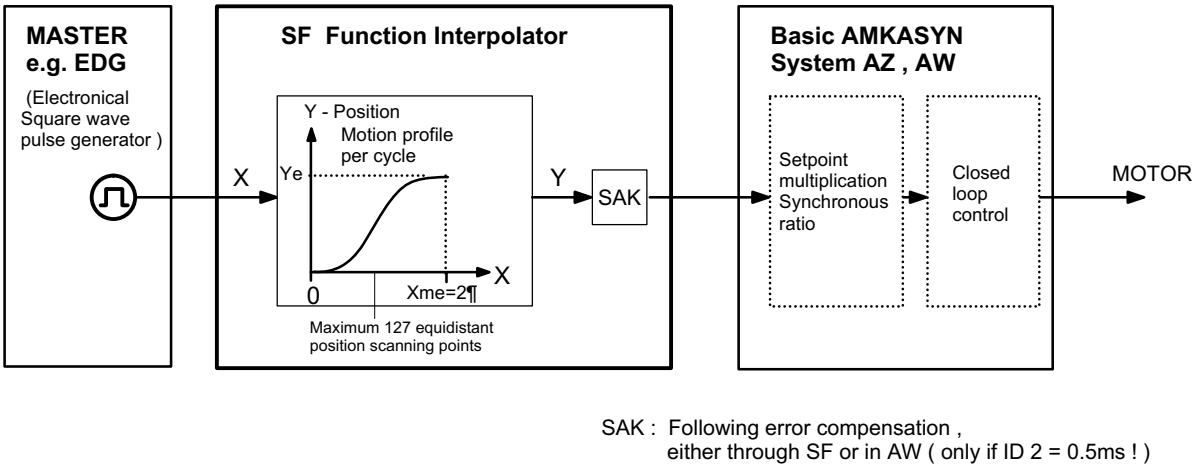


Figure 11: Principle of the function interpolator in the distance mode

The input variable X is treated as absolute variable. The modulo function for table processing is formed with the numerical value for Xme (= 2π = input increments of the master per cycle; [increments per master revolution]). After 2π the program starts anew with the table value (0) and the function is updated relatively. The command values Y are multiplied with the synchronous ratio in the drive.

Operating modes (cf. Section 3.2.2.3; SFKMD-BA):

- "Cyclic table processing" (SFKMD-BA=2)*:* Independently of a binary input (from the start of the SF by means of FB 208), Table 0 is processed by this depending upon the master position X. Processing can be interrupted only by resetting the SF by means of FB 208.
- "Start immediately with auto stop" (SFKMD-BA=26): Controlled through a binary input (logical transition from 0 to 1), Table 0 is processed by this depending upon the master position X. Processing takes place immediately after detection of the positive input edge and begins with every positive edge at X = 0. Processing ends automatically on output of the last Y value (at X = Xme).

  Remarks: The master position X = 0 is not determined by means of FB 208 at the start of the SF, but with the positive edge of the binary input.

- "Clocking in/out with auto stop" (SFKMD-BA=82): Controlled through a binary input (logical transition from 0 to 1), **m** (total number of tables) tables, which are switched over to one after the other, in each case after 2π master increments, are processed by this. The drive is then stopped ("clocked out"). The function interpolator remains in this condition until the binary input again has a flank change (logical transition from 0 to 1) ("clocking in").

  Remarks: The master position X = 0 is determined by means of FB 208 at the start of the SF. The master position X is also acquired during the "clocked out" state. On "clocking in", the master position is not reset. Clocking in is only within a start window that can be defined about the 0-point (Modulo Xme).

- "Clocking in/out" (SFKMD-BA=98): Controlled through a binary input (logical transition from 0 to 1), the program starts with **q** start table(s) which are switched over to one after the other in each case after 2π. The working table q+1 is then switched over to. With the transition of the binary input to the logical value 0, the drive is stopped ("clocked out") through **r** table(s) (with r = m - q - 1; **m** = total number of tables). The function interpolator remains in this condition until the binary input is logic 1 again ("clocking in").

  Remarks: The master position X = 0 is determined by means of FB 208 at the start of the SF. The master position X is also acquired during the "clocked out" state. On "clocking in", the master position is not reset. Clocking in or clocking out is only within a start window that can be defined about the 0-point (Modulo Xme).

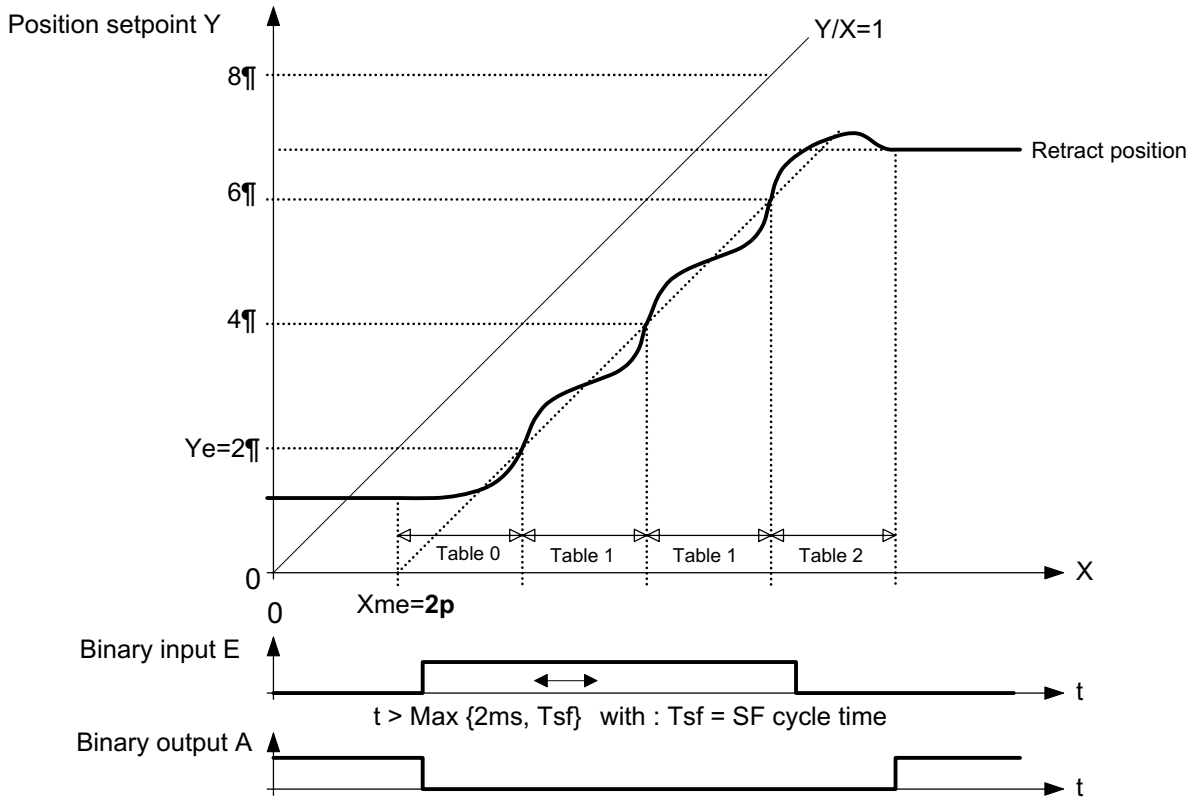


Figure 12: Distance function in the clocking in/clocking out mode

3.2.1.3 Synchronization on an external master drive

In most operating modes (see above) the master position X = 0 is determined by means of FB 208 at the start of the SF, i.e. at the start command the value "0" is assigned to the current master position of the FIPW-internal input variable X. If the master drive is an AMKASYN drive, "X = 0" can be assigned selectively to a master position (e.g. by a preceding homing cycle). However, if the master drive is an external drive which cannot be exactly homed (positioned) and the input variable X at the "Start" command can nevertheless be assigned selectively to a position of the external drive, then the synchronization to an external master can be selected at the start by means of FB 208 (cf. Section 3.2.2.3; SFKMD fct). In this way after the start the assignment input variable X = 0 is performed only at the next zero pulse of the master drive. In this case X = 0 is assigned to the master zero position of the input variable.

Remarks: The master offset angle is also processed with selected synchronization, i.e. if this offset angle is unequal to zero, then the input variable X is set to the offset angle at the start command after synchronization (X = master offset angle).

The command "Start with synchronization on external master" must run as follows:

- Command values and zero pulse are controlled through the AZ pulse generator input or through an optional pulse generator input card.
  Remarks: Should the function interpolator be operated simultaneously with external synchronization and mark control, the command values must be fed at 2 pulse generator inputs. The printing mark signal is fed as reference pulse at the first input (input which is defined by means of FB 207 on initialization of the SF) (see Section 3.2.1.4, printing mark control), the master zero pulse is fed at the second pulse generator input. This second input must be copied to a flag double word with the aid of the "SF COPY". This flag double word address is transferred to the function interpolator at the SF commanding "Start" (cf. Section 3.2.2.3; MD-Adr. Sync. ext. Master).
  On SF initialization by means of FB 207 the SF number of the "SF COPY" must be selected smaller than the SF number of the "SF FIPW".
- Homing the slave drive to the position wanted at master zero pulse.
- Master drive turns with low speed through the zero position.
- Start of the SF by means of FB 208 with selected synchronization on external master drive.

3.2.1.4 The printing mark control

The printing mark control is a special function within the scope of the FIPW functionality. It facilitates the correction of the travel of a drive controlled by the FIPW, depending upon a mark signal (binary input signal).

Figure 13 shows a possible arrangement with printing mark control in which three drives participate:
– the master drive (main drive or EDG),
– a synchronous drive without correction (e.g. blade drive) and
– a synchronous drive with correction by the printing mark control (e.g. transport drive).

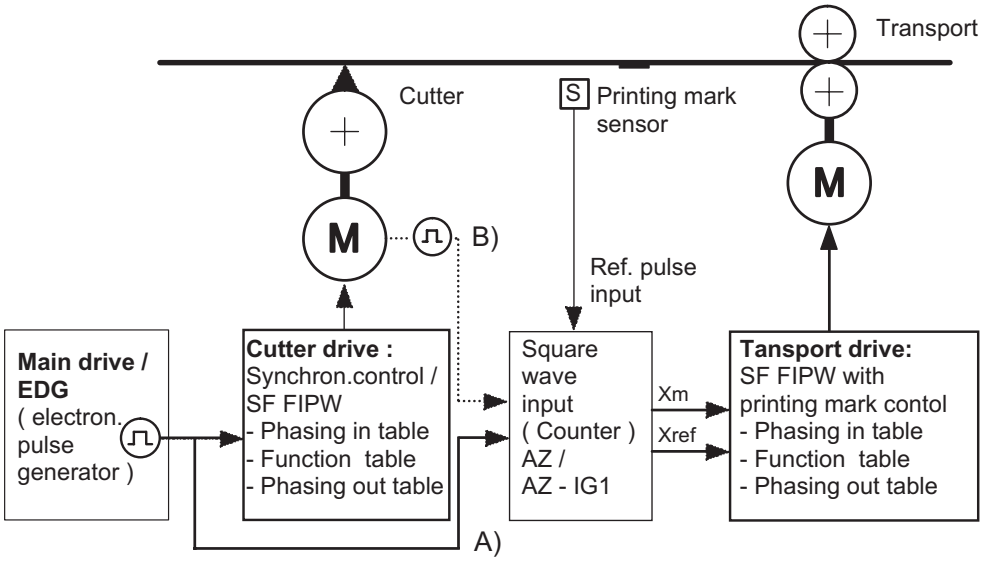


Figure 13: Possible drive arrangement for printing mark control

The blade drive is either operated in synchronous control to the main drive or controlled by the SF FIPW in a distance operating mode, whereby the main drive (or the EDG) is master.

In printing mark control according to Figure 13, the feed of a transport drive is corrected with the aid of a printing mark on the feed material, in order to be able to cut despite deviations in the material length at a point defined by the printing mark (synchronous point; cf. Figure 15 or Figure 16).

The blade is homed to the cutting position after switching on. The mark material is also brought with the aid of the homing cycle into a defined starting position (e.g. withdrawal position). The SF is then started, whereby the zero point results from the distance-distance assignment table.

On clocking in the mark material is transported up to the cutting position through the coupling table in the first cycle (the output start angle in the coupling table must correspond to the withdrawal position or the complementary value to the format length; cf. documentation "AMK-specific function blocks, FB 210 table value calculation, coupling table"). The transport conveyor is then controlled through the working table.

The printing mark control works only while the working table is active. Deviations of the printing mark distances from the format length determined by the working table are compensated for.

The following must be taken into account for the drive working with printing mark control:

- The drive (e.g. transport drive according to Figure 13) is controlled in the distance operating mode "cyclic table processing" (SFKMD-BA = 2) or "clocking in/out" (SFKMD-BA = 98) with integrated printing mark control (SFKMD fct, Bit0 = 1) (cf. Section 3.2.2.3). through the SF FIPW.
- The master axis of the transport drive is either a main drive (Figure 13, A) or the blade drive (Figure 13, B).
- Command values and printing mark signal are controlled through the AZ counter input or an optional counter module.
- The printing mark is acquired by a sensor and conducted to the reference pulse input of the counter.
- The distance increments of the master axis of the transport drive (either blade drive or main drive) are also conducted to the counter.
- The pulses of the printing mark must occur in a defined grid to the master distance; i.e. the pulse is expected at a certain master position (defined angle) at every revolution of the master axis.
- On deviations of the pulse from the defined angle, the output value of the SF FIPW is changed by addition of a correction value and thus the control of the transport conveyor is corrected (cf. Figure 15: Principle of the printing mark control).

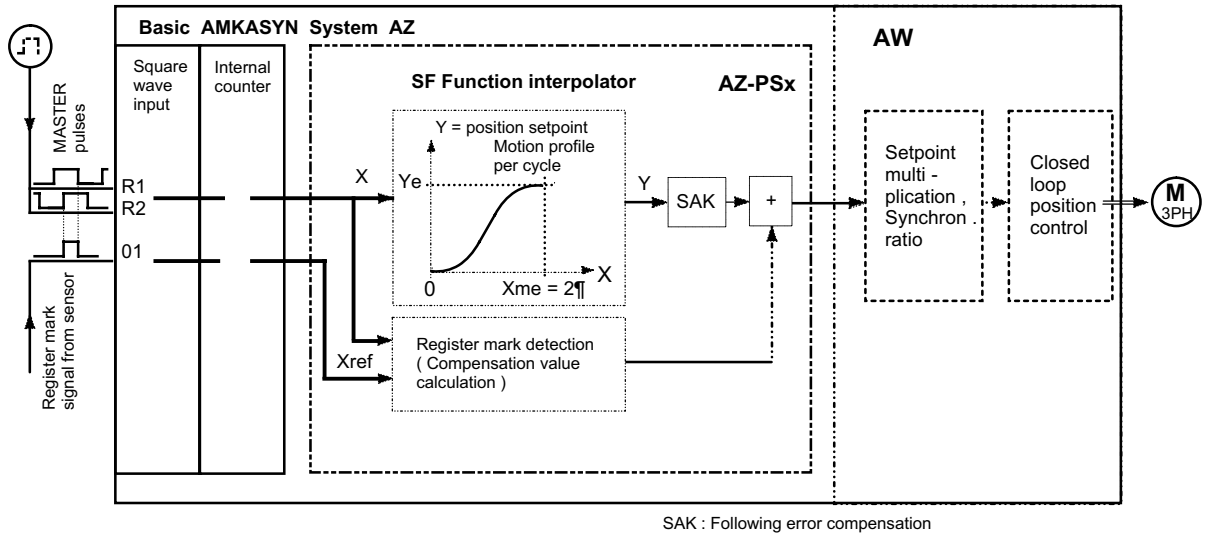
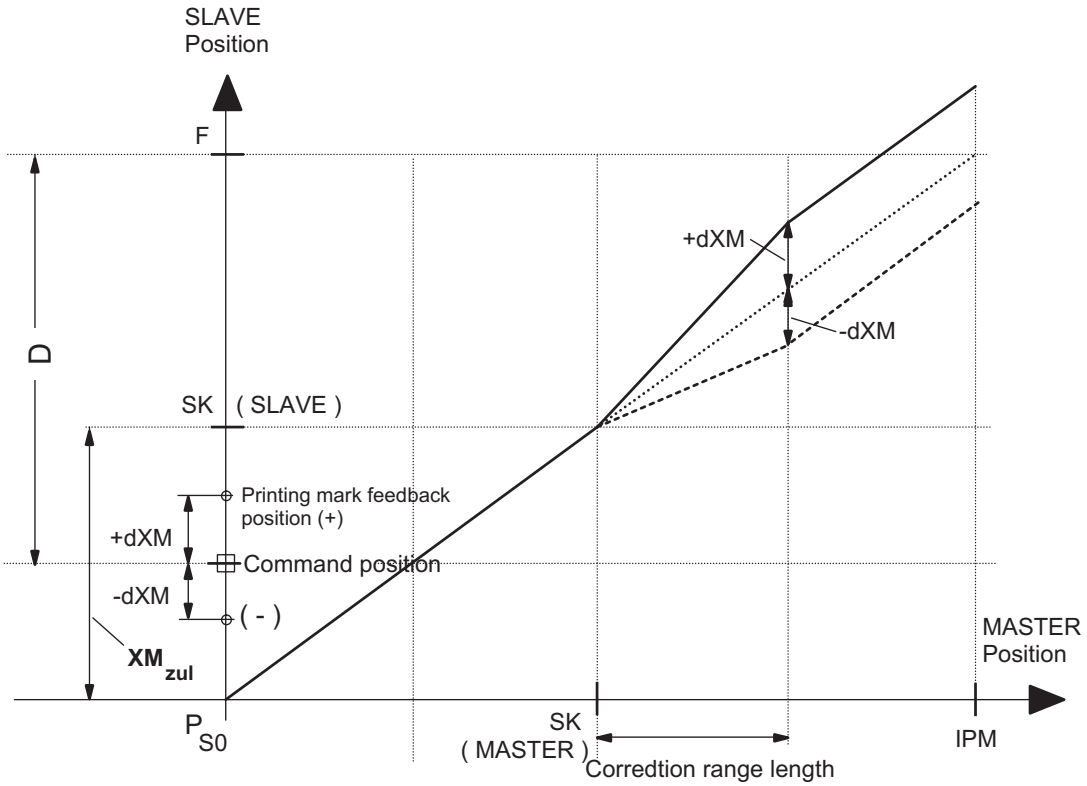


Figure 14: Block diagram of printing mark control



D Printing mark sensor + sinchronous point shift distance
F Format length (corresponds to the end value of the working table)
PSO Synchronous points (COMMAND intersection, corresponds to the zero point of the working table)
IPM Increments per MASTER revolution (cycle)
SK Correction range start angle
dXM Printing mark deviation
XM_{perm} Permitted range for printing mark deviation

Figure 15: Principle of printing mark control

Initializing and commanding the SF FIPW with printing mark control

Printing mark control is implemented as subfunction of the SF FIPW. On initialization of the SF with printing mark control the following points must be observed:

- On initialization of the SF FIPW (FB 207) the AZ (source address = 0) must be selected as source address and one of the AZ messages 1 to 4 (source address offset = 16, 18, 20 or 22) must be selected as source address offset.
- The AMKASYN parameter ID 32948 must be initialized to the corresponding counter input according to the above selected AZ message (1 .. 4) (cf. documentation: Parameters).
- On the "Start" commanding of the SF FIPW (FB 208), the printing mark control must be selected (SFKMF-Fkt, Bit0 = 1) and a suitable distance operating mode must be specified (SFKMD-BA = 98).

- In addition to the standard FIPW parameters, the following printing mark control parameters are required: format length, printing mark sensor distance, synchronous point shift, valid range, start angle correction range, length correction range.

Before SF commanding "Start" the participating drives according to Figure 13 must be brought into a defined starting position. Here it is possible to proceed as follows:

- Homing the blade drive to the position which is wanted at the time of the zero passage of the table of the transport drive. (At "master offset angle = 0", this position corresponds to the cutting position.)

- Homing the transport drive in reference to the mark, e.g. in that the sensor signal is switched to the reference cam input.
  If the "printing mark sensor distance" is known, then this is used as reference offset (ID 150) in the course of homing. (If "coupling tables" are used, then for determining the reference offset the travel in the course of "coupling" must be subtracted from the "printing mark sensor distance".)

  Remarks:
  If the "printing mark sensor distance" is not specified as system variable, then it can be determined at start-up by homing the slave axis (transport drive) with reference to the mark and subsequent further movement of the transport drive. In this case the mark must be moved into the position wanted for the zero passage of the table (cutting position). The travel length corresponds to the "printing mark sensor distance".

3.2.2 User interface of the FIPW

3.2.2.1 Prerequisites and marginal conditions

Expedient settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32809):

- BA command value source = 3C (hexadecimal; commanding interface)
- Position control without following error compensation (SAK is implemented by the SF if required), synchronous ratio (ID 32892, ID 32893) is effective:
  ⇒ SF sink = 16-bit command value source
  Example: ID 32800 = 3C0004
- Position control with fine interpolation (if required):
  ⇒SF sink = 32-bit command value source
  Example: ID 32800 = 3C0404

Time mode		
Source address	Offset	Meaning / remarks
0	0	In the time mode not required
Distance mode		
Source address	Offset	Meaning / remarks
0	1,3,5,7	Config.-AZ message1, 2, 3, 4 (High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32) / permitted only for FIPW **without** printing mark control and **without** synchronization on an external master drive
0	16,18,20, 22	Config.-AZ message1, 2, 3, 4 (Low and High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32) / permitted only for FIPW **with** printing mark control **and/or** on synchronization on an external master drive
1..8	3	Config.-AW message32 (Low Word) of AW1..8 / configurable by means of ID 32786; only position command or feedback values are expedient
1..8	5	Position feedback value (Low Word) of AW1..8
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
130	0,2,4 ..30	Input range of the PS process image / EW 0, .. ,30
131	0,4,8.. 28	Input range of the PS process image / ED 0, .. ,28
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2 .. 7 / for the logic operation of the source with the sink of another SF
Time mode or distance mode		
Sink address	Offset	Meaning
1..8	4	16-bit command value source of AW1..8 / ID 32892, ID 32893 are effective
1..8	16	32-bit command value source of AW1..8 / fine interpolator through ID 32800.. ID 32809 can be used; ID 1 = ID 2 required
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
255	0	Internal sink for logic operation with further SF without output on an AW

Table 7: Settings of the FIPW data holder interfaces (SF source/sink)

3.2.2.2 Interpolation point tables

The distance-time and distance-distance curves are described in the form of interpolation point tables, (Table 0 .. Table 7) which in each case are created as data block. In contrast to the SF XFIPW only Y tables (table form = 0) are permitted:

Data double word	High-Word	Low-Word
00	Table form = 0	Interpolation number+1
02	1. interpolation point	
04	2. interpolation point	
06	3. interpolation point	
..	..	
252	126. interpolation point	
254	127. interpolation point	

Total number: max. 256 data words

Table 8: FIPW/FIPZ interpolation point table

Interpolation number+1 (DW 0)
- Meaning: Number of the table interpolation points + 1.
- Value range: 3..128

1. interpolation point (DD 2)
- Meaning: 1. distance interpolation point of the table.
- Value range: 0 (the table must begin with value "0" !)
- Unit: Increments

2. .. 127. interpolation point (DD 4 .. DD 254)
- Meaning: 2. .. 127. distance interpolation point of the table.
- Value range: -2^{31} .. $+2^{31} - 1$
- Unit: Increments

Caution: The absolute amount of the value difference between two consecutive table values must be less than 32768! The data blocks (DB) assigned to the SF by the SF initialization (FB 207) may not be deleted (or newly generated)!

3.2.2.3 Structure and parameters of the DB for SF commanding

Data double word	High word		Low word	
	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		SAK factor	
04	Start table number		Total table number	
06	Reserved = 0	MD addr. ext. sync.	Division exponent	
08	Multiplication factor			
10	Increments per revolution /cycle time			
12	Reserved = 0		Master offset angle	
14	Reserved = 0		Start angle	
16	Reserved = 0		Stop angle	
18	Reserved = 0		Format length	
20	Printing mark sensor distance			
22	Valid range		Synchronous point shift	
24	Length correction range		Start angle correction range	
26	Correction counter	Correction weighting	MD addr. correction value	
28	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 9: FIPW commanding DB

SF number (DR 0)

- Meaning: SF number under which a SF of the SF type 1 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)

- Meaning: SF commanding function; selection of the printing mark control and of the correction point for the starting values.
- Value range: bit-coded:
  - Bit 0 = 0: FIPW without printing mark control
    = 1: FIPW with printing mark control
  - Bit 1 = 0: Printing mark control correction after SAK
    ⇒ A following error occurs during the correction value output.
    = 1: Printing mark control correction before SAK
    ⇒ The non-linearity of the reference input variable leads to increased uneven running.
  - Bit 2 = 0: No synchronization to external master
    = 1: Synchronization to external master
- Proposal: As a rule higher system evenness should be preferred; especially if the cutting time (zero point of the table) is not in the correction range.

SFKMD code (DR 1)

- Meaning: SF commanding code
- Value range: 0 (RESET): Reset of the SF
  1 (START): Start of the SF

SFKMD-BA (DL 1)

- Meaning: SF commanding operating mode (cf. Section 3.2.1.1 or 3.2.1.2).
- Value range:
  - 2 Distance operating mode: cyclic table processing
  - 26 Distance operating mode: start immediately with auto stop
  - 82 Distance operating mode: clocking in/out with auto stop
  - 98 Distance operating mode: clocking in/out
  - 4 Time operating mode: cyclic table processing
  - 132 Time operating mode: start immediately with auto stop
  - 84 Time operating mode: clocking in/out with auto stop
  - 100 Time operating mode: clocking in/out

SAK factor (DW 2)

- Meaning: Following error compensation error (cf. documentation: PS command set, Section "Position controller synchronization").
  If the input command value of the SF comes from the position feedback value of another AW (internal drive):
  SAK factor = 7680000 / ID2 / ID104 + 128 (1 + 1 / ID2)
  If the input command value of the SF comes from the pulse generator input (external drive):
  SAK factor = 7680000 / ID2 / ID104 + 256
  (ID2 in ms; ID104 in rpm).
- Remarks: Following error compensation is urgently required in connection with the printing mark control, since otherwise the following error is corrected by the DMR; which after "decoupling" from the working table leads to a following error-dependent position deviation.
- Value range: 0 No following error compensation
  1...+2^{15}-1 Following error compensation
- Example: ID 2 = 2ms, ID 104 = 1000 rpm, internal drive $\Rightarrow$ SAK = 4032

SF cycle time (DW 3)

- Meaning: Cycle time of the fast function; time grid in which the SF is selected or in which command values are output; must be specified corresponding to ID 2.
- Value range: 1..+2^{15}-1
- Unit: 0.5 ms
- Example: Value = 2 $\Rightarrow$ SF cycle time = 1 ms

Total table number (DW 4)

- Meaning: Total number of used tables.
- Value range: 1..8

Start table number (DW 5)

- Meaning: Number of the tables to be used for the start process, starting from Table 0
- Value range: 0..Total table number - 1

Division exponent (DW 6)

- Meaning: Exponent to the base of 2, as division factor for the table value (0 = no division).
- Value range: 0..15

MD addr. ext. sync. (DR 7)

- Meaning: Flag double word address to which the SF "COPY" copies the pulse generator values of the second pulse generator input (only necessary for simultaneous printing mark control and synchronization on an external master drive).
- Value range: 0..124

Multiplication factor (DD 8)

- Meaning: Multiplication factor for the table value (1 ⇒ no multiplication; shorter SF execution time).
- Value range: -2^{15} ..$+2^{15}-1$

Increments per revolution (DW 10) / cycle time (DD 10)

- Meaning: Distance mode: Number of the increments of the master encoder per revolution (= Modulo value Xme, distance at which a table is processed).
  Time mode: cycle time (= Modulo value Te; time in which a table is processed).
- Value range: Distance mode: 50..$2^{15}-1$
  Time mode: 1..($2^{15}-1$) * SF cycle time
- Unit: Distance mode: increments
  Time mode*:* 0.5 ms

Master offset angle (DW 12)

- Meaning: Offset to which the input variable is set on the SF commanding "Start".
- Value range: Distance mode*:* 0 .. number of increments per revolution - 1
  Time mode: 0 .. cycle time - 1
- Unit: Distance mode: increments
  Time mode: 0.5 ms

Start angle (DW 14)

- Meaning: Range of the input variable within which there is "clocking in".
- Value range: Distance mode: 0 .. number of increments per revolution - 1
  Time mode: 0 ..cycle time - 1
- Unit: Distance mode*:* increments
  Time mode*:* 0.5 ms

Stop angle (DW 16)

- Meaning: Range of the input variable within which there is "clocking out".
- Value range: Distance mode: 0 .. number of increments per revolution - 1
  Time mode: 0 ..cycle time - 1
- Unit: Distance mode: increments
  Time mode*:* 0.5 ms

The parameters listed below are relevant only for the printing mark control (SFKMD fct, Bit0 = 1) , whereby SFKMD-BA = 2 or 98 is assumed:

Format length (DW 18)

- Meaning: Standardization value for the material length between two cuts.
- Remarks: The format length in DW18 is solely a standardization value for the statement of printing mark sensor distance (DD20), synchronous point shift (DW22) and valid range (DW23). The actual format length which is moved per master cycle (DW10) results from the drive movement, which is determined essentially by the working table. The format length in DW18 can be selected e.g. so that it corresponds to the value in 0.1 mm corresponding to this movement (see example above). However, the format length can also be standardized in 0.1 degrees by a value of e.g. 3600.
- Value range: 0 .. +32767
- Unit: e.g. 0.1 mm
- Example: Format length = 100 mm $\Rightarrow$ value = 1000

Printing mark sensor distance (DD 20)

- Meaning: Distance of the printing mark sensor from the synchronous point (zero point of the working table) for synchronous point shift = 0.
- Value range: 0 ..+2^{31}-1
- Unit: e.g. 0.1 mm
- Example: Value = 10 $\Rightarrow$ Distance of the printing mark sensor from the cutting position = 1 mm

Synchronous point shift (DW 22)

- Meaning: Shift of the synchronous point in the direction to the printing mark sensor.
- Value range: 0 .. format length - 1
- Unit: e.g. 0.1 mm
- Example: Value = 10 $\Rightarrow$ Shift of the synchronous point in the direction to the printing mark sensor = 1 mm

Valid range (DW 23)

- Meaning: Range about the command position of the printing mark, in which a valid printing mark is detected. At 0 a printing mark in the entire range is permitted.
- Remarks: The valid range refers to the starting range of the FIPW (slave position). In connection with RFPAK hardware the value "0" is not permitted. Select the value "format length / 2" for selecting the total range!
- Value range: 0 .. format length / 2
- Unit: e.g. 0.1 mm
- Example: Value = 10 $\Rightarrow$ Range in which a valid printing mark is detected = 1 mm

Start angle correction range (DW 24)

- Meaning: Angle position of the master at which the addition of the correction values of the printing mark control is started (0 = cutting position = start of the working table).

– Remarks: The start angle correction range refers to the input range (master position). The correction window is determined by this parameter and the "Length correction range" parameter. From a control engineering viewpoint it is important that the acquisition of the printing mark signal does **not** coincide with the correction value output, since it otherwise leads to **control oscillations**! This means (cf. Figure 15) the printing mark feedback position (printing mark command position + printing mark deviation dXM) must be within the permitted printing mark deviation range Xm_{perm} (with: $0 < Xm_{perm} < SK_{Slave}$).
– Value range: 0 .. number of increments per revolution
– Unit: Increments

Length correction range (DW 25)
– Meaning: Length of the range in which the correction values of the printing mark control are output.
– Value range: 0 .. number of increments per revolution - start angle correction range
– Unit: Increments

Remarks: Start angle correction range = 0 and length correction range = 0
⇒ Default setting:
Start angle correction range =
Number of increments per revolution * 3 / 4
Length correction range = number of increments per revolution * 1 / 8

MD addr. correction value (DW 26)
– Meaning: Flag double word address to which the correction value dXM (cf. Figure 15) is written by the SF on selected printing mark control.

– Value range: 0: No output of the correction value.
4..124: Output of the correction value in MD4..MD124

Remarks: The correction value is output in increments. If no printing mark is detected, then the value 0 is output.

Correction weighting k (DR 27)
– Meaning: The determined deviation of the printing mark is not compensated for completely, but weighted with the factor $F = 2^{-k}$: for $0 \leq k < 32$
(or $F = -2^{128-k}$: for $128 \leq k < 160$).

– Value range: 0: Complete correction (F = 1).
1..31: Partial correction ($F = 2^{-1} .. 2^{-31}$)
32: No correction (F = 0)
128: Complete correction (F= -1).
129..159: Partial correction ($F = -2^{-1} .. -2^{-31}$)

Remarks: The inversion of the control sense can be achieved by setting the most significant bit 7 (DR 27 >= 128).
A correction value output is suppressed by setting bit 5 (DR 27 = 32).
However, the determined correction value can be displayed through DW 26 in the flag range.

Correction counter n (DL 27)
– Meaning: Only the deviation of every nth printing mark is compensated for.

– Value range: 0, 1: Each printing mark deviation is compensated for.
2..255: Only every nth printing mark deviation is compensated for (with: n = 2,..,255).

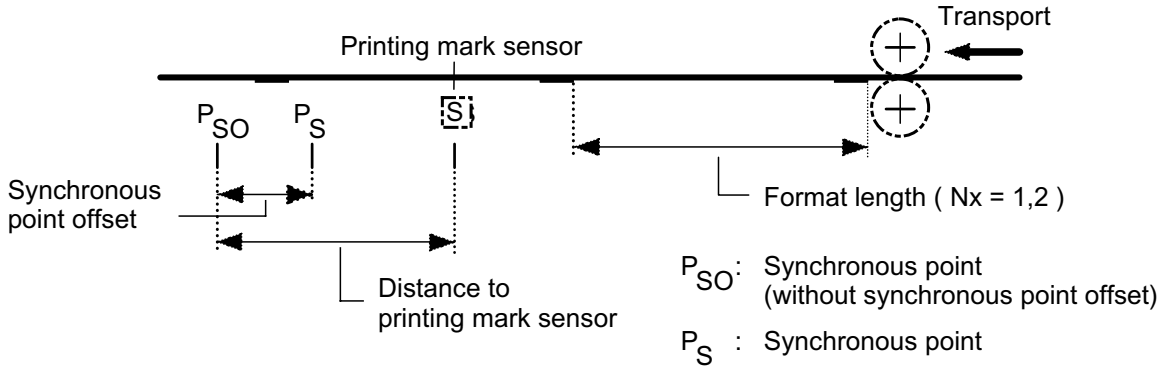


Figure 16: Printing mark control parameters

DW/DD	Parameter	BA (distance-distance)				BA (distance-time)			
		2	26	82	98	4	84	100	132
DW 02	SAK factor	x	x	x	x	x	x	x	x
DW 03	SF cycle time	x	x	x	x	x	x	x	x
DW 04	Total table number	1	1	x	x	1	x	x	1
DW 05	Start table number	0	0	0	x	0	0	x	0
DW 06	Division exponent	x	x	x	x	x	x	x	x
DR 07	MD addr. ext. sync.	x[2)]	0	0	x[2)]	0	0	0	0
DL 07	Reserve	0	0	0	0	0	0	0	0
DD 08	Multiplication factor	x	x	x	x	x	x	x	x
DD 10	Incr. per revolution	x	x	x	x	-	-	-	-
DD 10	Cycle time	-	-	-	-	x	x	x	x
DW 12	Master offset angle	x	0	x	x	0	0	0	0
DW 13	Reserve	0	0	0	0	0	0	0	0
DW 14	Start angle	x	0	x	x	0	0	0	0
DW 15	Reserve	0	0	0	0	0	0	0	0
DW 16	Stop angle	0	0	0	x	0	0	0	0
DW 17	Reserve	0	0	0	0	0	0	0	0
DW 18	Format length	x[1)]	-	-	x[1)]	-	-	-	-
..	..								
DW 25	Length of corr. calculation	x[1)]	-	-	x[1)]	-	-	-	-
DW 26	MD address corr. value	x[1)]	-	-	x[1)]	-	-	-	-
DR 27	Correction weighting k	x[1)]	-	-	x[1)]	-	-	-	-
DL 27	Correction counter n	x[1)]	-	-	x[1)]	-	-	-	-
DD 28	Reserve	0	0	0	0	0	0	0	0
DD 30	Reserve	0	0	0	0	0	0	0	0
DD 32	Reserve	0	0	0	0	0	0	0	0

x = value within the scope of the permitted limits
\- = not defined
[1)] only in connection with printing mark control
[2)] only in connection with printing mark control and simultaneous synchronization onto an external master drive

Table 10: Dependence of the FIPW parameters on the SFKMD operating mode

3.2.3 Examples

3.2.3.1 Initializing the FIPW with printing mark control

;* DB for initializing the SF "FIPW with printing mark control"

```
;
:KB 1       ;DR 0  SF type                 FIPW
:KB 0       ;DL 0  SF number               SF0
:KB 0       ;DR 1  E/A-M mode              E/A mode
:KB 0       ;DL 1  Reserved
:KB 16      ;DR 2  Source address offset   Conf. AZ message 1
:KB 0       ;DL 2  Source address          AZ
:KB 4       ;DR 3  Sink address offset     16-bit command value source
:KB 1       ;DL 3  Sink address            AW 1
:KB 1       ;DR 4  Input bit mask          Bit 0
:KB 8       ;DL 4  Input byte address      E-Byte 8
:KB 1       ;DR 5  Output bit mask         Bit 0
:KB 8       ;DL 5  Output byte address     A-Byte 8
:KB 16      ;DR 6  DB number Tab0          DB16 (coupling table)
:KB 17      ;DL 6  DB number Tab1          DB17 (working table)
:KB 18      ;DR 7  DB number Tab2          DB18 (decoupling table)
:KB 0       ;DL 7  DB number Tab3          Not used
:KB 0       ;DR 8  DB number Tab4          Not used
:KB 0       ;DL 8  DB number Tab5          Not used
:KB 0       ;DR 9  DB number Tab6          Not used
:KB 0       ;DL 9  DB number Tab7          Not used
```

AMKASYN parameter setting:

- ID 32948 = 00000003 $\Rightarrow$ AZ message 1 = pulse generator input AZ (terminal X32)

3.2.3.2 Commanding the FIPW with printing mark control

;DB for commanding the SF "FIPW with printing mark control"

```
;
:KB 0       ;DR 0  SF number                    SF0
:KB 1       ;DL 0  SFKMD fct                    Printing mark control (corr. behind SAK;
                                                no sync. on external master)
:KB 1       ;DR 1  SFKMD code                   Start
:KB 98      ;DL 1  SFKMD-BA                     Distance function "clocking in/out"
:KF 0       ;DW 2  SAK                          No following error compensation
:KF 4       ;DW 3  SF cycle time                ID 2 = 2ms
:KF 3       ;DW 4  Total table number           3 tables
:KF 1       ;DW 5  Start table number           1 start table
:KF 0       ;DW 6  Division exponent            0 (no division)
:KB 0       ;DR 7  MD addr. ext. sync.          0 (not required)
:KB 0       ;DL 7  Reserved
:KD 1       ;DD 8  Multiplication factor        1 (no multiplication)
:KD 20000   ;DD10  Increments per rev.          20000 increments p. U.
:KF 0       ;DW12  Master offset angle          0 increments (no angle shift)
:KF 0       ;DW13  Reserved
:KF 0       ;DW14  Start angle                  0 increments (start only at
                                                the table start)
:KF 0       ;DW15  Reserved
:KF 0       ;DW16  Stop angle                   0 increments (stop only at
                                                the table end)
:KF 0       ;DW17  Reserved
:KF 3000    ;DW18  Format length in 0.1mm       300 mm
:KF 0       ;DW19  Reserved
:KD 1000    ;DD20  Distance of printing mark sensor      100 mm
:KF 0       ;DW22  Synchronous point shift        0 mm (no synchronous point shift)
:KF 200     ;DW23  Valid range                    20 mm
:KF 5000    ;DW24  Start angle correction range   5000 increments (  90°)
:KF 10000   ;DW25  Length correction range        10000 increments (180°)
:KF 0       ;DW26  MD addr. correction value      0 = Not selected
:KB 0       ;DR27  Correction weighting k         0 = Complete correction
:KB 0       ;DL27  Correction counter n           0 = Correction for every mark
.           .
:KD 0       ;DD32  Reserved
```

3.3 "SF FIPZ" function interpolator for time function

SF type = 2

The SF FIPZ generates command positions for the drives with the aid of a table interpolator. The table input variable of time is formed internally (cf. Section 3.2.1.1). In contrast to the time operating modes of the FIPW (cf. Section 3.2) it is possible to select very quickly between different movement profiles through binary inputs.

Caution:
- The absolute amount of the value difference between 2 consecutive table values must be less than 32768!
- Table values of a started SF may not be changed!
- The data blocks (DB) assigned to the SF by the SF initialization (FB 207) may not be deleted (or newly generated)!

Operating modes (cf. Section 3.3.1.2, SFKMD-BA):
- "Start immediately with auto stop" and selection of the table as well as of the cycle time by an assigned input signal (SFKMD-BA=16):
  Controlled through a binary input (logical transition from 0 to 1), the assigned table is processed in an also assigned cycle time by this. The binary inputs are assigned to the distance-time tables as well as to the cycle time parameters as follows:

Logical input address	Table[1)]	Cycle time[2)]
E1	Tab0-DB number	Cycle time Tab0
E2	Tab1-DB number	Cycle time Tab1
E3	Tab2-DB number	Cycle time Tab2
E4	Tab3-DB number	Cycle time Tab3
E5	Tab4-DB number	Cycle time Tab4
E6	Tab5-DB number	Cycle time Tab5
E7	Tab6-DB number	Cycle time Tab6
E8	Tab7-DB number	Cycle time Tab7
[1)] determined in initialization DB for FB 207 [2)] determined in commanding DB for FB 208		

Table 11: Tables and cycle time assignment by an assigned input signal

Processing is immediately after detection of the positive input edge and begins with every start at t = 0. Processing ends automatically on output of the last Y value (at t = Te).

"Start immediately with auto stop" and selection of the table as well as of the cycle time by 4 input signals (SFKMD-BA=16):
In this case, controlled through a binary input (E1: logical transition from 0 to 1) and by 3 further binary inputs (E2 .. E3) the assigned table is processed in an also assigned cycle time. The binary inputs are assigned to the distance-time tables as well as to the cycle time parameters as follows:

Logical input address				Table[1)]	Cycle time[2)]
E1	E2	E3	E4		
0 → 1	0	0	0	Tab0-DB number	Cycle time Tab0
0 → 1	1	0	0	Tab1-DB number	Cycle time Tab1
0 → 1	0	1	0	Tab2-DB number	Cycle time Tab2
0 → 1	1	1	0	Tab3-DB number	Cycle time Tab3
0 → 1	0	0	1	Tab4-DB number	Cycle time Tab4
0 → 1	1	0	1	Tab5-DB number	Cycle time Tab5
0 → 1	0	1	1	Tab6-DB number	Cycle time Tab6
0 → 1	1	1	1	Tab7-DB number	Cycle time Tab7
[1)] according to initialization DB for FB 207 [2)] according to commanding DB for FB 208					

Table 12: Tables and cycle time assignment by an input signal combination

Processing is immediately after detection of the positive input edge at E1 and begins with every start at t = 0. Processing ends automatically on output of the last Y value (at t = Te).

3.3.1 User interface of the FIPZ

3.3.1.1 Prerequisites and marginal conditions

Suitable settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32805):

- BA command value source = 3C (hexadecimal; commanding interface)
- Position control without following error compensation (SAK is implemented by the SF if required), synchronous ratio (ID 32892, ID 32893) is effective:
  ⇒ SF sink = 16-bit command value source
  Example: ID 32800 = 3C0004
- Position control with fine interpolation (if required):
  ⇒ SF sink = 32-bit command value source
  Example: ID 32800 = 3C0404

Time mode		
Source address	Offset	Meaning / remarks
0	0	In the time mode not required
Time mode		
Sink address	Offset	Meaning
1..8	4	16-bit command value source of AW1..8 / ID 32892, ID 32893 are effective
1..8	16	32-bit command value source of AW1..8 / fine interpolator through ID 32800.. ID 32805 can be used; ID 1 = ID 2 required
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
255	0	Internal sink for logic operation with further SF without output on an AW

Table 13: Settings of the FIPZ data holder interfaces (SF source/sink)

The structure of the data blocks (Table 0 .. Table 7) for specifying the interpolation points - for describing the distance-time curves – corresponds to that of the SF FIPW.

3.3.1.2 Structure and parameters of the DB for SF commanding

Data	High word		Low word	
double word	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		SAK factor	
04	Reserved = 0		Total table number	
06	Reserved = 0		Division exponent	
08	Multiplication factor			
10	Cycle time Tab1		Cycle time Tab0	
12	Cycle time Tab3		Cycle time Tab2	
14	Cycle time Tab5		Cycle time Tab4	
16	Cycle time Tab7		Cycle time Tab6	
18	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 14: FIPZ commanding DB

SF number (DR 0)

- Meaning: SF number under which a SF of the SF type 2 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)

- Meaning: Currently not used.
- Value range: 0

SFKMD code (DR 1)
- Meaning: SF commanding code.
- Value range: 0 (RESET): Reset of the SF
  1 (START): Start of the SF

SFKMD-BA (DL 1)
- Meaning: SF commanding operating mode.
- Value range: 16: Start of a table (Table 0 ..Table 7) after positive edge at binary signal 1 .. binary signal 8 with the assigned cycle time (cycle time Tab0.. cycle time Tab7). Automatic stop after going through the relevant table.
  17: Start of a table (Table 0 ..Table 7) after positive edge at binary signal E1 and selection of the table by binary signal E2 (less significant bit) .. binary signal E4 (most significant bit) with the assigned cycle time (cycle time Tab0 .. cycle time Tab7). Automatic stop after going through the relevant table.

SAK factor (DW 2)
- Meaning: Following error compensation error (cf. documentation: PS command set, Section "Position controller synchronization").
- Value range: 0: No following error compensation.
  1 .. $+2^{15}-1$: Following error compensation error with:
  SAK factor = 7680000 / ID2 / ID104 + 128 (1 + 1 / ID2),
  if the input command value of the SF comes from the position feedback value of another AW (internal drive);
  SAK factor = 7680000 / ID2 / ID104 + 256,
  if the input command value of the SF comes from the pulse generator input (external drive).
  ID2 in ms; ID104 in rpm
- Example: ID 2 = 2ms, ID 104 = 1000 rpm, internal drive $\Rightarrow$ SAK = 4032

SF cycle time (DW 3)
- Meaning: Cycle time of the fast functions. (Time with regard to the calculation of an output value = SERCOS cycle time = ID 2).
- Value range: $1..+2^{15}-1$
- Unit: 0.5 ms
- Example: Value = 2 $\Rightarrow$ SF cycle time = 1 ms

Total table number (DW 4)
- Meaning: Total number of used tables.
- Value range: 1..8

Division exponent (DW 6)
- Meaning: Division factor for the table value (statement as exponent to the base of 2; 0 = no division).
- Value range: 0..15

Multiplication factor (DD 8)
- Meaning: Multiplication factor for the table value (1 = no multiplication).
- Value range: $+1..+2^{15}-1$

Cycle time Tab0 (DW 10)...cycle time Tab7 (DW 17)
- Meaning: Time in which the assigned table is processed (movement time).
- Value range: $1..2^{15}-1$
- Unit: 0.5 ms
- Example: Value = 200 $\Rightarrow$ cycle time Tab*x* = 100 ms

3.3.2 Examples

3.3.2.1 Initializing the FIPZ

;* DB for initializing the SF "FIPZ"

```
;
:KB 2       ;DR 0  SF type                 FIPZ
:KB 1       ;DL 0  SF number               SF1
:KB 0       ;DR 1  E/A-M mode              E/A
:KB 0       ;DL 1  Reserved
:KB 0       ;DR 2  Source address offset   not required
:KB 0       ;DL 2  Source address          not required
:KB 4       ;DR 3  Sink address offset     16-bit command value source
:KB 2       ;DL 3  Sink address            AW 2
:KB 2       ;DR 4  Input bit mask          Bit 1
:KB 16      ;DL 4  Input byte address      E-Byte 16
:KB 2       ;DR 5  Output bit mask         Bit 1
:KB 16      ;DL 5  Output byte address     A-Byte 16
:KB 16      ;DR 6  DB number Tab0          DB16
:KB 17      ;DL 6  DB number Tab1          DB17
:KB 18      ;DR 7  DB number Tab2          DB18
:KB 19      ;DL 7  DB number Tab3          DB19
:KB 20      ;DR 8  DB number Tab4          DB20
:KB 0       ;DL 8  DB number Tab5          Not used
:KB 0       ;DR 9  DB number Tab6          Not used
:KB 0       ;DL 9  DB number Tab7          Not used
```

3.3.2.2 Commanding the FIPZ

;DB for commanding the SF "FIPZ"

```
;KB 1       ;DR 0  SF number               SF1
:KB 0       ;DL 0  SFKMD fct               Not used
:KB 1       ;DR 1  SFKMD code              Start
:KB16       ;DL 1  SFKMD-BA                "Start immediately with auto stop and
            ;                               single bit selection"
:KF 0       ;DW 2  SAK                     No following error compensation
:KF 4       ;DW 3  SF cycle time           ID 2 = 2ms
:KF 5       ;DW 4  Total table number      5 tables (Tab0..Tab4)
:KF 0       ;DW 5  Reserved
:KF 0       ;DW 6  Division exponent       0 (no division)
:KF 0       ;DW 7  Reserved
:KD 1       ;DD 8  Multiplication factor   1 (no multiplication)
:KF 2000    ;DW10  Cycle time Tab0         1000 ms
:KF 4000    ;DW11  Cycle time Tab1         2000 ms
:KF 6000    ;DW12  Cycle time Tab2         3000 ms
:KF 8000    ;DW13  Cycle time Tab3         4000 ms
:KF 10000   ;DW14  Cycle time Tab4         5000 ms
:KF 0       ;DW15  Cycle time Tab5         Not used
:KF 0       ;DW16  Cycle time Tab6         Not used
:KF 0       ;DW17  Cycle time Tab7         Not used
:KD 0       ;DD18  Reserved
:KD 0       ;DD32  Reserved
```

3.4 "SF STDFKT" standard functions

SF type = 3

Different standard functions, such as the fast change of an existing synchronous ratio between two drives or the fast specification of a speed command value are summarized within the scope of the "SF STDFKT".

A distinction is made between the following standard functions:

SF function number (SFKMD fct)	Short designation	Meaning
1	VARSYNC	Fast variation of the synchronous ratio through binary input signals
2	DIGDREH	Fast switching over between a command speed and the speed 0 through binary input signals

Table 15: Standard functions

3.4.1 General structure and parameters of the DB for SF commanding

The following table provides an overview of the commanding variables used jointly by all functions of the SF STDFKT. A detailed description of the function-dependent parameters is provided in subsequent sections.

SF number (DR0)
- Meaning: SF number under which a SF of the SF type 3 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
- Meaning: Selection of the standard functionality.
- Value range: 1: Variation of the synchronous ratio "VARSYNC"
  2: Digital speed command value input "DIGDREH"

SFKMD code (DR 1)
- Meaning: SF command code.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): start SF

SFKMD-BA (DL 1)
- Meaning: Selection of the SF operating mode.
- Value range: Function-dependent

Parameter (DD 2 .. DD 32)
- Meaning: SF commanding parameter.
- Value range: Function-dependent

3.4.2 "SF STDFKT-VARSYNC" SF for variation of the synchronous ratio via binary signal

The function VARSYNC (SFKMD fct = 1) implements synchronous control between two drives. Four operating modes for selecting the synchronous ratio are distinguished (SFKMD-BA = 0 .. 3) by means of the command variable SFKMD-BA. The operating modes 0..2 allow the fast selection of permanently parameterized synchronous factors by means of binary inputs. The operating mode 3 facilitates the agreement of a flag or input word address, under which an online synchronous factor specification can be made.

Operating modes:

- The program switches over between two synchronous factors (m1, m2) by means of a binary input (E1) in the operating mode 0 (SFKMD-BA = 0). The binary output (A1) is 0 for E1 = 0 (m1) and 1 for E1 = 1 (m2).

E1	A1	m
0	0	m1
1	1	m2

Table 16: Synchronous factor selection (BA0)

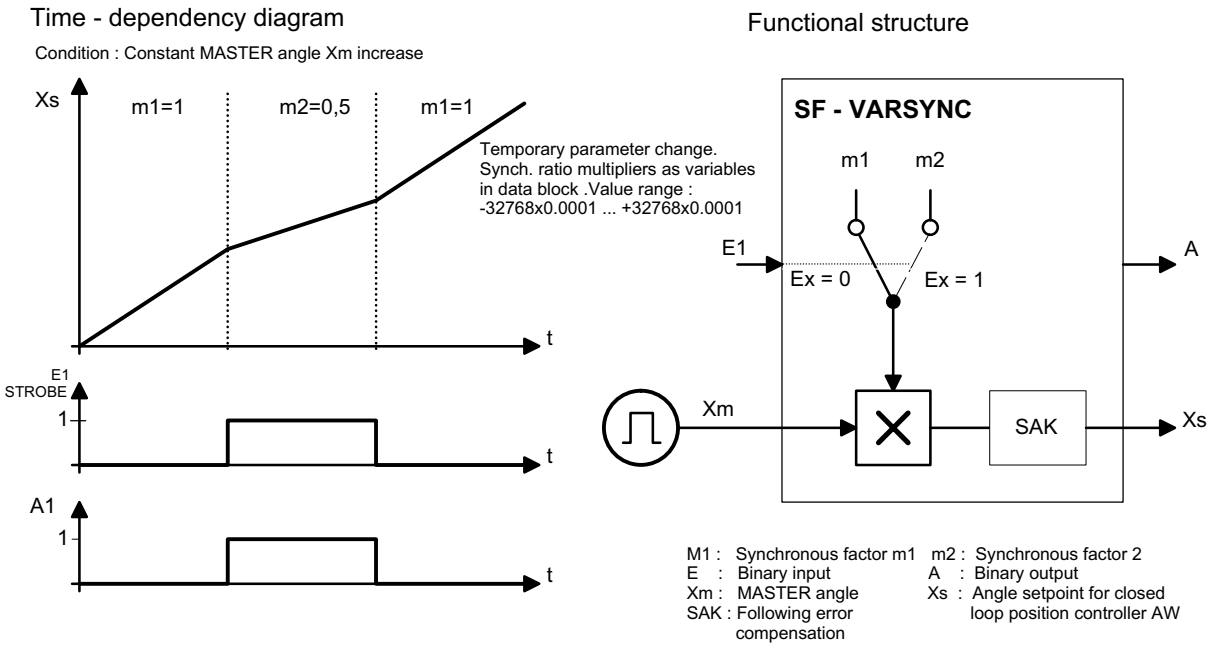


Figure 17: SF STDFKT-VARSYNC (BA0)

– In the operating mode 1 (SFKMD-BA = 1) the program switches over between eight synchronous factors (m1 .. m8) by means of four binary inputs (E1 .. E4). The synchronous factor results from the binary information at E2 (less significant bit) to E4 (more significant bit), for a positive edge change at E1. The binary output (A1) is 0 for E1 = 0 and becomes 1 for identification of the acceptance of the newly selected synchronous ratio at a positive edge change at E1.

E4	E3	E2	E1	A1	m
0	0	0	0→1	1	m1
0	0	1	0→1	1	m2
0	1	0	0→1	1	m3
0	1	1	0→1	1	m4
1	0	0	0→1	1	m5
1	0	1	0→1	1	m6
1	1	0	0→1	1	m7
1	1	1	0→1	1	m8
x[1)]	x[1)]	x[1)]	0	0	m[2)]

with [1)] : arbitrary
[2)] : synchronous ratio is not changed

Table 17: Synchronous factor selection (BA1)

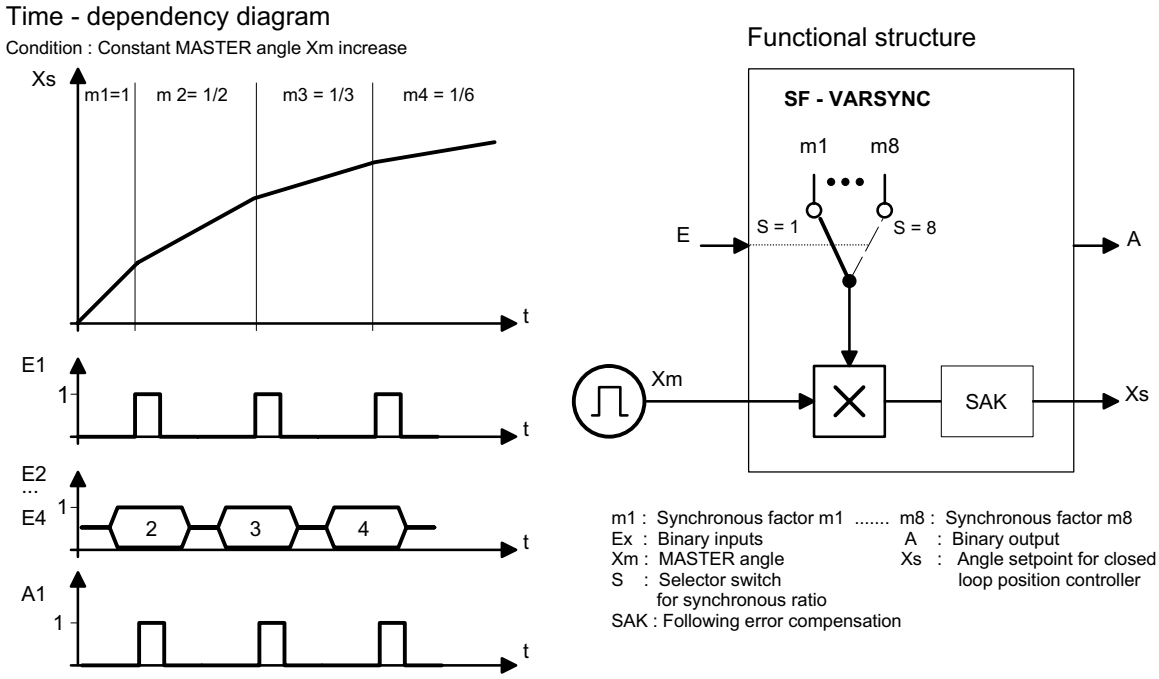


Figure 18: SF STDFKT-VARSYNC (BA1)

– In the operating mode 2 (SFKMD-BA = 2) the program switches over between three synchronous factors (m1 .. m3) by means of two binary inputs (E1, E2). The synchronous factor results from the binary information at E1 (less significant bit) and E2 (more significant bit) corresponding to the following table:

E2	E1	m
0	0	m1
0	1	m2
1	0	m3
1	1	m[1)]

with [1)] : synchronous ratio is not changed

Table 18: Synchronous factor selection (BA2)

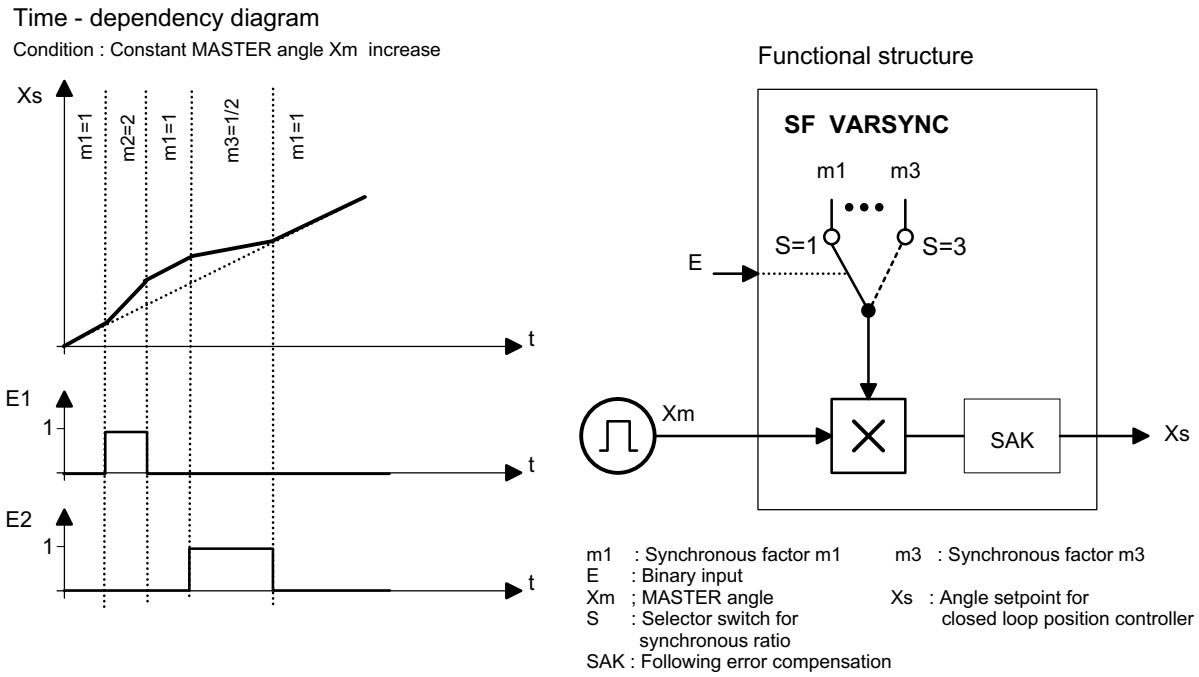


Figure 19: SF STDFKT-VARSYNC (BA2)

– In the operating mode 3 (SFKMD-BA = 3) the synchronous factor (m) is determined by the SF commanding parameters "Word address" (DR4) and "Word attribute" (DL4).
  Depending upon the parameters (cf. Section 3.4.2.1) "m" is formed online from the value of the agreed flag or input word.
  The synchronous factor is, analogous to the operating modes 0 to 2, standardized to the value of 10000. The value range for "m" goes from -32768 to +32767. This means: value in e.g. MW 100 = 10000 ⇒ synchronous ratio = 1 (value = -10000 ⇒ synchronous ratio = -1).
  Remarks: The synchronous ratio can be specified directly in the grid of the SF through the Profibus by parameterizing e.g. EW 16 and selecting the updating mode 1 in system DB0, DL25 (cf. documentation: PS command set, System DB functions, Section 4.2; or Profibus DP subscriber address, Section 4.2.8).

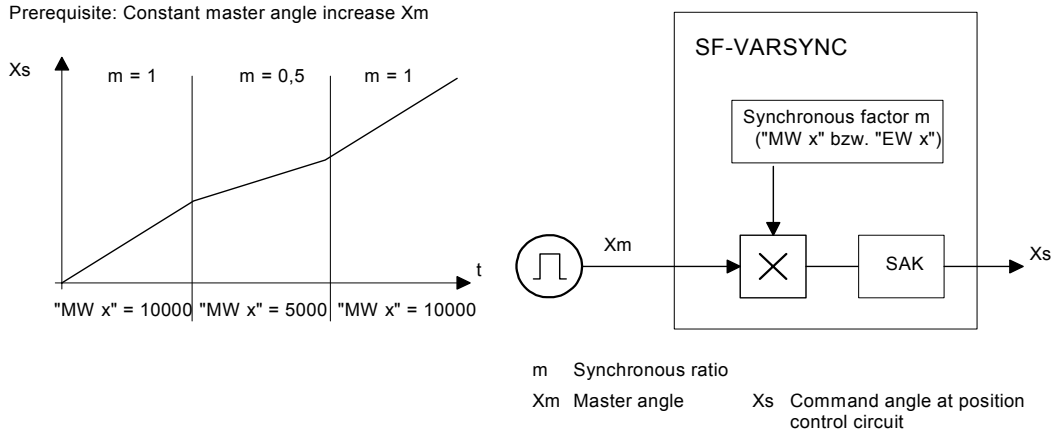


Figure 20: SF STDFKT-VARSYNC (BA3)

3.4.2.1 VARSYNC-specific user interface

Prerequisites and marginal conditions

Expedient settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800 .. 32805):

- BA command value source = 3C (hexadecimal; commanding interface)
- Position control without following error compensation (SAK is implemented by the SF if required), synchronous ratio (ID 32892, ID 32893) is effective:
  ⇒ SF sink = 16-bit command value source
  Example: ID 32800 = 3C0004
- Position control with fine interpolation (if required):
  ⇒ SF sink = 32-bit command value source
  Example: ID 32800 = 3C0404

Source address	Offset	Meaning / remarks
0	1,3,5,7	Config.-AZ message1, 2, 3, 4 (High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32)
1..8	3	Config.-AW message32 (Low Word) of AW1..8 / configurable by means of ID 32786; only position command or feedback values are expedient
1..8	5	Position feedback value (Low Word) of AW1..8
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
130	0,2,4 ..30	Input range of the PS process image / EW 0, .. ,30
131	0,4,8.. 28	Input range of the PS process image / ED 0, .. ,28
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2 .. 7 / for logic operation with the corresponding SF1, 2, .. 7
Sink address	Offset	**Meaning**
1..8	4	16-bit command value source of AW1..8 / ID 32892, ID 32893 are effective
1..8	16	32-bit command value source of AW1..8 / fine interpolator through ID 32800.. ID 32809 can be used; ID 1 = ID 2 required
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
255	0	Internal sink for logic operation with further SF without output on an AW

Table 19: Settings of the VARSYNC data holder interfaces (SF source/sink)

- Table 0 .. Table 7 are not used.

Structure and parameters of the DB for SF commanding (BA 0..2)

Data	High word		Low word	
double word	**High byte**	**Low byte**	**High byte**	**Low byte**
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	Reserved = 0		SAK factor	
04	Reserved = 0		Synchronous factor m1	
06	Reserved = 0		Synchronous factor m2	
08	Reserved = 0		Synchronous factor m3	
10	Reserved = 0		Synchronous factor m4	
12	Reserved = 0		Synchronous factor m5	
14	Reserved = 0		Synchronous factor m6	
16	Reserved = 0		Synchronous factor m7	
18	Reserved = 0		Synchronous factor m8	
20	Reserved = 0			
32	Reserved = 0			

Total number: 34 data words

Table 20: VARSYNC commanding DB

Structure and parameters of the DB for SF commanding (BA 3)

Data	High word		Low word	
double word	**High byte**	**Low byte**	**High byte**	**Low byte**
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		SAK factor	
04	Reserved = 0		Word attribute of the synchronous factor m	Word address of the synchronous factor m
06	Reserved = 0			
08	Reserved = 0			
10	Reserved = 0			
12	Reserved = 0			
14	Reserved = 0			
16	Reserved = 0			
18	Reserved = 0			
20	Reserved = 0			
32	Reserved = 0			

Total number: 34 data words

Table 21: VARSYNC commanding DB for die operating modes 3

SF number (DR0)
- Meaning: SF number under which a SF of the SF type 3 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
- Meaning: Selection of the standard functionality.
- Value range: 1: Variation of the synchronous ratio "VARSYNC"

SFKMD code (DR 1)
- Meaning: Code of the commands.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): start SF

SFKMD-BA (DL 1)
- Meaning: Selection of the operating mode.
- Value range: 0 (operating mode 0): 2 synchronous factors (m1, m2) selectable through one binary input.
  1 (operating mode 1): 8 synchronous factors (m1.. m8) selectable through four binary inputs.
  2 (operating mode 2): 3 synchronous factors (m1.. m3) selectable through two binary inputs.
  3 (operating mode 3): Online synchronous factor (m) through MW x or EW x (see: DR4 and RL4)

SAK factor (DW 2)
- Meaning: Following error compensation error (cf. documentation: PS command set, Section "Position controller synchronization").
- Value range: 0: No following error compensation.
  1 .. $+2^{15}$-1: Following error compensation error with:
  SAK factor = 7680000 / ID2 / ID104 + 128 (1 + 1 / ID2),
  if the input command value of the SF comes from the position feedback value of another AW (internal drive);
  SAK factor = 7680000 / ID2 / ID104 + 256,
  if the input command value of the SF comes from the pulse generator input (external drive).
  ID2 in ms; ID104 in rpm
- Example: ID 2 = 2ms, ID 104 = 1000 rpm, internal drive $\Rightarrow$ SAK = 4032

SF cycle time (DW 3)
- Meaning: Cycle time of the fast function; time grid in which the SF is selected or in which command values are output; must be specified corresponding to ID 2.
- Value range: 1..$+2^{15}$-1
- Unit: 0.5 ms
- Example: Value = 2 $\Rightarrow$ SF cycle time = 1 ms

Parameters for the operating modes 0..2:

Synchronous factor m1 (DW 4)
- Meaning: Multiplication factor1 (m1, valid for SFKMD-BA=0 .. 2).
- Value range: -32768 ..+32767
- Unit: 0.0001
- Example: Value =10000 ⇒ synchronous ratio = 1

Synchronous factor m2 (DW 6)
- Meaning: Multiplication factor2 (m2, valid for SFKMD-BA=0 .. 2).
- Value range: -32768 ..+32767
- Unit: 0.0001
- Example: Value =10000 ⇒ synchronous ratio = 1

Synchronous factor m3 (DW 8)
- Meaning: Multiplication factor3 (m3, valid for SFKMD-BA=1 .. 2).
- Value range: -32768 ..+32767
- Unit: 0.0001
- Example: Value =10000 ⇒ synchronous ratio = 1

Synchronous factor m4 (DW 10)
- Meaning: Multiplication factor4 (m4, valid for SFKMD-BA=1).
- Value range: -32768 ..+32767
- Unit: 0.0001
- Example: Value =10000 ⇒ synchronous ratio = 1

Synchronous factor m5 (DW 12)
- Meaning: Multiplication factor5 (m5, valid for SFKMD-BA=1).
- Value range: -32768 ..+32767
- Unit: 0.0001
- Example: Value =10000 ⇒ synchronous ratio = 1

Synchronous factor m6 (DW 14)
- Meaning: Multiplication factor6 (m6, valid for SFKMD-BA=1).
- Value range: -32768 ..+32767
- Unit: 0.0001
- Example: Value =10000 ⇒ synchronous ratio = 1

Synchronous factor m7 (DW 16)
- Meaning: Multiplication factor7 (m7, valid for SFKMD-BA=1).
- Value range: -32768 ..+32767
- Unit: 0.0001
- Example: Value =10000 ⇒ synchronous ratio = 1

Synchronous factor m8 (DW 18)
- Meaning: Multiplication factor8 (m8, valid for SFKMD-BA=1)
- Value range: -32768 ..+32767
- Unit: 0.0001
- Example: Value =10000 ⇒ synchronous ratio = 1

Parameters for the operating mode 3:

Word address of the synchronous factor m (DR 4)
- Meaning: The multiplication factor (m) is formed from the word value assigned to this address. (It is determined by means of the word attribute whether it is a flag word or an input word; see below.)
- Value range: 0..255 (The address is rounded down internally to the next smaller, even number address.)
- Example: 100 ⇒ Synchronous ratio m is formed by MW 100 (DL 4 = 0), or EW 100 (DL 4 = 1).

Word attribute of the synchronous factor m (DL 4)
- Meaning: It is determined by means of the word attribute whether the word address according to DR4 is a flag word or an input word.
- Value range: 0: Flag word range (MW x; with x = word address according to DR 4)
  1: Input word range (EW x; with x = word address according to DR 4)

Remarks: The synchronous factor m is, analogous to the operating modes 0 to 2, standardized to the value 10000. The value range for m goes from -32768 to +32767. This means: value in e.g. MW 100 = 10000 ⇒ synchronous ratio = 1 (value = -10000 ⇒ synchronous ratio = -1).

3.4.2.2 Examples

Example 1: Start of a SF "STDFKT-VARSYNC" with SFKMD-BA = 0:
- m1 = 10000 (synchronous ratio = 1,0000)
- m2 = -10000 (synchronous ratio = -1,0000)

Switching over the synchronous ratio of AW3 by means of "E1" = E 16.3.

Prerequisites:
- SF of the SF type = 3 with e.g. SF number 2
  - SF source: AZ message1 (pulse generator input AZ; terminal X32)
  - SF sink: 16-bit command value source (SWQ1) of AW3
- BA-position control with command value source AZ-PSx effective (e.g. through ID 32800 = 3C0004; cf. documentation: Parameters)
- ID 32948 = 00000003 ⇒ AZ message1 = pulse generator input AZ (terminal X32)
- ID 2 = 1 ms, ID 104 = 1000 rpm, external drive ⇒ SAK factor = 7936

Initialization of the SF STDFKT-VARSYNC

```
;DB for initializing the SF "STDFKT"
;
:KB 3       ;DR 0  SF type                 STDFKT
:KB 2       ;DL 0  SF number               SF2
:KB 0       ;DR 1  E/A-M mode              E/A
:KB 0       ;DL 1  SF cycle time factor    Default = 1
:KB 1       ;DR 2  Source address offset   AZ message 1
:KB 0       ;DL 2  Source address          AZ
:KB 4       ;DR 3  Sink address offset     16-bit command value source
:KB 3       ;DL 3  Sink address            AW 3
:KB 4       ;DR 4  Input bit mask          Bit 2
:KB 16      ;DL 4  Input byte address      Byte 16
:KB 4       ;DR 5  Output bit mask         Bit 2
:KB 16      ;DL 5  Output byte address     Byte 16
:KB 0       ;DR 6  DB number Tab0          Not used
:KB 0       ;DL 6  DB number Tab1          Not used
:KB 0       ;DR 7  DB number Tab2          Not used
:KB 0       ;DL 7  DB number Tab3          Not used
:KB 0       ;DR 8  DB number Tab4          Not used
:KB 0       ;DL 8  DB number Tab5          Not used
:KB 0       ;DR 9  DB number Tab6          Not used
:KB 0       ;DL 9  DB number Tab7          Not used
```

Commanding the SF STDFKT-VARSYNC

```
;* DB for commanding the SF "STDFKT"
;
:KB 2        ;DR 0  SF number              SF2
:KB 1        ;DL 0  SFKMD fct              Function 1: VARSYNC
:KB 1        ;DR 1  SFKMD code             Start
:KB 0        ;DL 1  SFKMD-BA               BA 0: Selection from 2 synchronous factors
:KF 7936     ;DW 2  SAK                    Following error compensation
:KF 0        ;DW 3  Reserved
:KF 10000    ;DW 4  Synchronous factor m1      1,0000
:KF 0        ;DW 5  Reserved
:KF -10000   ;DW 6  Synchronous factor m2      -1,0000
:KF 0        ;DW 7  Reserved
:KF 0        ;DW 8  Synchronous factor m3      Not used
:KF 0        ;DW 9  Reserved
:KF 0        ;DW10  Synchronous factor m4      Not used
:KF 0        ;DW11  Reserved
:KF 0        ;DW12  Synchronous factor m5      Not used
:KF 0        ;DW13  Reserved
:KF 0        ;DW14  Synchronous factor m6      Not used
:KF 0        ;DW15  Reserved
:KF 0        ;DW16  Synchronous factor m7      Not used
:KF 0        ;DW17  Reserved
:KF 0        ;DW18  Synchronous factor m8      Not used
:KF 0        ;DW19  Reserved
:KD 0        ;DD20  Reserved
:KD 0        ;DD32  Reserved
```

Example 2: Start of a SF "STDFKT-VARSYNC" with SFKMD-BA = 3. Specification of the synchronous ratio of AW1 through EW 16. Supply of the EW 16 through Profibus DP (cf. documentation: PS command set; Section 4.2.8, Profibus DP subscriber address) in the SF cycle (e.g. ID 2 = 1ms; cf. documentation: Parameters AZ).

Prerequisites:

- SF of the SF type = 3 with e.g. SF number 3
  - SF source: AZ message1 (pulse generator input AZ; terminal X32)
  - SF sink: 16-bit command value source (SWQ1) of AW1
- BA-position control with command value source AZ-PSx effective (e.g. through ID 32800 = 3C0004; cf. documentation: Parameters AZ)
- ID 32948 = 00000003 $\Rightarrow$ AZ message1 = pulse generator input AZ (terminal X32)
- ID 2 = 1 ms, ID 104 = 1000 rpm, external drive $\Rightarrow$ SAK factor = 7936
- Profibus-DP: Updating mode (DB0, DL 25) = 1 (cf. documentation: PS command set; Section 4.2.8, Profibus DP subscriber address).

Initializing the SF STDFKT-VARSYNC

```
;DB for initializing the SF "STDFKT"
;
:KB 3       ;DR 0  SF type                 STDFKT
:KB 3       ;DL 0  SF number               SF2
:KB 0       ;DR 1  E/A-M mode              E/A
:KB 0       ;DL 1  SF cycle time factor    Default = 1
:KB 1       ;DR 2  Source address offset   AZ message 1
:KB 0       ;DL 2  Source address          AZ
:KB 4       ;DR 3  Sink address offset     16-bit command value source
:KB 1       ;DL 3  Sink address            AW 1
:KB 0       ;DR 4  Input bit mask          Not used
:KB 0       ;DL 4  Input byte address      Not used
:KB 0       ;DR 5  Output bit mask         Not used
:KB 0       ;DL 5  Output byte address     Not used
:KB 0       ;DR 6  DB number Tab0          Not used
:KB 0       ;DL 6  DB number Tab1          Not used
:KB 0       ;DR 7  DB number Tab2          Not used
:KB 0       ;DL 7  DB number Tab3          Not used
:KB 0       ;DR 8  DB number Tab4          Not used
:KB 0       ;DL 8  DB number Tab5          Not used
:KB 0       ;DR 9  DB number Tab6          Not used
:KB 0       ;DL 9  DB number Tab7          Not used
```

Commanding the SF STDFKT-VARSYNC

```
;* DB for commanding the SF "STDFKT"
;
:KB 3       ;DR 0  SF number               SF3
:KB 1       ;DL 0  SFKMD fct               Function 1: VARSYNC
:KB 1       ;DR 1  SFKMD code              Start
:KB 3       ;DL 1  SFKMD-BA                BA 2: Online-synchronous factor
:KF 7936    ;DW 2  SAK                     Following error compensation
:KF 2       ;DW 3  SF cycle                SF cycle time = 1ms
:KB 16      ;DR 4  Word address            xW 16
:KB 1       ;DL 4  Word attribute          x = E (Input word)
:KF 0       ;DW 5  Reserved
:KD 0       ;DD06  Reserved
....        ....
:KD 0       ;DD32  Reserved
```

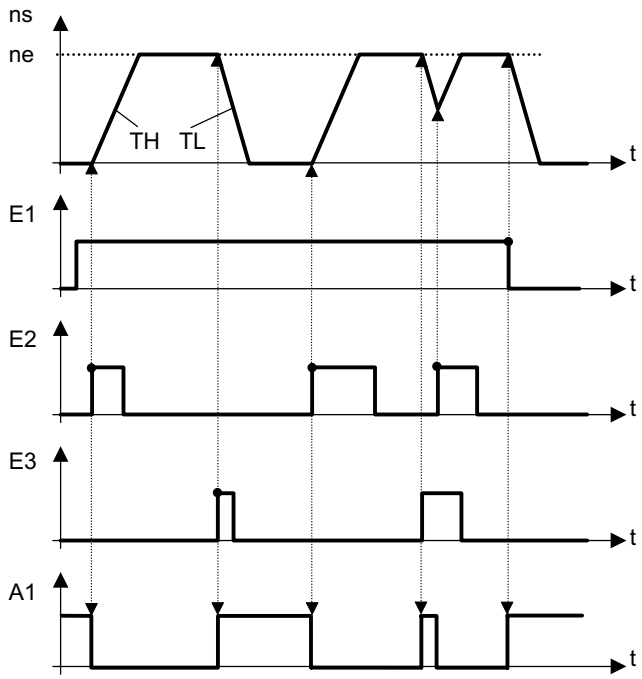
3.4.3 "SF STDFKT-DIGDREH" SF for the fast digital speed command value input via binary signal

The function DIGDREH implements a digital speed command value input, whereby by means of three binary inputs
- E1: Enable signal
- E2: Start signal
- E3: Stop signal

it is possible to switch over between a speed n_e and the speed n = 0. The binary output A1 is 1 for $n_s = 0$ and 0 for $n_s = n_e$.

E1: E bit determined by FB207
E2, E3: Next more significant following bits
A1: A bit determined by FB207 (cf. Section 2.3)

Time - dependency diagram



Truth table

E1	E2	E3	ns	A1
0	x	x	0	1
1	↓	x	ne	0
1	0	↓	0	1

x : Status ignored

E1 : Binary input " ENABLE "
E2 : Binary input " START "
E3 : Binary input " STOP "
ne : Final speed
ns : Speed setpoint
A1 : Binary output
("1" : Inactive / speed " Off ")
TH : Speed acceleration time (ID 32780)
TL : Speed deceleration time (ID 32781)

Figure 21: SF STDFKT-DIGDREH

3.4.3.1 DIGDREH-specific user interface

Prerequisites and marginal conditions

Expedient settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32805):
- BA command value source = 3C (hexadecimal; commanding interface)
- Speed control with and without speed ramp / with and without torque limitation
  ⇒ SF sink = 32-bit command value source
  Example: ID 32800 = 3C0043

Source address	Offset	Meaning / remarks
0	0	not required
Sink address	Offset	Meaning
1..8	16	32-bit command value source of AW1..8 / speed ramp and torque limitation selectable through ID 32800.. ID 32805
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
255	0	Internal sink for logic operation with further SF without output on an AW

Table 22: Settings of the DIGDREH data holder interfaces (SF source/sink)

– Table 0 .. Table 7 are not used.

Structure and parameters of the DB for SF commanding

Data	High word		Low word	
double word	**High byte**	**Low byte**	**High byte**	**Low byte**
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	Speed command value			
04	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 23: DIGDREH commanding DB

SF number (DR 0)
– Meaning: SF number under which a SF of the SF type 3 was initialized by means of FB 207.
– Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
– Meaning: SF commanding function.
– Value range: 2: SF DIGDREH (digital speed control).

SFKMD code (DR 1)
– Meaning: SF commanding code.
– Value range: 0 (RESET): Reset of the SF
1 (START): Start of the SF

SFKMD-BA (DL 1)
– Meaning: SF commanding operating mode.
– Value range: 0: Currently not used.

Speed command value (DD 2)
– Meaning: Speed command value (n_e).
– Value range: $-2^{31}..+2^{31}-1$
– Unit: 0.0001 rpm
– Example: Value = 100000 $\Rightarrow$ Speed = 10 rpm

3.4.3.2 Example

Start of a SF "STDFKT-DIGDREH " with n_e = 10000000 (1000 rpm)
Prerequisites:

- SF of the SF type = 3 with e.g. SF number 3
  - SF source: Not used
  - SF sink: 32-bit command value source (SWQ2) of AW4
- BA-speed control with command value source AZ-PSx (e.g. through ID 32800 = 3C0043; cf. documentation: Parameters) effective

Initializing the SF STDFKT-DIGDREH

;* DB for initializing the SF "STDFKT"

```
;
:KB 3          ;DR 0  SF type                 STDFKT
:KB 3          ;DL 0  SF number               SF3
:KB 0          ;DR 1  E/A-M mode              E/A
:KB 0          ;DL 1  SF cycle time factor    Default = 1
:KB 0          ;DR 2  Source address offset   Not used
:KB 0          ;DL 2  Source address          Not used
:KB 16         ;DR 3  Sink address offset     32-bit command value source
:KB 4          ;DL 3  Sink address            AW 4
:KB 8          ;DR 4  Input bit mask          Bit 3
:KB 16         ;DL 4  Input byte address      Byte 16
:KB 8          ;DR 5  Output bit mask         Bit 3
:KB 16         ;DL 5  Output byte address     Byte 16
:KB 0          ;DR 6  DB number Tab0          Not used
:KB 0          ;DL 6  DB number Tab1          Not used
:KB 0          ;DR 7  DB number Tab2          Not used
:KB 0          ;DL 7  DB number Tab3          Not used
:KB 0          ;DR 8  DB number Tab4          Not used
:KB 0          ;DL 8  DB number Tab5          Not used
:KB 0          ;DR 9  DB number Tab6          Not used
:KB 0          ;DL 9  DB number Tab7          Not used
```

Commanding the SF STDFKT-DIGDREH

;* DB for commanding the SF "STDFKT"

```
;
:KB 3          ;DR 0  SF number               SF3
:KB 2          ;DL 0  SFKMD fct               Function 2: DIGDREH
:KB 1          ;DR 1  SFKMD code              Start
:KB 0          ;DL 1  SFKMD-BA                Not used
:KD10000000 ;DD 2  Speed command value              1000 rpm
:KD 0          ;DD 4  Reserved
:KD 0          ;DD 32 Reserved
```

3.5 "SF DFKT" SF speed function table

SF type = 4

The SF speed function table (DFKT) implements for speed-controlled axes a speed-speed assignment with the aid of tables.

3.5.1 Basic functionality and operating modes

An output value is determined with the aid of a speed table and an absolute speed as input variable. The table values are assigned to the values of the cyclic input variable. A table value is assigned to every speed between 0 and a definable master speed end value. The calculated value from the table, multiplied and divided each with a factor (speed ratio V) forms the output variable of the SF.

The SF can be operated in different operating modes, which are selected through operating mode bits of the SF commanding variable SFKMD-BA (cf. Section 3.5.2.3). Selection of an operating mode is possible only in the SF commanding "START" (SFKMD fct = 1). A distinction is made between the following single operating modes, whereby all combinations are permitted:

- SFKMD-BA Bit0: 0: Speed input value (master speed) as absolute speed
  (speed feedback/command value of an AMKASYN internal master drive)
  1: Speed input value (master speed) as angle growth
  (e.g. increment difference of an external master generator)

This BA bit states how the input variable of the SF is generated. E.g. the speed feedback/command value of an AMKASYN internal master drive comes into question as absolute speed (Bit0 = 0). To determine the speed from the increment differences of an external master generator (e.g. through the pulse generator input AZ; terminal X32) an angle growth (in increments) must be chosen (Bit0 = 1) as speed input value. Using the parameters "SF cycle time" and "Command value generator resolution" the absolute speed is then calculated by the SF.

- SFKMD-BA Bit1: 0: No use of binary input signals
  1: Input of start/stop, selection of the table and synchronization at "SFKMD fct = VALUE NEW" through binary inputs

This BA bit states whether start/stop, the selection of the table and the synchronization at VALUE NEW are controlled only by a SF commanding (Bit1 = 0) or else by binary inputs (Bit1 = 1).

If the SFKMD-BA Bit1 = 1, then the following points must be observed:

- The slave axis can be started or stopped at any time through the start/stop input E1. In this case the slave drive remains stopped after the SF command "START". The axis is also started only if the start input is activated (E1 = 1).
- A table is activated with the aid of the selection strobe input E2 and the table selection inputs E3..E5. The table which is transferred as start table at the start command is active after a SF command "START". This remains active until the selection of a new table is requested through the selection strobe input (E2: 0→1).
- The transfer of the speed ratio is synchronized through the selection strobe input E2 after SF commanding "VALUE NEW". The speed ratio transferred at VALUE NEW becomes active only after a positive edge at the selection strobe input.

Remarks: It must be observed that in this operating mode (SFKMD-BA Bit1 = 1) at the "VALUE NEW" command the table stated in the "active table" parameter is not evaluated. A table switch-over can take place in this case through the selection strobe input on activation of the new speed ratio.

- SFKMD-BA Bit2: 0: Multiplication of the table value with the speed ratio V
  1: Standardization (division) of the speed ratio V with V_N (V_N = last table speed value / master speed end value)

If this operating mode bit is set, then the speed ratio V entered by the commanding variables (command value multiplier / command value divider) is divided by V_N. (Last table speed value / master speed end value).

Example: SFKMD-BA = 0 (Bit0 .. Bit 2 = 0) $\Rightarrow$ Speed input value as absolute speed, no use of binary input signals, multiplication of the table value with the speed ratio V

SFKMD-BA = 7 (Bit0 .. Bit 2 = 1) $\Rightarrow$ Speed input value as angle growth, use of binary input signals, multiplication of the table value with the standardized speed ratio V/V_N

Further features:

- The master speed may be positive or negative.
- The SF uses in the operating mode "Speed input value as absolute speed" a speed feedback value as input variable in the form of a signed 32-bit value. In the operating mode "Speed input value as angle growth" the SF uses as input variable an angle growth in the form of a signed 16-bit value. The SF generates as output variable a speed value (as absolute value) in the form of a signed 32-bit value.
- The SF reports in the initialization phase (after SF commanding "START") fatal errors which lead to an abort. They serve as message in the parameterization of the block.
- During operation (SFKMD status = SF-ACTIVE) changes of the input parameters are ignored, i.e. no change of the parameters entered at the START command is possible. A change of these parameters can be made with the aid of a command (VALUE NEW).
- It is possible to work with up to 7 speed value tables. The table just active is selected at the START command of the block. During operation the active table can be switched over by renewed command (command VALUE NEW). If no table is selected, the master feedback value is converted only with the speed ratio.
  Caution: The speed values may not be changed in the just active table.
- Linear interpolation of the speed is performed between the table interpolation points.
- If the feedback speed of the master is negative, then the output value is calculated either by point mirroring of the interpolation points at the origin or by limiting to the first table value.
- The speed output value is limited with the aid of maximum and minimum speed values as well as of maximum and minimum speed ratios.

– In the operating mode "External binary inputs/outputs" (SFKMD-BA Bit1 = 1) the following assignments exist:

E1: Start/stop of drives

E1	Meaning
0	Stop
1	Start

Table 24: Start/stop selection

E2: Switching over the active table / synchronization of the table selection and of the speed ratio after VALUE NEW command

E2	E3	E4	E5	Meaning
0→1	0	0	0	No table selected; only speed ratio effective
0→1	1	0	0	Table 0 selected
0→1	0	1	0	Table 1 selected
0→1	1	1	0	Table 2 selected
0→1	0	0	1	Table 3 selected
0→1	1	0	1	Table 4 selected
0→1	0	1	1	Table 5 selected
0→1	1	1	1	Table 6 selected

Table 25: Table switch-over

Remarks: If the maximum number of tables is not greater than 3, then only 2 inputs (E3 and E4) are used for the table selection. The physical input bits are determined through the statement of the first input bit in the course of SF initialization (cf. Section 2.3).

A1: Start/stop acknowledgement of the axis (in inverted logic, i.e. physical "1" means axis in the stop status).

A2: Acknowledgement of switching over the active table or activating the new speed ratio (if previously VALUE NEW command). The output is set if the selection is made and reset at a 1→0 transition of the selection strobe input.

– Different messages can be output through an output table (Table 7) (cf. Section 3.5.2.2).

3.5.2 User interface of the SF DFKT

3.5.2.1 Prerequisites and marginal conditions

Expedient settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32805):

- BA command value source = 3C (hexadecimal; commanding interface)
- Speed control with and without speed ramp / with and without torque limitation
  ⇒ SF sink = 32-bit command value source
  Example: ID 32800 = 3C0043

Source address	Offset	Meaning / remarks
0	1,3,5,7	Config.-AZ message1, 2, 3, 4 (High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32)
1..8	3	Config.-AW message32 (Low Word) of AW1..8 / configurable by means of ID 32786; only position command or feedback values are expedient
1..8	5	Position feedback value (Low Word) of AW1..8
1..8	19	Config.-AW message32 of AW1..8 / configurable by means of ID 32786; only speed command or feedback values are expedient
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
130	0,2,4 ..30	Input range of the PS process image / EW 0, .. ,30
131	0,4,8.. 28	Input range of the PS process image / ED 0, .. ,28
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2 .. 7 / for logic operation with the corresponding SF1, 2, .. 7
Sink address	Offset	**Meaning**
1..8	16	32-bit command value source of AW1..8 / speed ramp and torque limitation selectable through ID 32800.. ID 32809
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
255	0	Internal sink for logic operation with further SF without output on an AW

Table 26: Settings of the DFKT data holder interfaces (SF source/sink)

3.5.2.2 Tables

The SF DFKT uses two types of tables:
- the speed interpolation point tables (maximum 7) and
- the output table.

Speed interpolation point tables

The assignment of the input speed (master speed) to the output speed (slave speed) is defined by a speed interpolation point table.
A table is determined by N equidistant input speed intervals (0 .. input speed end value). A speed output value is assigned to each interval. The speed output values are filed in the speed interpolation point table. The input speed end value is a parameter of the SF commanding DB. Linear interpolation of the speed is performed between the table interpolation points.

It is possible to switch over between a maximum of 7 speed-speed assignments (Table 0 .. 6).

Data	High word	Low word
double word		
00	Reserved = 0	Interpolation number+1
02	Reserved = 0	1. interpolation point
04	Reserved = 0	2. interpolation point
06	Reserved = 0	3. interpolation point
..	..	
252	Reserved = 0	126. interpolation point
254	Reserved = 0	127. interpolation point

Total number: 256 data words

Table 27: Speed interpolation point table 0 .. 6

Interpolation number+1 (DW 0)
- Meaning: Number of the interpolation points in the table +1.
- Value range: 3 to 128 (corresponding to 2 .. 127 interpolation points)

1. to 127. interpolation point
- Meaning: Interpolation points of the speed-speed function filed in the table.
- Value range: -32767 to +32767
- Unit: rpm

Output table

In the output table (Table 7; cf. documentation: AMK-specific function blocks, FB207, DB number Tab7) different information is provided by the SF for the PS basic system, if on SF initialization (FB207) a data block is provided as output table ("DB number Tab7" > 0).

Data	High word		Low word	
double word	**High byte**	**Low byte**	**High byte**	**Low byte**
00	SF-DFKT status		Reserved=0	Access semaphore
02	Current speed ratio denominator		Current speed ratio numerator	
04	Reserved = 0		Reserved = 0	

Total number: 6 data words

Table 28: DFKT output table 7

Access semaphore (DR 0)
- Meaning: Controls the access of the SF to the data in the DB:
  0: Updating by the SF
  1: No updating
  To achieve consistent data the byte can be set to 1 by the user program before the access to the output data and reset to 0 after the access.
- Value range: 0, 1

SF-DFKT status (DW 1)
- Meaning: Status word for the operating statuses and errors.
- Value range: bit-coded
  - Bit 0 = 1: Positive limit of the speed ratio exceeded
  - Bit 1 = 1: Negative limit of the speed ratio exceeded
  - Bit 2 = 1: Upper output maximum speed exceeded
  - Bit 3 = 1: Lower output maximum speed exceeded
  - Bit 4 = 1: Upper table end exceeded
  - Bit 5 = 1: Lower table end exceeded

Current speed ratio numerator (DW 2)
- Meaning: Numerator of the current speed ratio.
- Value range: -32768 .. +32767

Current speed ratio denominator (DW 3)
- Meaning: Denominator of the current speed ratio.
- Value range: 0 .. 65535

3.5.2.3 Structure and parameters of the DB for SF commanding

To start or reset the speed table interpolator or to transfer new parameter values, the AMK-specific FB 208 ("Command SF") must be selected. The following commanding data must be transferred to this FB in the current DB:

Data	High word		Low word	
double word	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		Reserved = 0	
04	Current speed table		Number of speed tables	
06	Reserved = 0		Division factor	
08	Reserved = 0		Multiplication factor	
10	Input speed final value		Input encoder resolution	
12	Reserved = 0		max. output speed value	
14	Reserved = 0		min. output speed value	
16	Reserved = 0		max. output/input speed ratio	
18	Reserved = 0		min. output/input speed ratio	
20	Reserved = 0		Division factor for ratio calculation	
22	Continuation above the speed upper limit		Continuation below the speed lower limit	
24	Reserved = 0			
26	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 29: DFKT commanding DB

SF number (DR 0)

- Meaning: Number of the SF which is commanded.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD code (DR 1)

- Meaning: Code of the SF command.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): start SF
  5 (VALUE NEW): SF value change

SFKMD-BA (DL1)

- Meaning: Operating mode in which the SF is operated.
- Value range: 0..7
  bit-coded:
  - Bit 0 = 0: Speed input value (master speed) as absolute speed
    = 1: Speed input value (master speed) as angle growth
  - Bit 1 = 0: No use of binary input signals
    = 1: Input of start/stop, selection of the table and synchronization at "SFKMD fct = VALUE NEW" through binary inputs
  - Bit 2 = 0: Multiplication of the table value with the speed ratio V
    = 1: Standardization (division) of the speed ratio V with V_N (V_N = last table speed value / input speed final value)
- Example: Value = 2 $\Rightarrow$ Speed input value as absolute speed, input of start/stop, selection of the table and synchronization at "SFKMD fct = VALUE NEW" through binary inputs, multiplication of the table value with the speed ratio V

SF cycle time (DW3)

- Meaning: Time in which the SF is called cyclically. (This time is determined by ID 2 = SERCOS cycle time.) This parameter is required only in the operating mode "Speed input value as angle growth".
- Value range: 1 .. 32767
- Unit: 0.5 ms
- Example: Value = 2 $\Rightarrow$ SF cycle time = SERCOS cycle time = 1 ms

Number of speed tables (DW4)

- Meaning: Number of the maximum usable speed value tables.
- Value range: 0 : No speed table required
  (e.g. if "active table" = 0)
  1 .. 7: Number of the maximum usable speed value tables

Active table (DW 5)

- Meaning: Number of the table which is active after the START or VALUE NEW command.
- Value range: 0: No table is used (the speed ratio is effective)
  1 .. 7: Table0 .. Table6

Division factor (DW 6)

- Meaning: Current division factor of the speed ratio.
- Value range: 1 .. 32767

Multiplication factor (DW 8)

- Meaning: Current multiplication factor of the speed ratio.
- Value range: 0 .. $\pm$32767 / V_N: in the operating mode "Standardization of the speed ratio V with V_N"
  -32767 to +32767: other

Input encoder resolution (DW10)

- Meaning: Resolution of the master generator (is required only in the operating mode "Speed input value as angle growth").
- Value range: 1 .. +65535
- Unit: Increments

Input speed final value (DW11)
- Meaning: Final value of the input speed (master speed), which is assigned to the last output speed interpolation point of the table.
- Value range: 1 .. +32767
- Unit: rpm

Max. output speed value (DW 12)
- Meaning: Maximum value for the speed output. If the output value exceeds the maximum value, it is limited to this.
- Value range: 0 .. +32767
- Unit: rpm

Min. output speed value (DW 14)
- Meaning: Minimum value for the speed output. If the output value drops below the minimum value, it is limited to this.
- Value range: -32767 .. 0
- Unit: rpm

Max. output/input speed ratio (DW 16)
- Meaning: The ratio between output and input speed is limited with the aid of this parameter and a division factor (DW 20) to a maximum value.
- Value range: -32767 .. +32766

Min. output/input speed ratio (DW 18)
- Meaning: The ratio between output and input speed is limited with the aid of this parameter and a division factor (DW 20) to a minimum value.
- Value range: -32766 .. +32767

Ratio division factor (DW 20)
- Meaning: Division factor for calculating the ratio of output to input speed.
- Value range: 1 .. +32767

Continuation under the speed lower limit (DW 22)
- Meaning: Determining the continuation of the table under the lower limit; i.e. if the master feedback value is less than 0.
  Remarks: If the feedback value is negative and drops below in absolute value the input speed final value (DW11), then the parameter DW 22 is used in addition for determining the output value.
- Value range: 0: Limiting to the first table value
  2: Point mirroring of the table values at the origin

Continuation above the speed upper limit (DW 23)
- Meaning: Determining the continuation of the table above the upper limit; i.e. if the master feedback value is greater than the input speed final value (DW11).
- Value range: 0: Limiting to the last table value
  1: Linear extrapolation of the last interval

Reaction of the SF to the SFKMD codes

- The START command:
  With the START command the SF is transferred from the basic state (RESET) to the SF-ACTIVE state. If the state is SF-ACTIVE, then no renewed START command may be activated. At the START command all parameters are checked for their limits and their validity in an initialization phase. Faulty parameters are identified by the set error bit in the SF status flag (flag 232) and the error number in the SF error flag (flag 233). If an error was reported, the SF remains in the RESET status. A renewed START command with corrected parameters can then follow.

- The VALUE NEW command:
  The purpose of the VALUE NEW command is to supply the SF in the SF-ACTIVE status with new parameters. If this command is activated in other statuses, the command is acknowledged with an error. The following parameters of the commanding DB can be changed through VALUE NEW:
  - Active table (not in operating mode "Input of start/stop, selection of the table and synchronization at "SFKMD fct = VALUE NEW" through binary inputs")
  - Division factor
  - Multiplication factor
  - Input encoder resolution
  - Input speed final value
  - Max. output speed value
  - Min. output speed value
  - Max. output/input speed ratio
  - Min. output/input speed ratio
  - Division factor for ratio calculation
  - Continuation under the speed lower limit
  - Continuation above the speed upper limit

  To synchronize the switch-over of the speed ratio of several axes, which are controlled through the SF DFKT, the parameters of multiplication and division factor are not taken over immediately after the VALUE NEW command in the operating mode "Input of start/stop, selection of the table and synchronization at "SFKMD fct = VALUE NEW" through binary inputs". These parameters are taken over only after a positive edge (0->1) at the selection strobe input (E2).

  Remarks: It should be noted that in this operating mode the table stated in the "Current speed table" parameter is not selected on the "VALUE NEW" command. A table switch-over takes place in this case on activating the new speed ratio through the selection strobe input (E2).

- The RESET command:
  With the aid of the RESET command the SF is reset at any time into the basic status (RESET status). In this case the axis which is controlled through the SF DFKT is stopped (speed = 0). The sink channel, here e.g. the SWQ2 of the controlled axis, is then enabled, whereby this can be used again for other functions (drive commanding).

After SF commanding the SF status can be evaluated with the aid of the flag byte 232 and the SF error with the aid of the flag byte 233.

Remarks: Status and error flags are assigned to the corresponding SF number only after SF commanding (cf. documentation: AMK-specific function blocks)!

3.5.3 Examples

The drive 1 (AW1) works in analog speed control with the speed x. The feedback speed (ID 40) is defined for it as Config.-AW message32 (ID32786). The drive 2 (AW2) should be controlled with drive 1 as master through the SF DFKT. ID 32800 = 3C0043 is set as main operating mode (speed control with torque limitation and speed ramp).

3.5.3.1 Example of a speed table for die SF DFKT

;* DB, which implements a speed table for die SF "speed function table"

```
;
:KD 10      ;Table interpolation point number      9 interpolation points + 1
:KD 0       ;1st table interpolation point         0 rpm: first interpolation point, is
                    ;                              assigned to the input speed 0 rpm
:KD 500     ;2nd table interpolation point         500 rpm
:KD 1000    ;3rd table interpolation point         1000 rpm
:KD 1500    ;4th table interpolation point         1500 rpm
:KD 2000    ;5th table interpolation point         2000 rpm
:KD 2500    ;6th table interpolation point         2500 rpm
:KD 3000    ;7th table interpolation point         3000 rpm
:KD 3500    ;8th table interpolation point         3500 rpm
:KD 4000    ;9th table interpolation point         4000 rpm: last interpolation point,
            ;                                      is assigned to the input speed
            ;                                      according to DW11 (input speed
            ;                                      final value)
```

3.5.3.2 Initializing the SF DFKT

;* DB for initializing the SF "DFKT"

```
;
:KB 4       ;DR 0  SF type                 DFKT
:KB 4       ;DL 0  SF number               SF4
:KB 0       ;DR 1  E/A-M mode              E/A
:KB 0       ;DL 1  SF cycle time factor    Default = 1
:KB 19      ;DR 2  Source address offset   Config.-AW message32
:KB 1       ;DL 2  Source address          AW 2
:KB 16      ;DR 3  Sink address offset     32-bit command value source
:KB 2       ;DL 3  Sink address            AW 2
:KB 16      ;DR 4  Input bit mask          Bit 4
:KB 24      ;DL 4  Input byte address      Byte 24
:KB 16      ;DR 5  Output bit mask         Bit 4
:KB 24      ;DL 5  Output byte address     Byte 24
:KB 17      ;DR 6  DB number Tab0          Speed table 0 (DB 17)
:KB 18      ;DL 6  DB number Tab1          Speed table 1 (DB 18)
:KB 0       ;DR 7  DB number Tab2          Not used
:KB 0       ;DL 7  DB number Tab3          Not used
:KB 0       ;DR 8  DB number Tab4          Not used
:KB 0       ;DL 8  DB number Tab5          Not used
:KB 0       ;DR 9  DB number Tab6          Not used
:KB 16      ;DL 9  DB number Tab7          Output table (DB 16)
```

3.5.3.3 Commanding the SF DFKT

;* DB for commanding the SF "DFKT"

```
;
:KB 4        ;DR 0  SF number                    SF4
:KB 0        ;DL 0  SFKMD fct                    Not used
:KB 1        ;DR 1  SFKMD code                   Start
:KB 6        ;DL 1  SFKMD-BA                     Absolute speed input,
             ;                                   external binary inputs active,
             ;                                   standardization speed ratio
:KF 0        ;DW 2  Reserved
:KF 4        ;DW 3  SF cycle time                ID 2 = 2 ms
:KF 2        ;DW 4  Number of speed tables       2 speed tables
:KF 1        ;DW 5  Current speed table          Table 0 = current
:KF 1000     ;DW 6  Division factor              1000
:KF 0        ;DW 7  Reserved
:KF 1000     ;DW 8  Multiplication factor        1000
:KF 0        ;DW 9  Reserved
             ;                                   V = 1000 / 1000
:KF 20000    ;DW10  Input encoder resolution     20000 increments / rev.
:KF 2000     ;DW11  Input speed final value      2000 rpm
:KF 4000     ;DW12  max. output speed            4000 rpm
:KF 0        ;DW13  Reserved
:KF -4000    ;DW14  min. output speed            -4000 rpm
:KF 0        ;DW15  Reserved
:KF 2000     ;DW16  max. output/input speed      2000
             ;ratio
:KF 0        ;DW17  Reserved
:KF -2000    ;DW18  min. output/input speed      -2000
             ;ratio
:KF 0        ;DW19  Reserved
:KF 1000     ;DW20  Division factor for ratio
             ;calculation                        1000
:KF 0        ;DW 21         Reserved
             ;                                   max. A/E:  2000/1000
             ;                                   min. A/E : -2000/1000
:KF 2        ;DW22  Continuation under the       Point mirroring at the origin
             ;lower limit
:KF 1        ;DW23  Continuation above the       Linear extrapolation
             ;upper limit                        of the last interval
:KD 0        ;DD24  Reserved
:KD 0        ;DD32  Reserved
```

3.6 "SF FGEN" SF reference input variable generator

SF type = 5

The SF "FGEN" allows quickly controllable generation of defined X(t) profiles (distance-time profiles) through binary inputs. The primary application of the reference input variable generator is the control of distance-distance functions of the SF "FIPW"; with the result of obtaining a quickly controllable, table-supported distance-time function controlled through the reference input variable generator (cf. Figure 22 or Section 3.2).

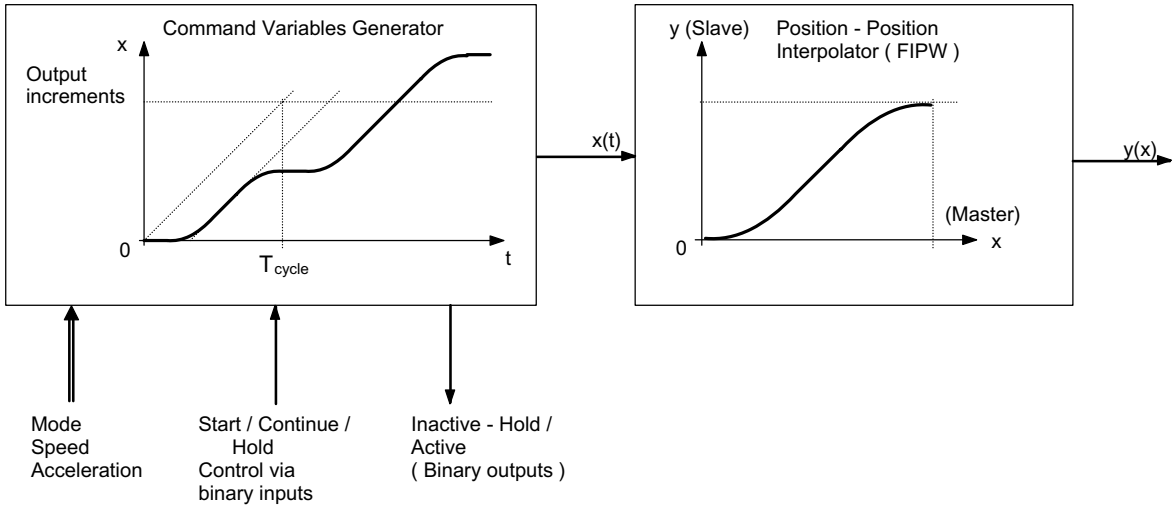


Figure 22: Principle of the reference input variable generator

3.6.1 Principle of the reference input variable generator

The SF FGEN (reference input variable generator) comprises apart from the basic functionality described above also the possibility of zeroing the position feedback value as well as monitoring the feedback position (cf. Section 3.6.1.2). Selection of these functions is possible within the scope of SF commanding through the command variable SFKMD fct.

3.6.1.1 Basic functionality

The basic functionality of the reference input variable generator comprises the generation the X(t) profile (ramp) according to the following Figure 23 and Figure 24. In a further operating mode it is also possible to determine the output function depending upon input increments at the data holder input interface (cf. Section 2.3). As from version AZ-PS4 V02.09 it is possible using a further binary input (E2) to switch over between two acceleration values, e.g. for the fast change to an "Emergency deceleration" (without SF commanding).

The different operating modes are selected by means of SFKMD-BA within the scope of SF commanding (FB208); cf. Section 3.6.2.2.

Operating modes:

- "Continuous mode / Sequential mode":
  - In the "Continuous mode" the reference input variable generator works infinitely (cf. Figure 23). After a positive edge change of the start signal E1 the generation of the X(t) ramp starts. If the start signal = 0, then the generation is interrupted. Both at the start and also on interruption (stop) the output values are changed through an adjustable acceleration (SFKMD parameter).
  - In the "Sequential mode" the reference input variable generator ends the value output after the output of a parameterizable number of distance increments independently (cf. Figure 24). After a positive edge change of the start signal E1 the generation of the X(t) ramp starts. Independently of the start signal, the generation is ended as soon as the input number of distance increments is output. The reference input variable output can be interrupted by removing the start signal through the adjustable acceleration and continued by renewed setting.

- "Internal velocity input / External velocity input":
  - In an "Internal velocity input" the functions displayed in Figure 23 and Figure 24 result. The ramp slope (velocity) results from the SF commanding parameters.
  - In an "External velocity input" the ramp slope (velocity) is determined by the SF by an external input of distance increments (e.g. through a master drive or an EDG) (i.e. the number of distance increments per time interval results in the velocity input).

    Remarks: The SF FGEN requires for this a suitable 16-bit source (e.g. Config.-AZ message1 configured by means of ID 32786 on pulse generator input AZ).

- One acceleration parameter / two acceleration parameters:
  - With one acceleration parameter (SFKMD-BA, Bit2=0) only the acceleration value filed in the SF commanding DB, DD 6, is effective.
  - With two acceleration parameters (SFKMD-BA, Bit2=1), depending upon a further binary input (E2), either the acceleration value filed in the SF commanding DB, DD 6, is effective (E2=0) or the acceleration value 2 filed in the SF commanding DB, DD 24, (E2=1).

The operating modes of the three operating mode groups can be combined arbitrarily. With an "External velocity input" the same statements apply concerning the start signal E1 as for an "Internal velocity input" according to Figure 23 and Figure 24.

It must further be noted:

- The ramp change characteristic (acceleration) as well as other information are input by means of parameters within the scope of SF commanding.
- A velocity override (0% .. ±200%) can be superimposed through a flag word that can be configured by means of parameters.
  Remarks: There is no value output at override = 0%!
- All velocity changes take place through one or two parameterizable acceleration ramp(s) (exception: beginning and end of a sequence in the sequence mode).

- The following parameters can be changed while the SF is active with the aid of the VALUE NEW command:
  - SFKMD-BA (It is only possible to switch over from the continuous mode into the sequence mode and vice versa!),
  - Cycle time,
  - Acceleration,
  - Acceleration2,
  - All position limits.

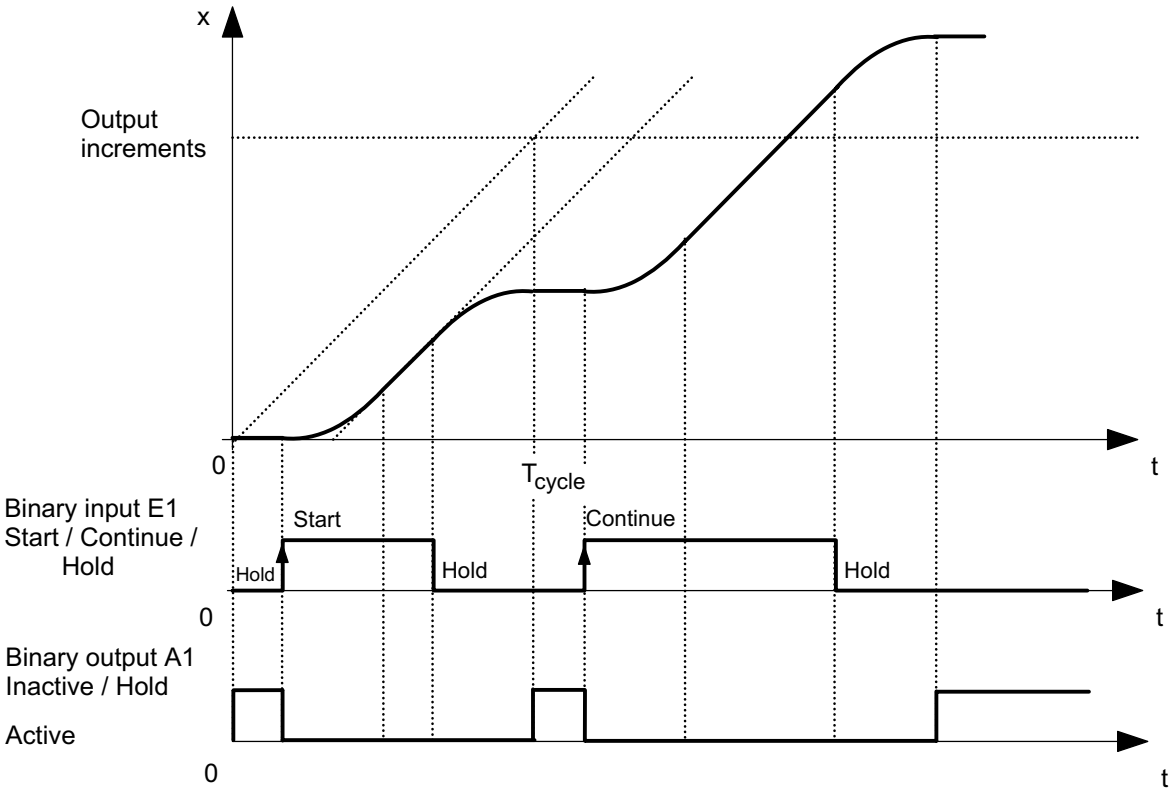


Figure 23: Principle of the reference input variable generator in the continuous mode

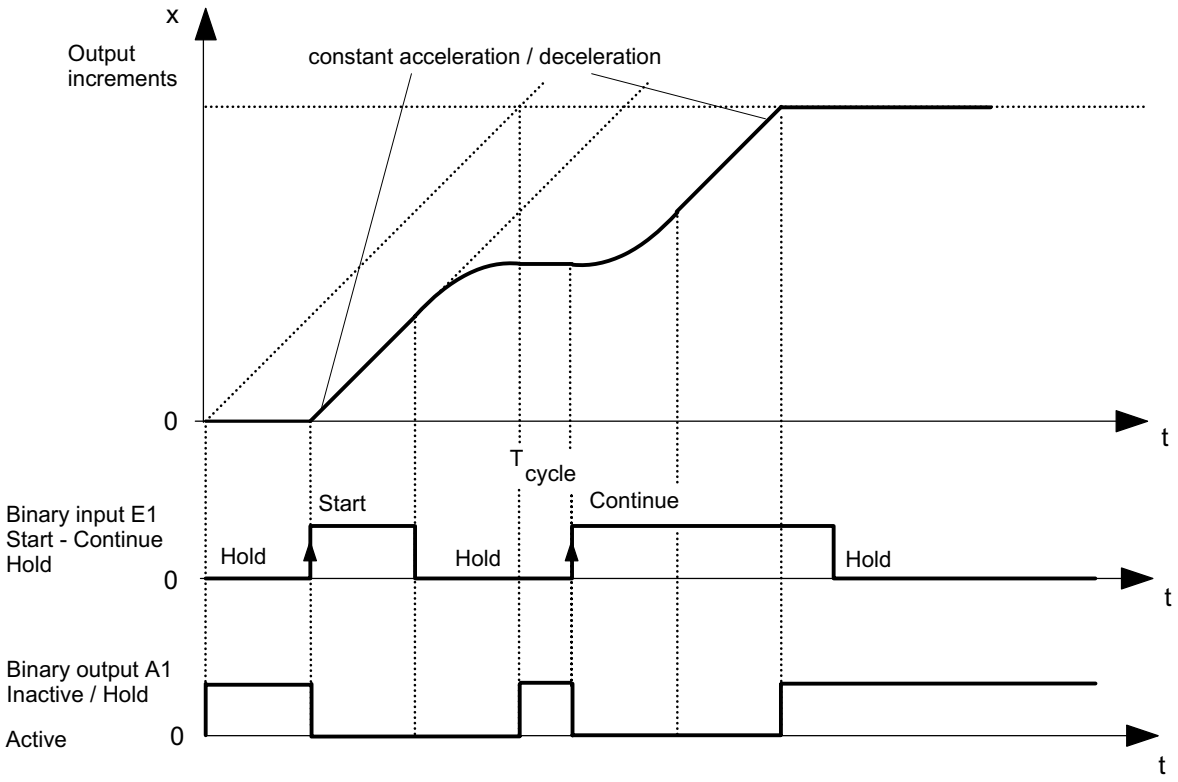


Figure 24: Principle of the reference input variable generator in the sequence mode

3.6.1.2 Feedback value zeroing and feedback position monitoring

The "Feedback value zeroing and feedback position monitoring" functions, as part functionality of the SF "FGEN", enable:

- Zeroing synchronous to the start continue/stop signal (E1) of the SF "FGEN" of the feedback values at the start as well as displaying these feedback values related to the start time in the PS internal 32-bit position feedback value input image of the selected AW modules (ED 128 .. 156 / corresponding to AW1 .. 8; cf. documentation: PS command set, drive-specific E/A/M image). The AW modules are selected by the AW mask parameter.

  Remarks: The feedback values are reset only on start (not on continue)!

- Monitoring the feedback positions with regard to an inputtable limit position (position limit0 .. position limit6) and signalling exceeding the limit through binary outputs (A2 .. A8).

  Remarks: Monitoring takes place exclusively for the AW modules selected through the AW mask parameter (Ax .. Ay: least significant selected AW number most significant selected AW number).

3.6.2 User interface of the SF FGEN

3.6.2.1 Prerequisites and marginal conditions

Expedient settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32805):

- BA command value source = 3C (hexadecimal; commanding interface)
- Position control without following error compensation (SAK is implemented by the SF if required), synchronous ratio (ID 32892, ID 32893) is effective:
  ⇒ SF sink = 16-bit command value source
  Example: ID 32800 = 3C0004
- Position control with fine interpolation (if required):
  ⇒ SF sink = 32-bit command value source
  Example: ID 32800 = 3C0404

Internal velocity input		
Source address	Offset	**Meaning** / remarks
0	0	Not required for internal velocity input
External velocity input		
Source address	Offset	**Meaning** / remarks
0	1,3,5,7	Config.-AZ message1, 2, 3, 4 (High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32)
1..8	3	Config.-AW message32 (Low Word) of AW1..8 / configurable by means of ID 32786; only position command or feedback values are expedient
1..8	5	Position feedback value (Low Word) of AW1..8
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
130	0,2,4 ..30	Input range of the PS process image / EW 0, .. ,30
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2 .. 7 / for logic operation with the corresponding SF1, 2, .. 7
Internal or external velocity input		
Sink address	Offset	**Meaning**
1..8	4	16-bit command value source of AW1..8 / ID 32892, ID 32893 are effective
1..8	16	32-bit command value source of AW1..8 / fine interpolator through ID 32800.. ID 32809 can be used; ID 1 = ID 2 required
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
255	0	Internal sink for logic operation with further SF without output on an AW

Table 30: Settings of the FGEN data holder interfaces (SF source/sink)

3.6.2.2 Structure and parameters of the SF commanding DB

Data	High word		Low word	
double word	**High byte**	**Low byte**	**High byte**	**Low byte**
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		Cycle time	
04	Cycle output increments (e.g. encoder resolution)			
06	Acceleration			
08	AW mask		Override address	
10	Position limit0			
12	Position limit1			
14	Position limit2			
16	Position limit3			
18	Position limit4			
20	Position limit5			
22	Position limit6			
24	Acceleration2			
26	Reserved = 0			
32	Reserved = 0			

Total number: 34 data words

Table 31: FGEN commanding DB

SF number (DR0)

- Meaning: SF number under which a SF of the SF type 5 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)

- Meaning: Selection of additional functionality.
- Value range: 0 .. 7
  bit-coded:
  Bit 0 = 1: Reference input variable generator active
  Bit 1 = 1: Feedback value zeroing active
  Bit 2 = 1: Feedback position monitoring active
- Example: 0: No function
  1: Reference input variable generator active
  7: Reference input variable generator, feedback value zeroing and feedback position monitoring active

SFKMD code (DR 1)

- Meaning: Code of the SF command.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): start SF
  5 (VALUE NEW): Transfer of new parameters to the active SF

SFKMD-BA (DL 1)

- Meaning: Selection of the operating mode.
- Value range: 0 .. 7
  bit-coded:
  Bit 0 = 0: Internal velocity input
  Bit 0 = 1: External velocity input
  Bit 1 = 0: Continuous operation
  Bit 1 = 1: Sequence operation
  Bit 2 = 0: One acceleration value (one binary input)
  Bit 2 = 1: Two acceleration values (two binary inputs)
- Example: 0: Internal velocity input through parameters and continuous mode (one acceleration parameter)
  1: Velocity input through distance increments of external and continuous mode (one acceleration parameter)
  2: Internal velocity input through parameters and sequence mode (one acceleration parameter)
  3: Velocity input through distance increments of external and sequence mode (one acceleration parameter)
  4: Internal velocity input through parameters and continuous mode (two according to parameters)
  5: Velocity input through distance increments of external and continuous mode (two according to parameters)
  6: Internal velocity input through parameters and sequence mode (two according to parameters)
  7: Velocity input through distance increments of external and sequence mode (two according to parameters)

Cycle time (DW 2)

- Meaning: Time within which the increments corresponding to the 2π value are output.
- Value range: 1 .. +32767
- Unit: 0.5 ms
- Example: Value = 2000 $\Rightarrow$ cycle time = 1000 ms

SF cycle time (DW 3)

- **Mea**n**ing**: Time in which the SF is called cyclically. (This time is determined by ID 2 = SERCOS cycle time.)
- Value range: 1 to +131
- Unit: 0.5 ms
- Example: Value = 2 $\Rightarrow$ SF cycle time = 1 ms

Cycle output increments (DD 4)

- Meaning: Increments which are output per cycle (e.g. = encoder resolution of the following FIPW).
- Value range: 1 .. $+2^{31}-1$
- Unit: Increments

Acceleration (DD 6)

- Meaning: Acceleration or deceleration value, if SFKMD-BA-Bit2 = 0 or if SFKMD-BA-Bit2 = 1 and E2 = 0..
- Value range: 1 .. +500,000,000
- Unit: $incr/s^2$

Override address (DW 8)

– Meaning: Flag word address, which is used for forming a velocity override.
Remarks: An override value of 1024 corresponds to 100%. The input range for the override value is 0 .. ±2048 (0 .. ±200%). There is no value output at an override value of 0!

– Value range: 0: No velocity override function.
2, 4, 6, ..,126: Flag word address regarding the velocity override function.

Relevant parameters regarding feedback value zeroing and feedback position monitoring functions:

AW mask (DW 9)

– Meaning: Bit-coded AW selection mask (Bit0 .. 7; corresponding to AW1 .. 8) for die feedback value zeroing and feedback position monitoring functions.

– Value range: 0: No AW selected
1: AW1 selected
2: AW2 selected
3: AW1 and AW2 selected
. : .
254: AW2 .. 8 selected
Remarks: A maximum of 7 AWs can be selected simultaneously!

– Example: Value = 129 ⇒ AW1 and AW8 selected

Position limit0 (DD 10)

– Meaning: Absolute feedback value from which the binary output A2 is set = 1, if this position is exceeded by the selected drive with the lowest AW number.

– Value range: 0 .. $+2^{31}$-1

– Unit: Increments

Position limit1 (DD 12)

– Meaning: Absolute feedback value from which the binary output A3 is set = 1, if this position is exceeded by the selected drive with the next higher AW number.

– Value range: 0 .. $+2^{31}$-1

– Unit: Increments

Position limit2 (DD 14)

– Meaning: Absolute feedback value from which the binary output A4 is set = 1, if this position is exceeded by the selected drive with the next higher AW number.

– Value range: 0 .. $+2^{31}$-1

– Unit: Increments

Position limit3 (DD 16)

– **Meaning**: Absolute feedback value from which the binary output A5 is set = 1, if this position is exceeded by the selected drive with the next higher AW number.

– Value range: 0 .. $+2^{31}$-1

– Unit: Increments

Position limit4 (DD 18)

- Meaning: Absolute feedback value from which the binary output A6 is set = 1, if this position is exceeded by the selected drive with the next higher AW number.
- Value range: 0 .. $+2^{31}$-1
- Unit: Increments

Position limit5 (DD 20)

- Meaning: Absolute feedback value from which the binary output A7 is set = 1, if this position is exceeded by the selected drive with the next higher AW number.
- Value range: 0 .. $+2^{31}$-1
- Unit: Increments

Position limit6 (DD 22)

- Meaning: Absolute feedback value from which the binary output A8 is set = 1, if this position is exceeded by the selected drive with the next higher AW number.
- Value range: 0 .. $+2^{31}$-1
- Unit: Increments

Acceleration2 (DD 24)

- Meaning: Acceleration or deceleration value if SFKMD-BA-Bit2 = 1 and E2 = 1.
- Value range: 1 .. +500,000,000
- Unit: incr/s^2

3.6.3 Examples

The drive 1 (AW1) should be controlled through a distance-time function. Here it should be possible to start the drive movement with a signal and to stop or continue it at any time. A movement cycle should be ended after a cycle time of 2s. For this purpose the reference input variable for a SF "FIPW" is generated through the SF "FGEN". The current position in the cycle is displayed as position feedback value.

3.6.3.1 Initializing the SF FGEN

```
; DB for initializing the SF "FGEN" (SF reference input variable generator)
;
:KB 5       ;DR0  SF type              FGEN
:KB 0       ;DL0  SF number            SF0
:KB 0       ;DR1  E/A-M mode           E/A
:KB 0       ;DL1  SF cycle time factor Default = 1
:KB 0       ;DR2  Source adr. offset   Not used
:KB 0       ;DL2  Source address       Not used
:KB 0       ;DR3  Sink address offset  Not used
:KB 255     ;DL3  Sink address         Internal, for further logic operation
            ;                          with a SF
:KB 16      ;DR4  E bit mask           E-Bit 4 = Start continue/
            ;                          stop input
:KB 8       ;DL4  E byte address       EB 8
:KB 16      ;DR5  A bit mask           A-Bit 4 = Inactive stop/active
            ;                          output
:KB 8       ;DL5  A byte address       AB 8
:KB 0       ;DR6  Tab0 DB No           Not used
:KB 0       ;DL6  Tab1 DB No           Not used
:KB 0       ;DR7  Tab2 DB No           Not used
:KB 0       ;DL7  Tab3 DB No           Not used
:KB 0       ;DR8  Tab4 DB No           Not used
:KB 0       ;DL8  Tab5 DB No           Not used
:KB 0       ;DR9  Tab6 DB No           Not used
:KB 0       ;DL9  Tab7 DB No           Not used
;DB for initializing the SF "FIPW" (SF function interpolator
;distance function)
;
:KB 1       ;DR0  SF type              FIPW
:KB 1       ;DL0  SF number            SF1
:KB 0       ;DR1  E/A-M mode           E/A
:KB 0       ;DL1  SF cycle time factor Default = 1
:KB 0       ;DR2  Source adr. offset   SF0
:KB 255     ;DL2                       Internal, for logic operation
            ;                          with a SF
:KB 4       ;DR3  Sink address offset  16-bit command value
:KB 1       ;DL3  Sink address  AW1
:KB 32      ;DR4  E bit mask           E-Bit 5 = Start input
:KB 8       ;DL4  E byte address       EB 8
:KB 32      ;DR5  A bit mask           A-Bit 5 = Acknowledgement start
            ;                          output
:KB 8       ;DL5  A byte address       AB 8
:KB 16      ;DR6  Tab0 DB No           DB16 is distance-distance table
:KB 0       ;DL6  Tab1 DB No           Not used
:KB 0       ;DR7  Tab2 DB No           Not used
:KB 0       ;DL7  Tab3 DB No           Not used
:KB 0       ;DR8  Tab4 DB No           Not used
:KB 0       ;DL8  Tab5 DB No           Not used
:KB 0       ;DR9  Tab6 DB No           Not used
:KB 0       ;DL9  Tab7 DB No           Not used
```

3.6.3.2 Commanding the SF FGEN

```
; DB for commanding the SF "FGEN" (SF reference input variable
; generator)
;
:KB 0          ;DR0   SF number                SF0: FGEN corresponds to SF-Init.
:KB 3          ;DL0   SFKMD fct                Reference input variable generator
               ;                               with feedback value zeroing at start
:KB 1          ;DR1   SFKMD code               Start
:KB 2          ;DL1   SFKMD-BA                 Sequence mode
:KF 4000       ;DW2   Cycle time               2 s
:KF 2          ;DW3   SF cycle time            1 ms
:KD 20000      ;DD4   Output increments        20000 incr
:KD 1000000    ;DD6   Acceleration             1000000 incr/ss
:KF 10         ;DW8   Override flag address    MW 10
:KF 1          ;DW9   AW mask                  AW1
:KD 0          ;DD10  Position limit 0         Not used
:KD 0          ;DD12  Position limit 1         Not used
:KD 0          ;DD14  Position limit 2         Not used
:KD 0          ;DD16  Position limit 3         Not used
:KD 0          ;DD18  Position limit 4         Not used
:KD 0          ;DD20  Position limit 5         Not used
:KD 0          ;DD22  Position limit 6         Not used
:KD 0          ;DD24  Acceleration2            Not active
:KD 0          ;DD26  Reserved
:KD 0          ;DD28  Reserved
:KD 0          ;DD30  Reserved
:KD 0          ;DD32  Reserved
; DB for commanding the SF "FIPW" (SF function interpolator
; distance function)
;
:KB 1          ;DR0   SF number                SF1: FIPW corresponds to SF-Init.
:KB 0          ;DL0   SFKMD fct                Not used
:KB 1          ;DR1   SFKMD code               Start
:KB 2          ;DL1   SFKMD-BA                 Distance cyclic
:KF 0          ;DW2   SAK factor               Without SAK
:KF 2          ;DW3   SF cycle time            1ms
:KF 1          ;DW4   Total table number       One table
:KF 0          ;DW5   Start table number       0 start tables
:KF 0          ;DW6   Division exponent        / 1
:KF 0          ;DW7   Reserved
:KD 1          ;DD8   Multiplication factor    * 1
:KD 20000      ;DD10  Inc.p.rev/cycle time     20000 increments per revolution
:KF 0          ;DW12  Master offset angle      0 incr.
:KF 0          ;DW13  Reserved
:KF 0          ;DW14  Start angle              0 incr.
:KF 0          ;DW15  Reserved
:KF 0          ;DW16  Stop angle               0 incr.
:KF 0          ;DW17  Reserved
:KD 0          ;DD18  Reserved
:KD 0          ;DD20  Reserved
:KD 0          ;DD22  Reserved
:KD 0          ;DD24  Reserved
:KD 0          ;DD26  Reserved
:KD 0          ;DD28  Reserved
:KD 0          ;DD30  Reserved
:KD 0          ;DD32  Reserved
```

3.7 "SF REGL" SF control

SF type = 6

"SF REGL" allows configurable control of drive-internal and drive-external variables.

3.7.1 Principle of "SF REGL"

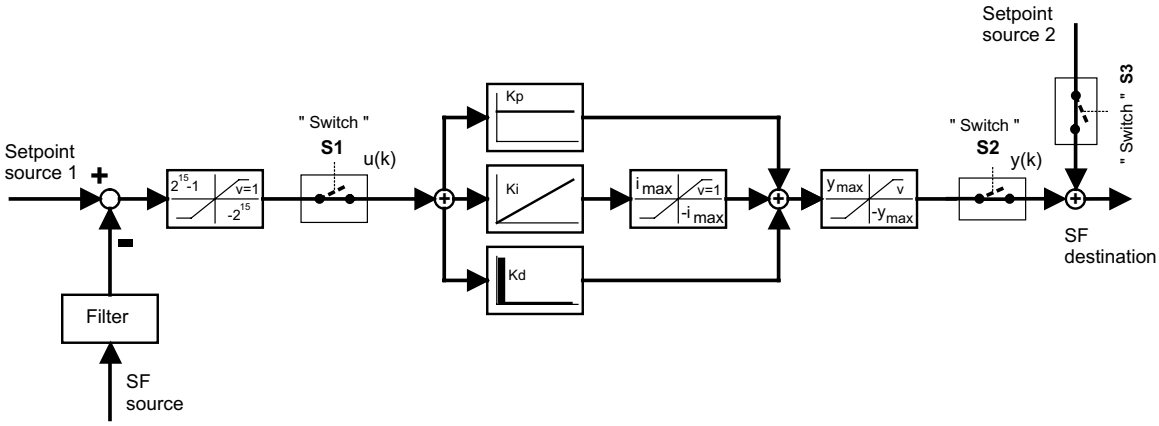


Figure 25: Principle of "SF REGL"

"SF REGL" comprises the PID controller structure shown in Figure 25. The configuration of all controller functions is possible within the scope of SF commanding "START". Switch operation (cf. S1 .. S3 according to Figure 25) can be either by means of SF commanding or binary input signals (E1..E3). Further it is possible to synchronize the controller clock with an external binary signal (E1/E4[1)]). The selection is made by the operating mode (SFKMD-BA; cf. Section 3.7.2.2):

[1)] E1, if operating mode without binary controller switch-over
E4, if operating mode with binary controller switch-over

Operating modes (cf. Section 3.7.2.2, SFKMD-BA):

- *"Without binary controller switch-over":* The switches S1 .. S3 of the controller configuration according to Figure 25 can be operated exclusively by SF commanding.
- *"With binary controller switch-over":* The switches S1 .. S3 of the controller configuration according to Figure 25 can be operated by binary input E1 .. E3.
- *"Without external synchronization":* The controller works with the sampling time defined by ID2 (SERCOS cycle time).
- *"With external synchronization":* The controller acquires with the cycle time defined by ID2 (SERCOS cycle time) a binary input signal. A control cycle occurs only at the positive edge of the input signal.
- *"Positive output limit":* 0 or "positive value" in DD10 of the commanding DB.
- *"Negative output limit":* 0 or "negative value" in DD10 of the commanding DB.
- *"Limitation + amplification":* Before or after the summation point with command value source2 (SP).
- *"Delete integrator":* If this mode is selected (cf. Section 3.7.2.2, SFKMD-BA) the I component is deleted automatically on interrupting the control circuit by opening the switch S2 (cf. Figure 25, S2 = 0).

Interference variable filtering can be set in the feedback branch by means of the filter type commanding parameter (cf. Section 3.7.2.2, filter type). The SF source assessment parameter (cf. Section 3.7.2.2, SF source assessment) enables the negation of the feedback branch for adapting the position control sense as well as switching off the adaptation to the binary value input by means of D/A converter (for the direct input of a 16-bit value in two's complement representation).

The following parameters can be changed with the SF commanding code "VALUE NEW" (cf. Section 3.7.2.2) while the controller is active:

- Switch bit mask
- Proportional gain Kp
- I component Ki
- D component Kd
- Output limit (including positive/negative selection according to SFKMD-BA, Bit 2 / 3)
- Output gain
- Command value source1
- Command value source2

The output limitation can be controlled through the binary outputs A1 or A2:

- A1 = 0; A2 = 0: No limitation
- A1 = 1; A2 = 0: Positive limitation $y(k) = y_{max}$
- A1 = 0; A2 = 1: Negative limitation $y(k) = -y_{max}$

3.7.2 AWL interface of the SF REGL

3.7.2.1 Prerequisites and marginal conditions

Expedient settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32809):

- BA command value source = 3C (hexadecimal; commanding interface)
- Speed control (with / without speed ramp according to ID 32780 or ID 32781):
  ⇒ SF sink = 32-bit command value source
  Example: ID 32800 = 3C0043

Source address	**Offset**	**Meaning / remarks**
1..8	2	Config.-AW message16 of AW1..8 / configurable by means of ID 32785; only AW analog input voltage A1 / A2 are expedient (ID 32785=32897 / 32898)
128	0,2,4 ..126	Flag word range of the PS / MW 0, .. ,126
130	0,2,4 ..30	Input word range of the PS process image / EW 0, .. ,30
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2 .. 7 / for logic operation with the corresponding to SF0, 1, .. 7
Sink address	**Offset**	**Meaning**
1..8	16	32-bit command value source of AW1..8
129	0,4,8.. 124	Flag double word range of the PS / MD 0, .. ,124
255	0	Internal sink for logic operation with further SF without output on an AW

Table 32: Settings of the REGL data holder interfaces (SF source/sink)

3.7.2.2 Structure and parameters of the SF commanding DB

Data double word	**High word**		**Low word**	
	High byte	**Low byte**	**High byte**	**Low byte**
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		Reserved = 0	
04	SF source assessment	Filter type	Switch bit mask	
06	Ki		Kp	
08	Reserved = 0		Kd	
10	Output limit (y_{max})			
12	Reserved = 0		Output gain (v)	
14	Integration limit (i_{max})			
16	MD address source2		MW address source1	
18	Reserved = 0		Command value source1	
20	Command value source2			
22	Reserved = 0			
24	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 33: REGL commanding DB

SF number (DR0)
- Meaning: SF call number under which a SF of the SF type 6 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
- Meaning: Selection of additional functionality.
- Value range: 0: PID controller

SFKMD code (DR 1)
- Meaning: Code of the SF command.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): Start SF
  5 (VALUE NEW): Transfer of new parameters to the active SF

SFKMD-BA (DL 1)
- Meaning: Selection of the operating mode.
- Value range: 0 .. 15
  bit-coded:
  - Bit 0 = 0: Without binary controller switch-over (S1.. S3 through SF commanding)
    = 1: With binary controller switch-over (S1.. S3 through binary E/A)
  - Bit 1 = 0: Without external synchronization
    = 1: With external synchronization
  - Bit 2 = 0: Positive output limit corresponding to DD10
    = 1: Positive output limit = 0
  - Bit 3 = 0: Negative output limit corresponding to DD10
    = 1: Negative output limit = 0
  - Bit 4 = 0: "Limitation + amplification" before the summation point (SP)
    = 1: "Limitation + amplification" after the summation point (SP)
  - Bit 5 = 0: "Delete integrator" is deselected
    = 1: "Delete integrator" is selected
- Example: Value = 0 $\Rightarrow$ Symmetric limitation ($-y_{max}$ .. y_{max}) before the SP
  Value = 20 $\Rightarrow$ Asymmetric limitation ($-y_{max}$ .. 0) after the SP
  Value = 24 $\Rightarrow$ Asymmetric limitation (0 .. y_{max}) after the SP

SF cycle time (DW 3)
- Meaning: Time Tsf in which the SF is called cyclically. (This time is determined by ID 2 = SERCOS cycle time.)
- Value range: 1 to +131 (*Currently not used!*)
- Unit: 0.5 ms
- Example: Value = 2 $\Rightarrow$ SF cycle time Tsf = 1 ms

Switch bit mask (DW 4)
- Meaning: Bit mask for selecting the controller switches S1 .. S3 (cf. Figure 25), if in SFKMD-BA Bit 0 = 0.
- Value range: 0..7
  bit-coded:
  - Bit 0 = 0: Switch S1 open
    1: Switch S1 closed
  - Bit 1 = 0: Switch S2 open
    1: Switch S2 closed
  - Bit 2 = 0: Switch S3 open
    1: Switch S3 closed
- Example: Value = 4 $\Rightarrow$ Only speed command value input through MD address source2 effective.

Filter type (DR 5)
- Meaning: Selection of a feedback value filter.
- Value range: 0: No filtering
  1: Masking the less significant 2 bits
  2: Mean value formation over four sampling points

SF source assessment (DL 5)
- Meaning: Assessment of the SF source information.
- Value range: 0 .. 3
  bit-coded:
  - Bit 0 = 0: No negation of the SF source information
    = 1: Negation of the SF source information
  - Bit 1 = 0: Converting the 12-bit A/D converter value into a two's complement representation
    = 1: No conversion
- Example: Value = 2 $\Rightarrow$ No negation of the SF source information; no conversion of the 12-bit A/D converter value into a two's complement representation

Kp factor (DW 6)
- Meaning: Proportional gain (P) of the PID controller.
- Value range: 0..16383
- Unit: 1/256
- Example: Value = 256 $\Rightarrow$ P gain = 1

Ki factor (DW 7)
- Meaning: Integration gain (I) of the PID controller.
- Value range: 0..16383
- Unit: 1/256
- Example: Value = 128 $\Rightarrow$ I gain = 0.5
  $\Rightarrow$ Tn = Tsf * Kp / Ki

Kp factor (DW 8)
- Meaning: Differential gain (D) of the PID controller.
- Value range: 0..16383
- Unit: 1/256
- Example: Value = 64 $\Rightarrow$ D gain = 0.25
  $\Rightarrow$ Tv = Tsf * Kd / Kp

Output limit (DD 10)
- Meaning: Absolute amount of the maximum controller output value (y_{max}). According to operating mode, a symmetric limitation ($-y_{max}$ .. y_{max}) or an asymmetric limitation ($-y_{max}$ ..0; 0 .. y_{max}) can be implemented (cf. SFKMD-BA).
- Value range: $0..2^{30}-1$

Output gain (DW 12)
- Meaning: Output gain factor v
- Remarks: With a negative output gain factor, reversing the action sense of the controller can be implemented (e.g. direction of rotation reversal).
- Value range: $-2^{15}..-1, 1..2^{15}-1$

Integration limit (DD 14)
- Meaning: Maximum integrator output value (i_{max}).
- Value range: 0.. 2^{21}-1

MW address source1 (DW 16)
- **Meaning**: Flag word address under which the command value of source1 is read.
- Value range: 0: The command value of source1 is determined by the SF commanding parameter command value source1 (DW 18)
  2, 4, .., 126: The command value of source1 is determined by the value of the flag word 2, 4, .. 126.

MD address source2 (DW 17)
- Meaning: Flag double word address under which the command value of source2 is read.
- Value range: 0: The command value of source2 is determined by the SF commanding parameter command value source2 (DD 20)
  4, 8, .. 124: The command value of source2 is determined by the value of the flag double word 4, 8, .. 124.

Command value source1 (DW 18)
- Meaning: Command value of source1, if MW address source1 = 0.
- Value range: $-2^{15}..+2^{15}-1$

Command value source2 (DD 20)
- Meaning: Command value of source2, if MD address source2 = 0.
- Value range: $-2^{31}..+2^{31}-1$

3.7.3 Example

Force control should be superimposed on the drive 1 operated in speed control (AW1) by means of the "SF REGL". The force actual value is acquired through the analog input A1 of the AW1. Force command value as well as a basic speed command value are input through the SF commanding parameters command value source1 and command value source2. The positive or negative limitation of the controller should be indicated at the binary outputs A 0.0 or A 0.1.

Drive settings:

- ID 32800 = 3C0043 ⇒ Main operating mode for AW1: Digital speed control
- ID 32785 = 32897 ⇒ Config.-AW message16 of AW1: AW analog input voltage A1 in binary representation

Definitions regarding A1:

- Force change = 1 N ⇒ Value change in Config.-AW message16 = 1Bit

3.7.3.1 Initialization of SF REGL

```
;*******************************************************************************
;
; DB for initializing the SF "REGL"
;*******************************************************************************
;
;
:KB 6           ;DR0  SF type               REGL
:KB 0           ;DL0  SF number             SF0
:KB 0           ;DR1  E/A-M mode            E/A
:KB 0           ;DL1  SF cycle time factor  Default = 1
:KB 2           ;DR2  Source adr. offset    Config.-AW message16
:KB 1           ;DL2  Source address        AW1
:KB 16          ;DR3  Sink address offset   32-bit command value source
:KB 1           ;DL3  Sink address          AW1
:KB 0           ;DR4  E bit mask            No input
:KB 0           ;DL4  E byte address        Byte x = 0
:KB 1           ;DR5  A bit mask            Bit x.0
:KB 0           ;DL5  A byte address        Byte x = 0
:KB 0           ;DR6  Tab0 DB No            Not used
:KB 0           ;DL6  Tab1 DB No            Not used
:KB 0           ;DR7  Tab2 DB No            Not used
:KB 0           ;DL7  Tab3 DB No            Not used
:KB 0           ;DR8  Tab4 DB No            Not used
:KB 0           ;DL8  Tab5 DB No            Not used
:KB 0           ;DR9  Tab6 DB No            Not used
:KB 0           ;DL9  Tab7 DB No            Not used
;*******************************************************************************
;
```

3.7.3.2 Commanding the SF REGL

```
;*******************************************************************************
;
; DB for commanding the SF "REGL"
;*******************************************************************************
;
;
:KB 0           ;DR0   SF number                 SF0: REGL corresponds to SF-Init.
:KB 0           ;DL0   SFKMD fct                 PID controller
:KB 1           ;DR1   SFKMD code                Start
:KB 0           ;DL1   SFKMD-BA                  Reserved
:KF 0           ;DW2   Reserved
:KF 2           ;DW3   SF cycle time             1 ms
:KF 7           ;DW4   Switch bit mask           S1..S3 = 1
:KB 0           ;DR5   Filter type               No filtering
:KB 0           ;DL5   SF source assessment      No negation; conversion
:KF 512         ;DW6   Kp                        2
:KF 128         ;DW7   Ki                        0.5
:KF 64          ;DW8   Kd                        0.25
:KF 0           ;DW9   Reserved
:KD 10000000;DD10  Output limit                  y_max = 1000 rpm
:KF 1000        ;DW12  Output gain               v = 1000
:KF 0           ;DW13  Reserved
:KD 1000000     ;DW14  Integration limit         i_max = 1000000
:KF 0           ;DW16  MW address source1        Command value source1 active
:KF 0           ;DW17  MD address source2        Command value source2 active
:KF 100         ;DW18  Command value source1     F_Command = 100 N
:KF 0           ;DW19  Reserved
:KD 5000000     ;DD20  Command value source2     n_Command = 500 rpm
:KD 0           ;DD22  Reserved
:KD 0           ;DD24  Reserved
:KD 0           ;DD26  Reserved
:KD 0           ;DD28  Reserved
:KD 0           ;DD30  Reserved
:KD 0           ;DD32  Reserved
```

3.8 "SF IMES" SF pulse distance measurement

SF type = 7

With the aid of "SF IMES" a pulse distance measurement can be performed on the basis of input increments (e.g. distance increments).

3.8.1 Principle of "SF IMES"

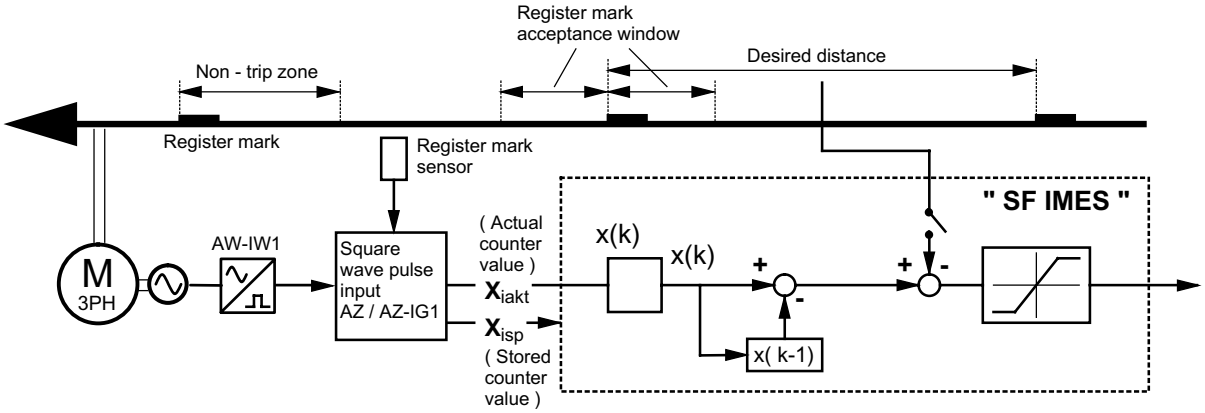


Figure 26: Principle of "SF IMES"

"SF IMES" performs a measurement of pulse distances (mark distances). The pulse signal is led to the zero pulse input of the AMKASYN pulse generator input. Square signals serve as reference variable for the distance measurement (e.g. distance increments of a pulse generator) which are fed through the increment inputs of the same AMKASYN pulse generator input.
With the aid of the "Permissibility window" parameter, a range in which a pulse signal is valid can be defined. With the "Blocked range" parameter a range after a valid pulse signal in which no further signals are valid can be stated (cf. Figure 26, Figure 27, or Section 3.8.3.2).

The following binary output signals are generated:

1st bit (A1): A *trigger output* which is set to "1" for identifying a new output value and remains active one SF cycle long. (A new output value is entered in the SF sink if a valid input pulse is detected.)
2nd bit (A2): A *pulse valid output* which remains set to "1" as long as valid pulse signals are detected.

The following parameters (cf. Section 3.8.3.2) can be changed while the fast function is active with the SF commanding "VALUE NEW":
- Command spacing of the pulses
- Permissibility window
- Blocked range

3.8.2 Description of the operating modes

The operating mode is determined by the parameter SF operating mode at the START command.

Operating modes (cf. Section 3.8.3.2, SFKMD-BA):

Difference measurement:	The output value is the measured difference between the pulse spacing and a command spacing which is input by means of SF commanding.
Absolute value measurement:	The output value is the pulse spacing (measured in encoder increments).
Set on Yes/No:	Selection whether in *difference measurement* an invalid pulse signal is rejected or used as new start value.
Output value limitation:	Selection whether the output value in *difference measurement* is output only positive, only negative or positive and negative (no limitation).

3.8.2.1 Difference measurement operating mode

The output value of the "SF IMES" is the difference between the pulse spacing measured in the form of increments and a command spacing, which is input by means of SF commanding. This means that the command spacing is subtracted from the measured actual spacing of the pulses.

Remarks: Modulo calculation is performed to form the output value; with: "Output value" = "Pulse spacing modulo command spacing". Thus correct values are calculated if pulse signals fail.

Difference formation can be influenced as follows with the aid of the output value limitation:
- If "Positive limitation" is selected, then the output value is in the range 0 to (command spacing - 1)
- If "Negative limitation" is selected, then the output value is in the range -(command spacing - 1) to 0
- If no limitation is selected, then the output value is in the range (-command spacing / 2) to (command spacing / 2)

Whether a pulse signal is valid depends upon the "Permissibility window" and the "Output value limitation" parameter.

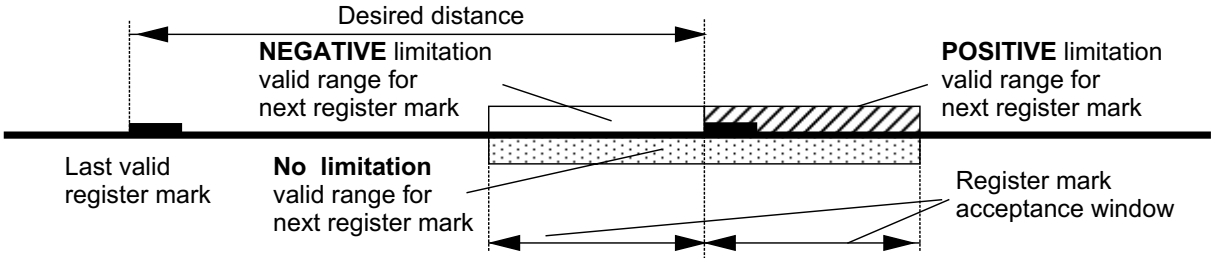


Figure 27: Mode of operation of the permissibility window and output value limitation

Figure 27 shows that

- at "Positive limitation" a pulse signal in the permissible range is valid only if the feedback pulse spacing is greater or equal to the command spacing,
- at "Negative limitation" a pulse signal in the permissible range is valid only if the feedback pulse spacing is smaller than the command spacing, and
- without limitation all pulse signals in the permissible range are valid.

Remarks: It must be observed that pulse signals in the blocked range are always rejected.

It is selected with the aid of the "Set on" operating mode bit how an invalid pulse signal is processed. If the "Set on bit" is set, then an invalid pulse signal is stored as new start value for difference formation, if the bit is not set then an invalid pulse signal is rejected.

3.8.2.2 Absolute value measurement operating mode

The measured pulse spacing is output as output value. Pulses in the blocked range are ignored.

3.8.3 AWL interface of the SF IMES

3.8.3.1 Prerequisites and marginal conditions

Expedient settings of the interface for the pulses (cf. documentation: Parameters; ID 32948):

- Config.AZ message = 03h Pulse generator input AZ; terminal X32
  04h, 05h, 06h, 07h AZ-IG1; slot1; channel 1, 2, 3, 4
  08h, 09h, 0Ah, 0Bh AZ-IG1; slot2; channel 1, 2, 3, 4
  0Ch, 0Dh, 0Eh, 0Fh AZ-IG1; slot3; channel 1, 2, 3, 4
  10h, 11h, 12h, 13h AZ-IG1; slot4; channel 1, 2, 3, 4

Source address	**Offset**	**Meaning / remarks**
0	16,18,20, 22	Config.AZ message 1..4 / the AZ message must be configured by means of ID 32948
Sink address	**Offset**	**Meaning**
128	0,2,4.. 126	Flag word range of the PS / MW 0, .. ,126
255	0	Internal sink for logic operation with further SF without output on an AW

Table 34: Settings of the SF IMES data holder interfaces (SF source/sink)

3.8.3.2 Structure and parameters of the SF commanding DB

Data double word	High word		Low word	
	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		Reserved = 0	
04	Command spacing			
06	Permissible window			
08	Blocked range			
10	Reserved = 0			
12	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 35: SF IMES commanding DB

SF number (DR0)
- Meaning: SF number under which a SF of the SF type 7 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
- Meaning: not used.
- Value range: 0

SFKMD code (DR 1)
- Meaning: Code of the SF command.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): Start SF
  5 (VALUE NEW): Transfer of new parameters to the active SF

SFKMD-BA (DL 1)
- Meaning: Selection of the operating mode.
- Value range: bit-coded:
  - Bit 0 = 0: *Difference measurement*; output value is the difference between the measured pulse spacing (in the form of increments) and a command spacing, which is input by means of SF commanding
    = 1: *Absolute value measurement;* output value is the measured pulse spacing
  - Bit 1 = 0: *Do not set down*; i.e. an invalid pulse signal is rejected
    = 1: *Set down;* i.e. an invalid pulse signal becomes new start value for the next difference formation
  - Bit 3, 2 = 0, 0: No output value limitation
    = 0,1: Positive limitation
    = 1,0: Negative limitation

SF cycle time (DW 3)

- Meaning: Time Tsf in which the SF is called cyclically. (This time is determined by ID 2 = SERCOS cycle time.)
- Value range: 1 to +131 (*Currently not used!*)
- Unit: 0.5 ms
- Example: Value = 2 ⇒ SF cycle time Tsf = 1 ms

Command spacing (DD 4)

- Meaning: Command spacing of the pulses; this parameter is of significance only in the difference measurement operating mode
- Value range: 0 to $+2^{30}$-1
  0 : No command spacing, the output value reproduces the pulse spacing
- Unit: Increments

Permissible window (DD 6)

- Meaning: Range about the command spacing in which a pulse is valid.
- Value range: 0 to $+2^{30}$-1
  0 : Pulse always valid
- Unit: Increments

Blocked range (DD 8)

- Meaning: Range after a valid pulse in which further pulses are ignored. It is possible to prevent with this parameter that with pulses present for a long time several pulses are detected internally.
- Value range: 0 to $+2^{30}$-1
  0 : No blocked range
- Unit: Increments

3.8.4 Example

The drive 1 operated in speed control (AW1) moves a film. Printing marks the spacing of which should be recorded are placed on this film. The marks are acquired by means of an optical sensor and fed together with the encoder signals of AW1 (decoupled through an AWIW) through the pulse generator input AZ into the AMKASYN system. The difference between the feedback mark spacing and the command spacing is transferred through the internal SF sink of the SF "REGL". With the aid of the SF "REGL" the speed controller is actuated so that the segments identified by the marks are stretched to the command length. Since the segments may be only shorter than the command spacing in the measurement (compression of the segments is not possible) a "Negative limitation" is selected in "IMES". The SF "REGL" works as integrator (only I component effective). By means of the synchronizsation between "IMES" and "REGEL" through M 22.0 there is a correction only if a new mark spacing value is recorded.

Drive settings:

- ID 32800 = 3C0043H ⇒ Main operating mode for AW1: Digital speed control
- ID 32948 = 3H ⇒ Config.AZ message1: Pulse generator input AZ

3.8.4.1 Initializing the SF IMES

```
; DB for initializing the SF "IMES"
;
:KB 7       ;DR0  SF type              IMES
:KB 0       ;DL0  SF number            SF0
:KB 2       ;DR1  E/A-M mode           E byte on input
                                       A byte on flag
:KB 0       ;DL1  Reserved
:KB 16      ;DR2  Source adr. offset   AZ message 1
:KB 0       ;DL2  Source address       AZ
:KB 0       ;DR3  Sink address offset
:KB 255     ,DL3  Sink address         internal
:KB 0       ;DR4  E bit mask           Not used
:KB 0       ;DL4  E byte address       Not used
:KB 1       ;DR5  A bit mask           M x.0 = Trigger bit,
                                       M x.1 = Pulse valid bit
:KB 22      ;DL5  A byte address       MB x (x = 22
:KB 0       ;DR6  Tab0 DB No           Not used
:KB 0       ;DL6  Tab1 DB No           Not used
:KB 0       ;DR7  Tab2 DB No           Not used
:KB 0       ;DL7  Tab3 DB No           Not used
:KB 0       ;DR8  Tab4 DB No           Not used
:KB 0       ;DL8  Tab5 DB No           Not used
:KB 0       ;DR9  Tab6 DB No           Not used
:KB 0       ;DL9  Tab7 DB No           Not used
```

```
; DB for initializing the SF "REGL"
;
:KB 6       ;DR0  SF type                 REGL
:KB 1       ;DL0  SF number               SF1
:KB 1       ;DR1  E/A-M mode              E byte on flag
                                          A byte on output
:KB 0       ;DL1  Reserved
:KB 0       ;DR2  Source adr. offset      Internally by SF0
:KB 255     ;DL2  Source address          internal
:KB 16      ;DR3  Sink address offset     32-bit command value source
:KB 1       ;DL3  Sink address            AW1
:KB 1       ;DR4  E bit mask              M x.0. = ext. synchronization bit
:KB 22      ;DL4  E byte address          MB x (x = 22
:KB 0       ;DR5  A bit mask              Not used
:KB 0       ;DL5  A byte address          Not used
:KB 0       ;DR6  Tab0 DB No              Not used
:KB 0       ;DL6  Tab1 DB No              Not used
:KB 0       ;DR7  Tab2 DB No              Not used
:KB 0       ;DL7  Tab3 DB No              Not used
:KB 0       ;DR8  Tab4 DB No              Not used
:KB 0       ;DL8  Tab5 DB No              Not used
:KB 0       ;DR9  Tab6 DB No              Not used
:KB 0       ;DL9  Tab7 DB No              Not used
```

3.8.4.2 Commanding the SF IMES

```
; DB for commanding the SF "IMES"
;
:KB 0       ;DR0  SF number               SF0: IMES corresponds to SF-Init.
:KB 0       ;DL0  SFKMD fct               Reserved
:KB 1       ;DR1  SFKMD code              Start
:KB 8       ;DL1  SFKMD-BA                BA diff. measurement, do not set down,
            ;                             Negative limitation
:KF 0       ;DW2  Reserved
:KF 2       ;DW3  SF cycle time           1 ms
:KD 10000   ;DD4  Command spacing         10000 increments
:KF 2000    ;DD6  Permissible window      ±2000 increments
:KF 1000    ;DD8  Blocked range           1000 increments
:KD 0       ;DD10 Reserved
:KD 0       ;DD12 Reserved
:KD 0       ;DD14 Reserved
:KD 0       ;DD16 Reserved
:KD 0       ;DD18 Reserved
:KD 0       ;DD20 Reserved
:KD 0       ;DD22 Reserved
:KD 0       ;DD24 Reserved
:KD 0       ;DD28 Reserved
:KD 0       ;DD30 Reserved
:KD 0       ;DD32 Reserved
```

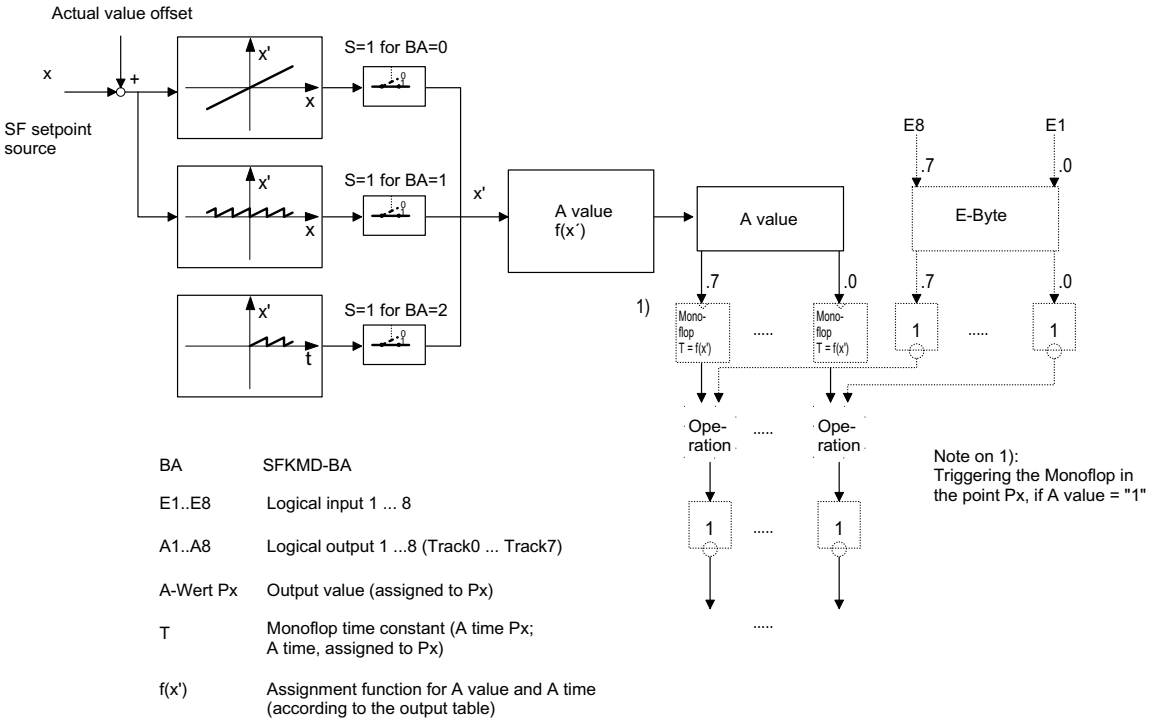
```
; DB for commanding the SF "REGL"
;
:KB 1           ;DR0  SF number                SF1: REGL corresponds to SF-Init.
:KB 0           ;DL0  SFKMD fct                PID controller
:KB 1           ;DR1  SFKMD code               Start
:KB 2           ;DL1  SFKMD-BA                 Input S1..S3 by means of DW4,
                ;                              with ext. sync,
                ;                              pos. output limit = DD10
                                               neg. output limit = DD10
:KF 0           ;DW2  Reserved
:KF 2           ;DW3  SF cycle time            1 ms
:KH 7           ;DW4  Switch bit mask          S1..S3 = 1
:KB 0           ;DR5  Filter type              No filtering
:KB 3           ;DL5  Input assessment
:KF 0           ;DW6  Kp                       0
:KF 256         ;DW7  Ki                       1
:KF 0           ;DW8  Kd                       0
:KF 0           ;DW9  Reserved
:KD 10000000;DD10  Output limit                1000 rpm
:KF 100         ;DW12 Output gain              v_y = 100
:KF 0           ;DW13 Reserved
:KD 1000000     ;DD14 Integration limit        i_max = 1000000
:KF 0           ;DW16 MW address source1       Command value source1 = DW18
:KF 24          ;DW17 MD address source2       Command value source2 = MD24
:KF 0           ;DW18 Command value source1    Command spacing 0
:KF 0           ;DW19 Reserved
:KD 0           ;DD20 Command value source2    not relevant (input through
                ;                              flag MD24)
:KD 0           ;DD22 Reserved
:KD 0           ;DD24 Reserved
:KD 0           ;DD26 Reserved
:KD 0           ;DD28 Reserved
:KD 0           ;DD30 Reserved
:KD 0           ;DD32 Reserved
```

3.9 "SF BINEA" Binary input/output

SF type = 8

The "SF BINEA" allows a configurable output of maximum 8 binary signals as function of a SF source (e.g. distance information) in the form of a cam controller; this means the signal status of the binary outputs can be determined by means of a table (a data block) e.g. depending upon position values. Moreover the possibility exists of the Boolean logic operation of these signals with in each case a binary input signal.

3.9.1 Principle of "SF BINEA"



BA	SFKMD-BA
E1..E8	Logical input 1 ... 8
A1..A8	Logical output 1 ...8 (Track0 ... Track7)
A-Wert Px	Output value (assigned to Px)
T	Monoflop time constant (A time Px; A time, assigned to Px)
f(x')	Assignment function for A value and A time (according to the output table)

Figure 28: Principle of "SF BINEA"

The SF BINEA comprises the structure shown in Figure 28. The formation regulation for generating the internal variable x' results through the SFKMD-BA as follows:

Operating modes:

- *"Absolute feedback value input" (BA = 0):* The SF source information is handled as 32-bit signed fixed point number (32-bit integer value).
- *"Incremental feedback value input" (BA = 1):* The SF source information is handled as 16-bit signed fixed point number (16-bit integer value). Internally the feedback value differences of two source informations consecutive in time are summed to form a positive 32-bit value (signed bit = 0). On exceeding a configurable modulo value (e.g. increments per revolution) the system starts anew at value 0 (modulo counting). Analogously on dropping below 0 counting is downwards from the modulo value. As from version AZ-PS4 V02.09 a dead time compensation can be selected on incremental feedback value input (cf. Section 3.9.2.2, SFKMD fct or dead time).
- *"Time mode" (BA = 2):* This operating mode works analogously to the "Incremental feedback value input", with the difference that the feedback value input is not derived from a SF source value, but from a parameterizable cycle time.

The dashed parts according to Figure 28 can be configured individually per track (binary output) by means of the SF commanding DB parameters "Mode track0 .. Mode track7" (cf. Section 3.9.2.2).

The SF commanding DB parameters MW address feedback value offset and feedback value offset facilitate for the operating modes 0 and 1 a shift of the SF source information by one additive component. Whereby it is possible to work either directly with a flag word, or else to produce an offset shift within the scope of VALUE NEW commanding (cf. Section 3.9.2.2 or Figure 28).

The following parameters can be changed while the SF BINEA is active with the SF commanding code "VALUE NEW" (cf. Section 3.9.2.2):

- Feedback value offset (if it is worked directly through a flag.)
- Dead time (if increment feedback value input "SFKMD-BA=1" and dead time compensation "SFKMD fct=1" is selected.)

3.9.2 AWL interface of the SF BINEA

3.9.2.1 Prerequisites and marginal conditions

The settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32809) are without significance for the SF BINEA, since no SF sink is used.

Time mode		
Source address	**Offset**	**Meaning / remarks**
0	0	Not required in the time mode
Absolute / incremental feedback value input		
Source address	**Offset**	**Meaning / remarks**
0	1,3,5,7	Config.-AZ message1, 2, 3, 4 (High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32)
1..8	3	Config.-AW message32 (Low Word) of AW1..8 / configurable by means of ID 32786; only position command or feedback value are expedient
1..8	5	32-bit position feedback value (Low Word) of AW1..8
1..8	19	Config.-AW message32 of AW1..8 / configurable by means of ID 32786; only position command or feedback value are expedient
1..8	21	32-bit position feedback value of AW1..8
128	0,2,4 ..126	Flag word range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag double word range of the PS / MD 0, .. ,124
130	0,2,4 ..30	Input word range of the PS process image / EW 0, .. ,30
131	0,4,8.. 28	Input double word range of the PS process image / ED 0, .. ,28
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2 .. 7 (for logic operation with the corresponding SF1, 2, .. 7)
Sink address	**Offset**	**Meaning**
0	0	not required

Table 36: Settings of the SF BINEA data holder interfaces (SF source/sink)

3.9.2.2 Structure and parameters of the SF commanding DB

Data double word	High word		Low word	
	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		Dead time	
04	MW address feedback value offset		Tracks	
06	Reserved = 0		Feedback value offset	
08	Mode track1		Mode track0	
10	Mode track3		Mode track2	
12	Mode track5		Mode track4	
14	Mode track7		Mode track6	
16	Reserved = 0		Dead time mean factor	
18	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 37: BINEA commanding DB

SF number (DR0)
- Meaning: SF call number under which a SF of the SF type 8 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
- Meaning: Selection of additional functions.
- Value range: bit-coded
  - Bit 0 = 1: Dead time compensation selected.

SFKMD code (DR 1)
- Meaning: Code of the SF command.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): Start SF
  5 (VALUE NEW): Transfer of new parameters to the active SF

SFKMD-BA (DL 1)
- Meaning: Selection of the operating mode.
- Value range: 0: Absolute feedback value input
  1: Incremental feedback value input
  2: Time mode

Dead time (DW 2)
- Meaning: Dead time, if SFKMD fct = 1 and SFKMD-BA = 1.
- Value range: 0 .. 32000
  0: No dead time compensation
  otherwise: Dead time
- Unit: 0.5 ms
- Example: Value = 100 $\Rightarrow$ Dead time = 50 ms

SF cycle time (DW 3)
- Meaning: Time Tsf in which the SF is called cyclically. (This time is determined by ID 2 = SERCOS cycle time.)
- Value range: 1 to +131
- Unit: 0.5 ms
- Example: Value = 2 $\Rightarrow$ SF cycle time Tsf = 1 ms

Tracks (DW 4)
- Meaning: Number of the tracks to be taken into account (binary inputs/outputs); commencing as from track0.
- Value range: 1 .. 8

MW address feedback value offset (DW 5)
- Meaning: Flag word address under which the feedback value offset is read.
- Value range: 0: The feedback value offset is determined by the SF commanding parameter feedback value offset (DW 6)
  2, 4, .., 126: The feedback value offset is determined by the value of the flag word 2, 4, .. 126.

Feedback value offset (DW 6)
- Meaning: Feedback value offset which is calculated additively to the SF source value, if MW address feedback value offset (DW 5) is = 0.
- Value range: -2^{15} .. 2^{15} -1
- Unit: Unit of the SF source (e.g. increments for position feedback values)

Mode track0 .. Mode track7 (DW 8 .. DW15)

- Meaning: Mode in which track0 .. track7 is operated.
- Value range: bit-coded
  - Bit 0 = 1: The output bit of the track is inverted
  - Bit 1 = 1: The input bit of the track is inverted
  - Bit 3/2 = 0/0: No logical operation with the input bit of the track
    = 0/1: AND operation with the input bit of the track
    = 1/0: OR operation with the input bit of the track
  - Bit 4 = 0: The bit information "0" or "1" of the output table determines the table-dependent component of the binary output.
    = 1: The bit information change "0"→"1" in the output table identifies the start edge from which the table-dependent component of the binary output is set = "1". The value drops back to "0" after the table-dependent time constant has passed.
  - Bit 5 = 1: The output bit of the track is switched off (is not updated)
- Example: Value = 0 ⇒ Pure cam controller:
  - No A bit inversion,
  - No E bit inversion,
  - No logic operation with the input bit of the track,
  - The bit information "0" or "1" of the output table determines the binary output,
  - The output bit of the track is output.

Dead time mean factor (DW 16)

- Meaning: Within the scope of dead time compensation an offset (lead) of the binary information depending upon the current velocity is performed. Mean value formation is performed over several velocity values to dampen the influence of velocity changes. The dead time mean factor determines the number of the SF cycles (velocity values) over which the mean value is formed.
- Value range: 0 .. 30000
  0: Default value (⇒ 20 SF cycles).
  1: No averaging.
  otherwise: Number of the SF cycles over which the mean value is formed.
- Unit: SF cycles

3.9.2.3 Structure of the output table

Data double word	High word	Low word	
00	Reserved = 0	Number of points+1	
02	Reserved = 0		
04	Point0		
06	A time P0	Reserved = 0	A-value P0
08	Point1		
10	A time P1	Reserved = 0	A-value P1
12			
252	Point62		
254	A time P62	Reserved = 0	A-value P62

Total number: max. 256 data words

Table 38: BINEA output tables DB

Number of points+1 (DW 0)
- Meaning: Number of the output points + 1.
- Value range: 1 .. 63
- Example: Value = 11 ⇒ Number of the output points = 10

Point0 .. point 62 (DD 4 .. DD 252)
- Meaning: Mode track<y>, Bit 4 =0: point<x> up to which the assigned A-value P<x> is output.
  Mode track<y>, Bit 4 =1: point<x> at which the monoflop according to Figure 28 is triggered if the assigned bit of the A-value P<x> changes from "0" to "1".
  With: x = 0..62, y = 0..7.
- Remarks: For SFKMD-BA = 1 the last table point determines the modulo limit.
  For SFKMD-BA = 2 the last table point determines the cycle time.
- Value range: SFKMD-BA = 0: -2^{31} .. 2^{31} -1
  SFKMD-BA = 1..2: 0 .. 2^{31} -1
- Unit: SFKMD-BA = 0..1: Unit of the SF source (e.g. increments for position feedback values)
  SFKMD-BA = 2: 0.5 ms
- Example: SFKMD-BA = 2: Value = 2000 ⇒ Time = 1000 ms

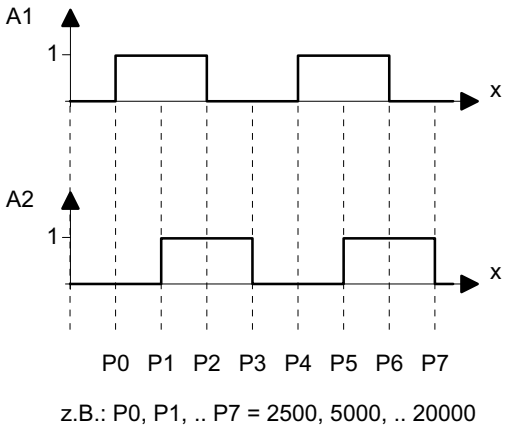
A-value P0 .. A-value P62 (DR 6 .. DR 254)
- Meaning: Binary value <x> which has to be output from the preceding point<x-1> up to the current point<x>.
- Value range: 0 .. 255 (00000000 .. 11111111)
- Example: Value = 00000011 ⇒ Track0..1 = 1; track2..7 = 0
  (in the range: P<x-1> ≤ X < P<x>)

A time P0 .. A time P62 (DW 7 .. DW 255)
- Meaning: Time for which the output is held = "1". (Only relevant in mode track<x>: Bit 4 =1 and if the A-value of the track<x> changes from "0" to "1".)
- Value range: 0 .. 2^{15} -1
- Unit: 0.5 ms
- Example: Value = 200 ⇒ Time = 100 ms

3.9.3 Example

The following signal profile has to be achieved regarding the binary output A1 and A2 depending upon the position feedback value AW2 (x) (A1 and A2 should be output on binary output A8.0 and A8.1 respectively):

Time-dependency diagram



z.B.: P0, P1, .. P7 = 2500, 5000, .. 20000

Output value assignment

x	A2	A1	
0 < x <= P0	0	0	A value P0
P0 < x <= P1	0	1	A value P1
P1 < x <= P2	1	1	A value P2
P2 < x <= P3	1	0	A value P3
P3 < x <= P4	0	0	A value P4
P4 < x <= P5	0	1	A value P5
P5 < x <= P6	1	1	A value P6
P6 < x <= P7	1	0	A value P7

A1	Binary output 1	P0 .. P7	Point 0 ... Point 7
A2	Binary output 2	x	SF source information (e.g. actual position in increments)

Figure 29: Signal profile A1 / A2

3.9.3.1 Initializing the SF BINEA

```
; DB for initializing the SF "BINEA"
;
:KB 8       ;DR0  SF type                  BINEA
:KB 0       ;DL0  SF number                SF0
:KB 0       ;DR1  E/A-M mode               E/A
:KB 0       ;DL1  Reserved
:KB 5       ;DR2  Source adr. offset       Position feedback value (Low Word)
:KB 2       ;DL2  Source address           AW2
:KB 0       ;DR3  Sink address offset      Not used
:KB 0       ;DL3  Sink address             Not used
:KB 0       ;DR4  E bit mask               Not used
:KB 0       ;DL4  E byte address           Not used
:KB 1       ;DR5  A bit mask               A x.0
:KB 8       ;DL5  A byte address           AB x (with x = 8
:KB 16      ;DR6  Tab0 DB No               Output table = DB 16
:KB 0       ;DL6  Tab1 DB No               Not used
:KB 0       ;DR7  Tab2 DB No               Not used
:KB 0       ;DL7  Tab3 DB No               Not used
:KB 0       ;DR8  Tab4 DB No               Not used
:KB 0       ;DL8  Tab5 DB No               Not used
:KB 0       ;DR9  Tab6 DB No               Not used
:KB 0       ;DL9  Tab7 DB No               Not used
```

3.9.3.2 Commanding the SF BINEA

```
; DB for commanding the SF "BINEA"
:KB 0       ;DR0  SF number                SF0: BINEA corresponds to SF-Init.
:KB 0       ;DL0  SFKMD fct                Not used
:KB 1       ;DR1  SFKMD code               Start
:KB 1       ;DL1  SFKMD-BA                 Incremental
:KF 0       ;DW2  Reserved
:KF 2       ;DW3  SF cycle time            1 ms
:KF 2       ;DW4  Tracks                   2 tracks (track0 ..1)
:KF 0       ;DW5  MW address feedback value offset   SFKMD parameter DW 8 valid
:KF 0       ;DW6  Feedback value offset    Feedback value offset = 0
:KF 0       ;DW7  Reserved
:KF 0       ;DW8  Mode track0              Cam mode without inversion
:KF 0       ;DW9  Mode track1              Cam mode without inversion
:KF 0       ;DW10 Mode track2              Cam mode without inversion
:KF 0       ;DW11 Mode track3              Cam mode without inversion
:KF 0       ;DW12 Mode track4              Cam mode without inversion
:KF 0       ;DW13 Mode track5              Cam mode without inversion
:KF 0       ;DW14 Mode track6              Cam mode without inversion
:KF 0       ;DW15 Mode track7              Cam mode without inversion
:KD 0       ;DD16 Reserved
:KD 0       ;DD18 Reserved
:KD 0       ;DD20 Reserved
:KD 0       ;DD22 Reserved
:KD 0       ;DD24 Reserved
:KD 0       ;DD26 Reserved
:KD 0       ;DD28 Reserved
:KD 0       ;DD30 Reserved
:KD 0       ;DD32 Reserved
```

3.9.3.3 Output table of the SF BINEA

```
; DB for die output table of the SF "BINEA"
;
:KF 9           ;DW0  Number of points+1        8 points
:KF 0           ;DW1  Reserved
:KD 0           ;DD2  Reserved
:KD 2500        ;DD4  Point P0                  Point0 for 2500 increments
:KM 0000000000000000
                ;DW6  A-value P0                Binary output 0.. P0
:KF 0           ;DW7  A time P0                 "1" time (not relevant)
:KD 5000        ;DD4  Point P1                  Point1 for 5000 increments
:KM 0000000000000001
                ;DW6  A-value P1                Binary output P0 .. P1
:KF 0           ;DW7  A time P1                 "1" time (not relevant)
:KD 7500        ;DD4  Point P2                  Point2 for 7500 increments
:KM 0000000000000011
                ;DW6  A-value P2                Binary output P1.. P2
:KF 0           ;DW7  A time P2                 "1" time (not relevant)
:KD 10000       ;DD4  Point P3                  Point3 for 10000 increments
:KM 0000000000000010
                ;DW6  A-value P3                Binary output P2 .. P3
:KF 0           ;DW7  A time P3                 "1" time (not relevant)
:KD 12500       ;DD4  Point P4                  Point4 for 12500 increments
:KM 0000000000000000
                ;DW6  A-value P4                Binary output P3 .. P4
:KF 0           ;DW7  A time P4                 "1" time (not relevant)
:KD 15000       ;DD4  Point P5                  Point5 for 15000 increments
:KM 0000000000000001
                ;DW6  A-value P5                Binary output P4 .. P5
:KF 0           ;DW7  A time P5                 "1" time (not relevant)
:KD 17500       ;DD4  Point P6                  Point6 for 17500 increments
:KM 0000000000000011
                ;DW6  A-value P6                Binary output P5 .. P6
:KF 0           ;DW7  A time P6                 "1" time (not relevant)
:KD 20000       ;DD4  Point P7                  Point7 for 20000 increments
:KM 0000000000000010
                ;DW6  A-value P7                Binary output P6 .. P7
:KF 0           ;DW7  A time P7                 "1" time (not relevant)
```

3.10 "SF XFIPW" Extended function interpolator for distance and time function (only for AZ-PS4 module)

SF type = 9

With this "Fast function" drive command positions are generated both depending on the (master) position and on the time.

3.10.1 Principle of the function interpolator

The function interpolator assigns an output value, which e.g. corresponds to a command position, to an input variable by reference to a table containing interpolation points of the function. The input variable can be in principle any internal or external variable, e.g. a master position or the time t. The "Extended function interpolator XFIPW" can process two types of tables:

- Y tables,
- XY tables.

The table interpolation points are filed in a data block, whereby the 1st table value states the number of the interpolation points + 1. Limited by the maximum permissible size of a data block, 2000 interpolation points (for Y tables) or 1000 interpolation point pairs (for XY tables) are possible. The table values are 32-bit values. There is linear interpolation between the interpolation points.

Caution:
- The absolute amount of the value difference between 2 consecutive table values must be less than 32768!
- Values of the active table set of a started SF may not be changed!
- The data blocks (DB) assigned to the SF by the SF initialization (FB 207) may not be deleted (or newly generated)!

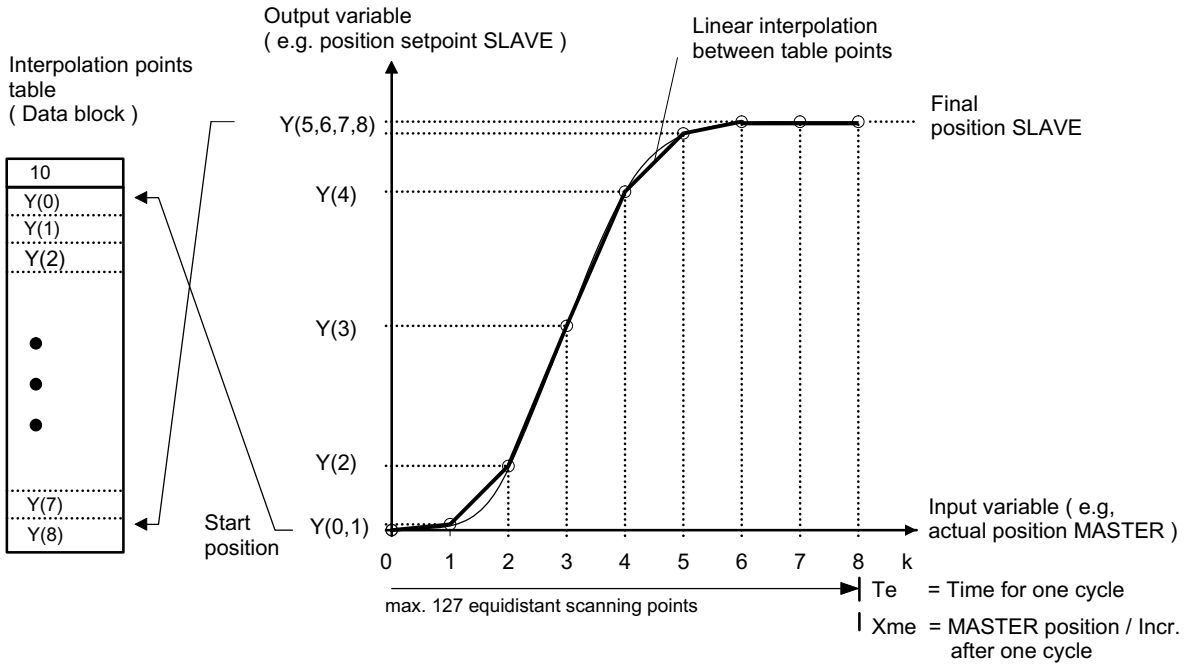


Figure 30: Principle of the function interpolator with Y table

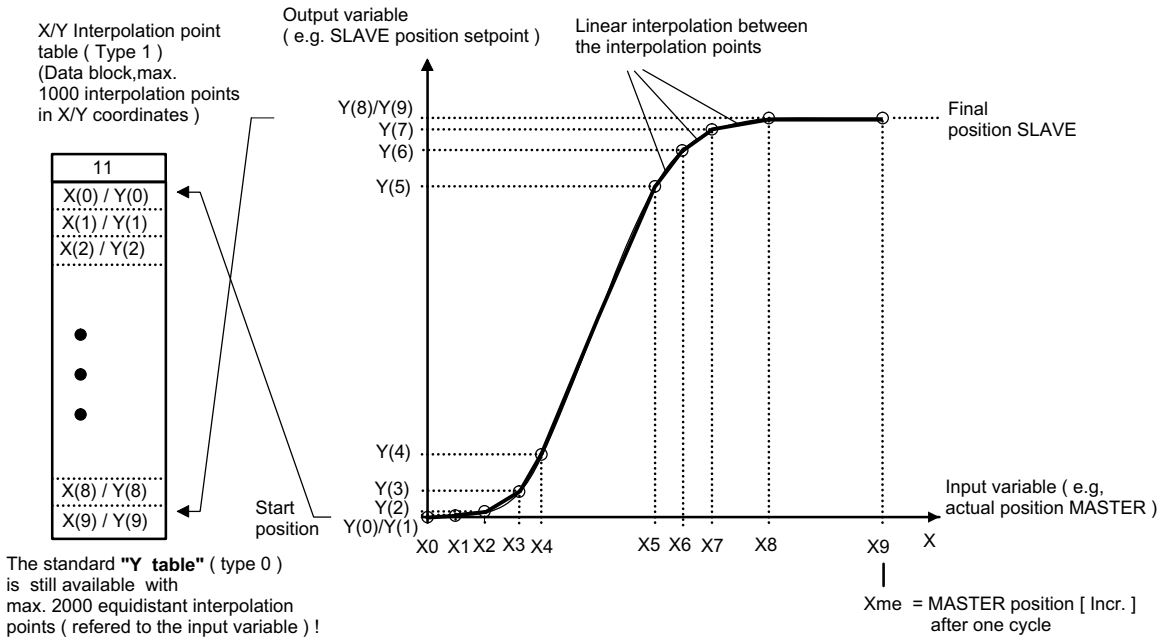


Figure 31: Principle of the function interpolator with XY table

Remarks: With regard to the cycle time a distinction must be made between:
- The cycle time Te (it determines the duration of a movement cycle in the time mode) and
- The SF cycle time Tsf (it determines the time grid in which the SF is called cyclically; i.e. the time grid in which e.g. command positions are output).

The output variable of the function interpolator can be multiplied with a factor K (multiplication factor) and divided with a factor n (division exponent) to the base of 2:

Output variable Y = [interpolated table value] • $K / 2^n$

It must be observed: |Output variable Y| < $2^{31}-1$

Remarks: The computing time is reduced with K=1 and n=0, i.e. $K / 2^n = 1$!

3.10.2 Structure of the Y and XY tables

The function interpolator type 9 can process two table forms, Y tables and XY tables. The distinction between the two table forms is made in the DW1 of the table DB (cf. Section 3.10.6.2). The Y tables have the same structure as in the function interpolator type 1.

In a Y table (table DB: DW1 = 0) the input end value is stated in the commanding DB in DD10 (increments per revolution / cycle time; cf. Section 3.10.6.3). This input range can be divided with a maximum of 2000 equidistant interpolation points into a maximum of 1999 equidistant intervals. An assigned Y interval end value (interpolation point) is entered in the DB for each interval. There is linear interpolation between the preceding Y interval end value and the current Y interval end value in the intervals. The "Y interval end value = 0" has to be assigned to the first interpolation point.
The table DB for 20000 increments slave movement per one revolution of the master with a division over 8 equidistant master intervals (9 interpolation points) can for example look as follows:

Data	High word	Low word

double word		
00	Table form = 0 (Y table)	Interpolation number+1 = 10
02	1st interpolation point Y value = 0	
04	2nd interpolation point Y value = 1000	
06	3rd interpolation point Y value = 1500	
08	4th interpolation point Y value = 2000	
10	5th interpolation point Y value = 4000	
12	6th interpolation point Y value = 8000	
14	7th interpolation point Y value = 12000	
16	8th interpolation point Y value = 15000	
18	9th interpolation point Y value = 20000	

An XY table (table DB: DW1 = 1; cf. Section 3.10.6.2) assigns an X and a Y value to every interpolation point. The value "Increments per revolution / cycle time" results from the last X value of the table.

The above Y table would have the following appearance as XY table for a master resolution of 20000 increments (increments per revolution / cycle time = 20000):

Data double word	High word	Low word
00	Table form = 1 (XY table)	Interpolation number+1 = 10
02	1st interpolation point X value = 0	
04	1st interpolation point Y value = 0	
06	2nd interpolation point X value = 2500	
08	2nd interpolation point Y value = 1000	
10	3rd interpolation point X value = 5000	
12	3rd interpolation point Y value = 1500	
14	4th interpolation point X value = 7500	
16	4th interpolation point Y value = 2000	
18	5th interpolation point X value = 10000	
20	5th interpolation point Y value = 4000	
22	6th interpolation point X value = 12500	
24	6th interpolation point Y value = 8000	
26	7th interpolation point X value = 15000	
28	7th interpolation point Y value = 12000	
30	8th interpolation point X value = 17500	
32	8th interpolation point Y value = 15000	
34	9th interpolation point X value = 20000	
36	9th interpolation point Y value = 20000	

The advantage of XY tables compared with Y tables is that one can arrange many interpolation points at the places at which the slave velocity changes quickly and no interpolation points must be arranged at places at which the slave velocity is constant (cf. Figure 31: Principle of the function interpolator with XY table).

If several tables are processed by the function interpolator, Y tables and XY tables can be mixed. The value "Increments per revolution / cycle time" must be then be the same for all Y tables.

3.10.3 Operating modes

Essentially a distinction is made between two operating modes of the SF XFIPW (see following sections):

- The table-supported movement input as function of time (time mode).
- The table-supported movement input as function of the position of a further movement unit (distance mode).

3.10.3.1 Time mode application

Fast movement to positions and fast cycle drives with variable end position and freely definable movement profile are supported by fast functions of the SF type 9. The input variable of time for the function interpolator is generated internally. The output variable can be forwarded as position command value, e.g. to one of the 8 drives.

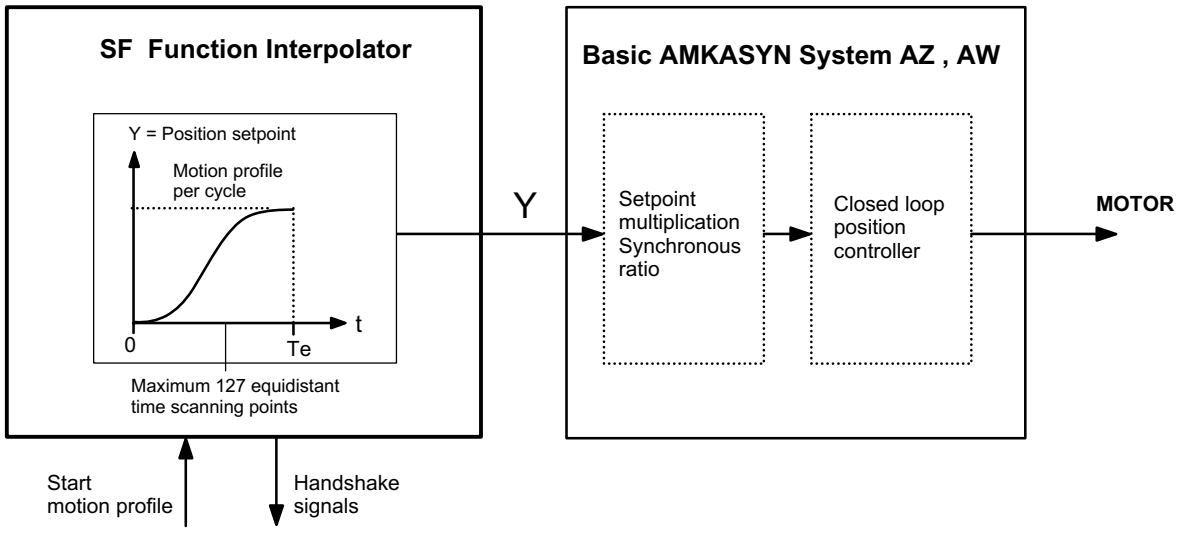


Figure 32: Principle of the function interpolator in the time mode

Depending upon the SF type and possibly upon the SFKMD-BA, the function is repeated cyclically or else performed once after a start signal (see following sections and figures).

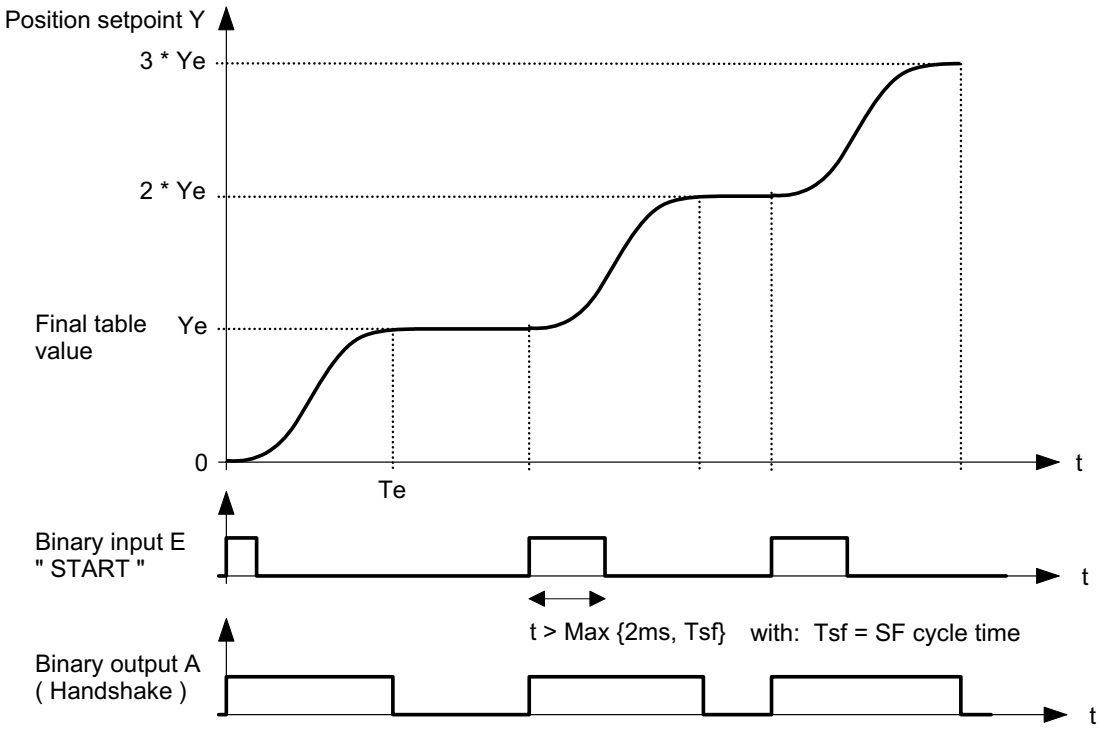


Figure 33: Time function in the cycle mode

The movement time Te is determined in the case of Y tables by the cycle time (commanding DB: DD10; cf. Section 3.10.6.3); in the case of XY tables the movement time Te (cycle time) is determined by the last X-value of the table.

Remarks: The time grid of the command position input (SF cycle time) is determined by the value of ID 2 (SERCOS cycle time). At ID 2 = 1 a 1ms grid results for instance.

The function end value Ye is determined by the table end value (Y end value) and the division and multiplication factor. A further exact multiplication of the output values Y with the synchronous ratio can also take place in the drive basic system (cf. documentation: Parameters; ID 32893, ID 32893).

Operating modes (cf. Section 3.10.6.3; SFKMD-BA):

- "Cyclic table processing" (BA = 4, 5): From the start of the SF by means of FB 208, the table 0 is processed depending upon time. Processing can be interrupted only by resetting the SF by means of FB 208.
- "Start immediately with auto stop" (BA = 132, 133): Controlled through a binary input (logical transition from 0 to 1, Table 0 is processed by this depending upon time. Processing takes place immediately after detection of the positive input edge and begins with every positive edge at t = 0. Processing ends automatically on output of the last Y value (at t = Te).
- "Clocking in/out with auto stop" (BA = 84, 85): Controlled through a binary input (logical transition from 0 to 1), in this case **m** (total number of tables) tables, which are switched over to one after the other, in each case after the time Te, are processed by this depending upon the time. The drive is then stopped ("clocked out"). The function interpolator remains in this condition until the binary input again has a flank change (logical transition from 0 to 1) ("clocking in").

Remarks: The time t = 0 is determined by means of FB 208 at the start of the SF. The time t also runs on during the "clocked out" state. On "clocking in" the time is not reset. Clocking in occurs only within a start window that can be defined around the 0-point (Modulo Te). (In XY tables the clock time "Te" of the first table is relevant.)

– "Clocking in/out" (BA = 100, 101): Controlled through a binary input (logical transition from 0 to 1), the program starts with **q** start table(s) which are switched over to one after the other in each case after the time Te. Then the working table q+1 is switched over to. With the transition of the binary input to the logical value 0, the drive is stopped ("clocked out") through **r** table(s) (with r = m - q - 1; **m** = total number of tables). The function interpolator remains in this condition until the binary input is logic 1 again ("clocking in").

Remarks: The time t = 0 is determined by means of FB 208 at the start of the SF. The time t also runs on during the "clocked out" state. On "clocking in" the time is not reset. Clocking in or clocking out occurs only within a start window that can be defined around the 0-point (Modulo Te). (In XY tables the clock time "Te" of the first table is relevant regarding clocking in and the clock time "Te" of the working table regarding clocking out.)

Note:
The operating modes 5, 85, 101, 133 correspond to the operating modes 4, 84, 100, 132, with the additional possibility of a table set switch-over (cf. Section 0).

3.10.3.2 Distance mode application

The fast function of the SF type 9 supports a quickly controllable coupling of drives defined by table values. The minimum reaction time of the SF is approx. 2 ms.

The input variable for the function interpolator is a master position encoder, e.g. EDG or the internal position feedback value of another drive. The output variable is forwarded as command position, e.g. to a drive.

Remarks: The time grid of the command position input (SF cycle time) is determined by the value of ID 2 (SERCOS cycle time). At ID 2 = 1 a 1ms grid results for instance.

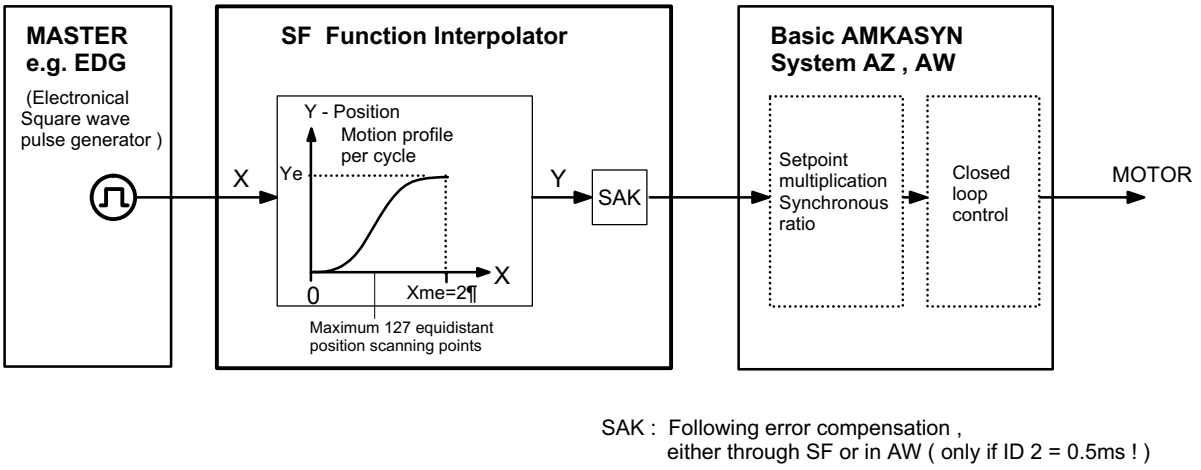


Figure 34: Principle of the function interpolator in the distance mode

The input variable X is treated as absolute variable. The modulo function for table processing is formed with the numerical value for Xme (= 2π = input increments of the master per cycle).

After 2π a start is made again with the table value "0" and the function is continued relatively. The master period Xme is determined in the case of Y tables by the "Increments per revolution" (commanding DB: DD10; cf. Section 3.10.6.3); in the case of XY tables the master period Xme is determined by the last X value of the table. The command values Y are multiplied with the synchronous ratio in the drive.

Operating modes (cf. Section 3.10.6.3; SFKMD-BA):

- "Cyclic table processing" (BA = 2, 3): From the start of the SF by means of FB 208 the table 0 is processed depending upon the master position X. Processing can be interrupted only by resetting the SF by means of FB 208.
- "Start immediately with auto stop" (BA = 26, 27): Controlled through a binary input (logical transition from 0 to 1), the Table 0 is processed depending upon the master position X. Processing takes place immediately after detection of the positive input edge and begins with every positive edge at X = 0. Processing ends automatically on output of the last Y value (at X = Xme).

  Remarks: The master position X = 0 is not determined at the start of the SF by means of FB 208, but with the positive edge of the binary input.

- "Clocking in/out with auto stop" (BA = 82, 83): Controlled through a binary input (logical transition from 0 to 1), in this case **m** (total number of tables) tables which are switched over to one after the other, are processed. The drive is then stopped ("clocked out"). The function interpolator remains in this condition until the binary input again has a flank change (logical transition from 0 to 1) ("clocking in").

  Remarks: The master position X = 0 is determined by means of FB 208 at the start of the SF. The master position X is also acquired during the "clocked out" state. On "clocking in", the master position is not reset. Clocking in is only within a start window that can be defined about the 0-point (Modulo Xme). (In XY tables the master period "Xme" of the first table is relevant.)

- "Clocking in/out" (BA = 98, 99): Controlled through a binary input (logical transition from 0 to 1), the program starts with **q** start table(s) which are switched over to one after the other in each case after 2π. The working table q+1 is then switched over to. With the transition of the binary input to the logical value 0, the drive is stopped ("clocked out") through **r** table(s) (with r = m - q - 1; **m** = total number of tables). The function interpolator remains in this condition until the binary input is logic 1 again ("clocking in").

  Remarks: The master position X = 0 is determined by means of FB 208 at the start of the SF. The master position X is also acquired during the "clocked out" state. On "clocking in", the master position is not reset. Clocking in or clocking out is only within a start window that can be defined about the 0-point (Modulo Xme). (In XY tables the master period "Xme" of the first table is relevant regarding clocking in and the master period "Xme" of the working table regarding clocking out.)

Note:
The operating modes 3, 27, 83, 99 correspond to the operating modes 2, 26, 82, 98 with the additional possibility of a table set switch-over (cf. Section 0).

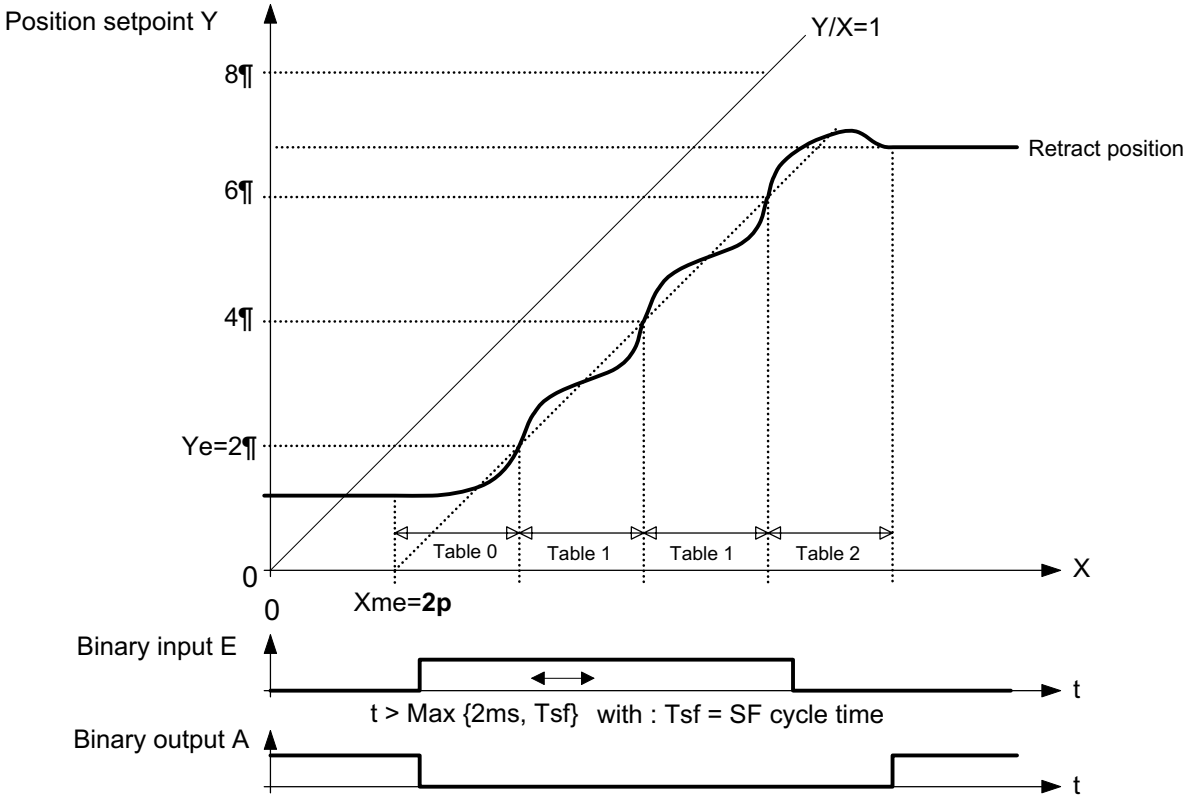


Figure 35: Distance function in the clock-in/clock-out mode

3.10.4 Optional function extensions

A distinction can be made between the following function extensions depending upon the SF commanding operating mode and the SF commanding function (see following sections):

- Table set switch-over
- Synchronization on an external master
- Printing mark control
- Setting onto the master position
- Retriggering after start (coupling)

3.10.4.1 Table set switch-over (from version AZ-PS4 V02.08)

Table set switch-over facilitates the fast changing of table sets by means of binary inputs/outputs.

Table set:

A table set consists of several tables which can be switched over together. The length of a table set (the number of simultaneously switchable tables) is determined by the total number of tables stated at SF commanding (cf. Section 3.10.6.3, DW 4). The number of the switchable table sets results from the number of the table DB numbers specified consecutively from DR 6 at SF initialization within the scope of the FB 207 call (cf. documentation: AMK-specific function blocks; FB 207) divided by the total number of tables.

Remarks: The tables specified at SF initialization must be a multiple of the total number of tables.

Example1: A table set consists e.g. only of one table (table set length = total number of tables = 1). ⇒ With a maximum of 8 tables that can be specified in the scope of SF initialization, it is possible to switch between a maximum of 8 table sets during the running time.

Example2: A table set consists of a coupling, a working and a decoupling table (table set length = total number of tables = 3). ⇒ With a maximum of 8 tables that can be specified in the scope of SF initialization, it is possible to switch over between a maximum of 2 table sets during the running time.

Selection of the table set switch-over:
The table set switch-over is selected within the scope of the operating mode of the XFIPW; by increasing the previous operating mode number by the value 1 (cf. Section 3.10.6.3; DL 1).

Caution: The binary EA signals described below are also activated on selection of the table set switch-over.

Table set switch-over:

The table set switch-over is controlled by means of 2 to 4 binary inputs (E_{SUEn}, E_{SU0}, E_{SU1}, E_{SU2}) and one binary output (A_{SU}).

With:
- E_{SUEn} = Enable table set switch-over
- E_{SU0} = Table set selection Bit0
- E_{SU1} = Table set selection Bit1
- E_{SU2} = Table set selection Bit2

- A_{SUK} = Table set switch-over control

Only as many table set selection bits are evaluated as are required for distinguishing between the table sets. The table set selection bits (0..2) are evaluated only if E_{SUEn} = 1. The change to a selected table set takes place:

- a) At the start of the movement, either because of the SF commanding (e.g. at BA 3, 5) or because of an active start bit (e.g. E_{St} = 1 at BA 99; with E_{St} = start input).
- b) At a zero passage within the scope of processing the working table (SFKMD fct, Bit 5 = 0; cf. Section 3.10.6.3) or after each table run-through (SFKMD fct, Bit 5 = 1; cf. Section 3.10.6.3).

The binary output A_{SUK} enables the table set switch-over process to be controlled:
E_{SUEn} = 1 and set switch-over performed: A_{SU} = 1
E_{SUEn} = 0: A_{SU} = 0

E/A bit determination:
If BA without start bit (e.g. BA = 3)
E1: E_{SUEn}
E2: E_{SU0}
E3: E_{SU1} ; if more than 2 table sets can be selected
E4: E_{SU2} ; if more than 4 table sets can be selected
A1: A_{SUK}

If BA with start bit (e.g. BA = 99)
E1: E_{St} ; start bit
E2: E_{SUEn}
E3: E_{SU0}
E4: E_{SU1} ; if more than 2 table sets can be selected
E5: E_{SU2} ; if more than 4 table sets can be selected
A1: A_{Akt} ; XFIPW-active
A2: A_{SUK}

3.10.4.2 Synchronization onto an external master drive

In most operating modes (see above) the master position X = 0 is determined at the start of the SF by means of FB 208, i.e. at the start command the value "0" is assigned to the current master position of the XFIPW-internal input variable X. If the master drive is an AMKASYN drive, "X = 0" can be assigned selectively to a master position (e.g. by a preceding homing cycle).
However, if the master drive is an external drive which cannot be exactly homed (positioned), and should the input variable X be assigned at the "Start" command nevertheless selectively to a position of the external drive, then at the start by means of FB 208 the synchronization onto an external master can be selected (cf. Section 3.10.6.3; SFKMD fct). In this way after the start the assignment input variable X = 0 is performed only at the next zero pulse of the master drive. In this case the master zero position is assigned to the input variable X = 0.

Remarks: The master offset angle is also processed with selected synchronization; i.e. if this offset angle is not equal to zero, then the input variable X is set at the start command after synchronization to the offset angle (X = master offset angle).

The command "Start with synchronization on external master" must run as follows:
- Command values and zero pulse are conducted through the AZ pulse generator input or an optional pulse generator input card.
- Homing the slave drive on the position required at master zero pulse.
- Master drive turns at slow speed through the zero position.
- Start of the SF by means of FB 208 with selected synchronization on an external master drive.

3.10.4.3 The printing mark control (from version AZ-PS4 V02.12)

The printing mark control is possible exclusively in the distance-distance operating modes without table change (SFKMD-BA = 2, 26, 82, 98; cf. Section 3.10.3.2).

The printing mark control is a special function within the scope of XFIPW functionality (cf. Section 3.10.3.2: SFKMD fct, Bit0). It facilitates the correction of the travel of a drive controlled by the XFIPW, depending upon a mark signal (binary input signal). It is effective only the area of the working table (cf. Section 3.10.3.2).

Caution: With the selection of the printing mark control a binary output signal is also activated to display a valid mark signal (A_{Dmr}). "A_{Dmr} = 1", if a valid mark is detected; otherwise "A_{Dmr} = 0". The output signal "A_{Dmr}" is output in each case at

the end of the working table and thus remains valid for at least one table run-through.
At SFKMD-BA = 2 it applies that:
A1 = A_{Dmr}; printing mark within the valid range.
At SFKMD-BA = 26, 82, 98 it applies that:
A1 = A_{Akt} ; XFIPW-Active,
A2 = A_{Dmr}; printing mark within the valid range.

Figure 13 shows two possible versions (A or B) with printing mark control, in which the two drives and an EDG, or three drives participate:
- the master drive (main drive or EDG = electronic rotary transducer),
- a synchronous drive without correction (e.g. cutter drive) and
- a synchronous drive with correction by the printing mark control (e.g. transport drive).

The cutter drive is operated either in synchronous control to the main drive or actuated by the SF XFIPW in a distance operating mode, whereby the main drive (or the EDG) is master.

In version A) the transport drive is controlled by the same reference input variable as the cutter drive.
In version B) the transport drive is controlled by the position feedback value of the cutter drive.

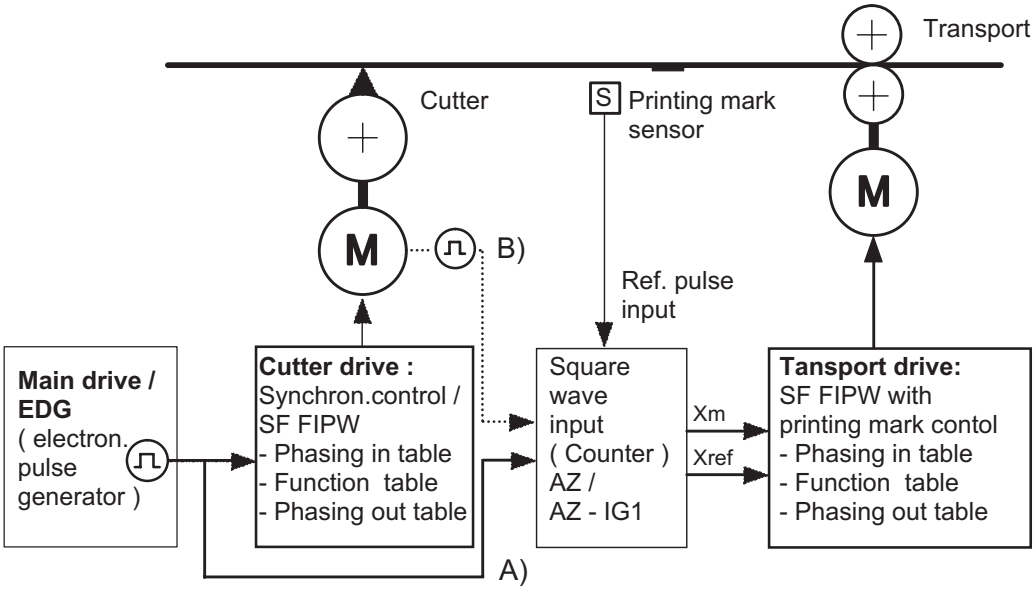


Figure 36: Possible drive arrangement for printing mark control

In printing mark control according to Figure 13 the feed of a transport drive is corrected with the aid of a printing mark located on the feed material. In such a way that the material is cut at a point defined by the printing mark (synchronous point; cf. Figure 38 or Figure 39)

Figure 29 even in the case of a deviation from the material length planned by the table end value (format length).

The cutter is referenced to the cutting position after switching on. The mark material is also brought into a defined starting position (e.g. withdrawal position) with the aid of the homing cycle. The SF is then started, whereby the zero point of the distance-distance assignment table results.

On clocking in the mark material is transported through the coupling table in the first cycle up to the cutting position (the output start angle in the coupling table must correspond to the withdrawal position or the complementary value to the format length; cf. documentation

"AMK-specific function blocks, FB 210 table value calculation, coupling table"). The transport conveyor is then controlled through the working table.

The printing mark control works only while the working table is active. Deviations of the printing mark distances from the format length determined by the working table are compensated for.

In the case of the drive working with printing mark control the following must be considered:

- The drive (e.g. transport drive according to Figure 13) is actuated through the SF XFIPW in the distance operating mode "Cyclic table processing" (SFKMD-BA = 2) or "clocking in/out"(SFKMD-BA = 98) with integrated printing mark control (SFKMD fct, Bit0 = 1) (cf. Section 3.10.6.3).
- The master axis of the transport drive is either a main drive Figure 13, A) or the cutter drive (Figure 13, B).
- Command values and printing mark signal are controlled through the AZ counter input or an optional counter module.
- The printing mark is detected by a sensor and applied to the reference pulse input of the counter.
- The distance increments of the master axis of the transport drive (either cutter drive or main drive) are also applied to the counter.
- The pulses of the printing mark are expected in a defined grid for the master distance; i.e. the pulse is expected at every revolution of the master axis at a certain master position (defined angle).
- In the case of deviations of the pulse from the defined angle, the output value of the SF XFIPW is changed by addition of a correction value and thus the control of the transport conveyor is corrected (cf. Figure 38; Principle of printing mark control).

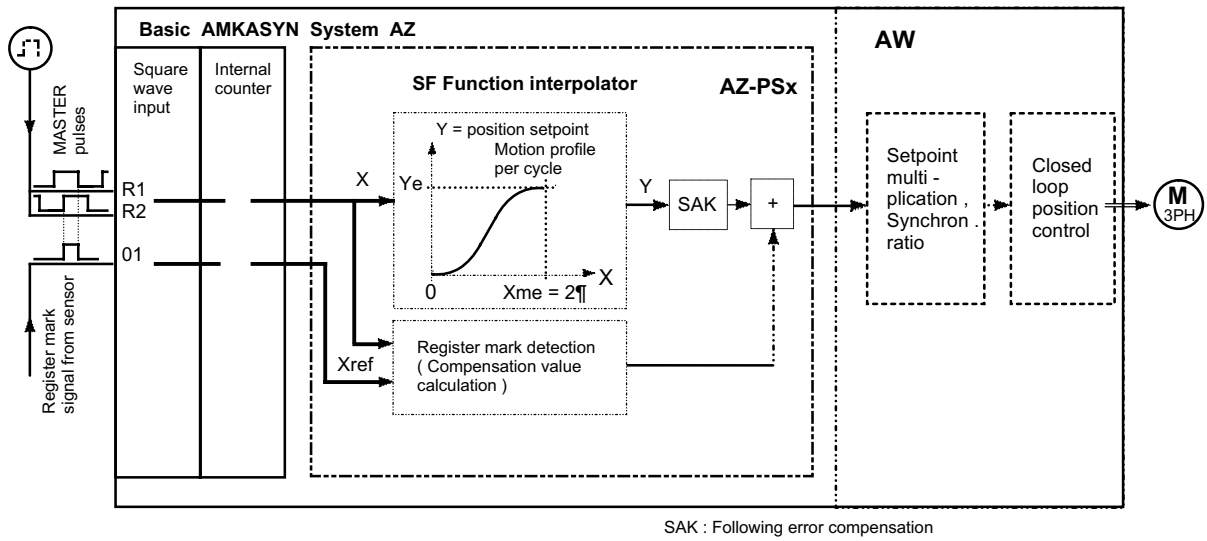
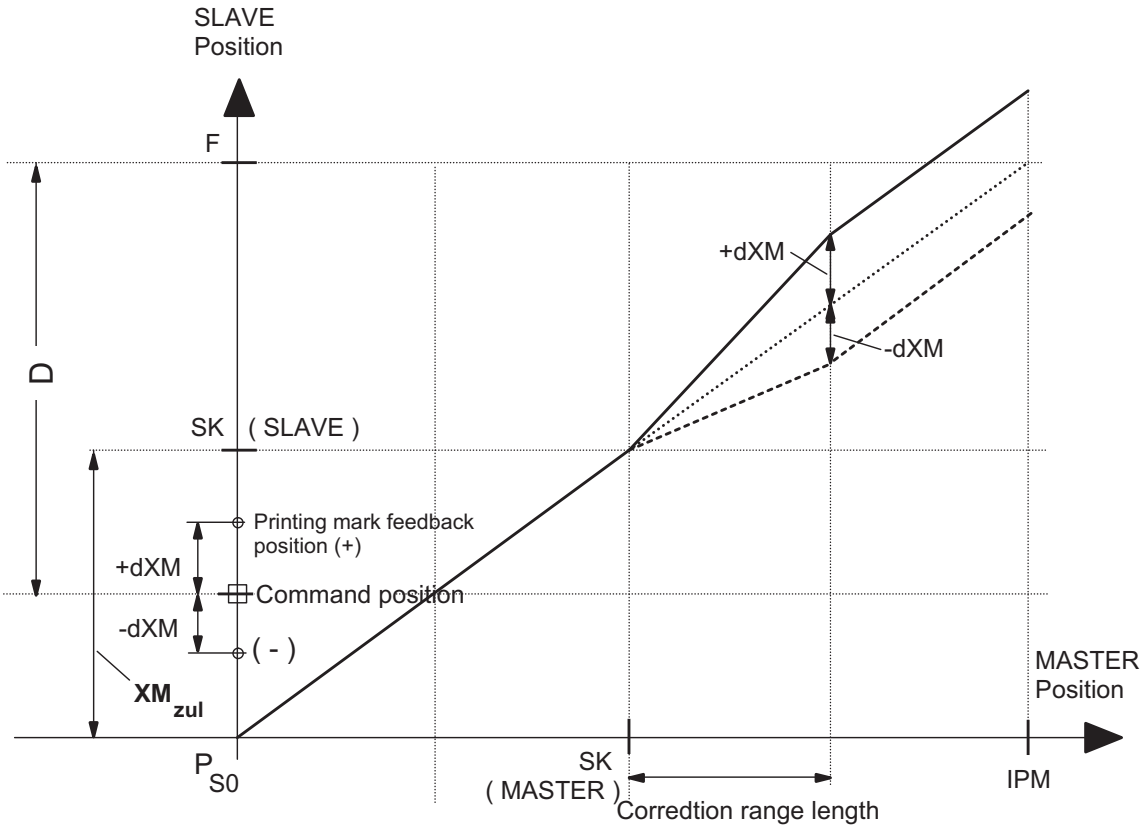


Figure 37: Block diagram of the printing mark control

Caution: It must be possible to represent the "Master pulses per master revolution" detected by the XFIPW as integer value (e.g. 20000 increments / revolution)!
The printing mark position must be changed in relation to the master position (cutter position) by correction movement of the slave axis (transport).



D Printing mark sensor + sinchronous point shift distance
F Format length (corresponds to the end value of the working table)
PSO Synchronous points (COMMAND intersection, corresponds to the zero point of the working table)
IPM Increments per MASTER revolution (cycle)
SK Correction range start angle
dXM Printing mark deviation
XM_{perm} Permitted range for printing mark deviation

Figure 38: Principle of printing mark control

Initializing and commanding the SF XFIPW with printing mark control

Printing mark control is implemented as part function of the SF XFIPW. On initialization of the SF with printing mark control the following points must be observed:

- On initialization of the SF XFIPW (FB 207) the AZ (source address = 0) must be selected as source address and one of the AZ messages 1 to 4 (source address offset = 16, 18, 20 or 22) must be selected as source address offset.
- The AMKASYN parameter ID 32948 must be initialized on the corresponding counter input according to the above selected AZ message (1 .. 4) (cf. documentation: Parameters).
- At the "Start" commanding of the SF XFIPW (FB 208) the printing mark control must be selected (SFKMF-Fkt, Bit0 = 1) and a suitable distance operating mode must be specified (e.g.: SFKMD-BA = 2 or 98).
- In addition to the standard XFIPW parameters the printing mark control parameters "Format length and printing mark sensor distance" must be created.

- The following printing mark control parameters are supported optionally: synchronous point shift, valid range, start angle correction range, length correction range, MD address correction value, correction weighting, correction counter.

Remarks: Should the function interpolator be operated simultaneously with external synchronization and mark control, the command values must be fed on 2 pulse generator inputs (cf. Section 3.10.4.2). The printing mark signal is fed in as reference pulse on the first input (SF source which is defined on initialization of the SF XFIPW by means of FB 207). The master zero pulse is fed on the second pulse generator input (SF source which is defined on initializing the SF COPY by means of FB 207). This second input must be copied to a flag double word with the aid of the "SF COPY" (SF sink which is defined by means of FB 207 on initializing the SF COPY). This flag double word address is transferred to the function interpolator at the SF commanding "Start" (cf. Section 3.10.6.3; MD-Adr. Sync. ext. Master).

On SF initialization by means of FB 207 the SF number of the "SF COPY" must be selected smaller than the SF number of the "SF XFIPW".

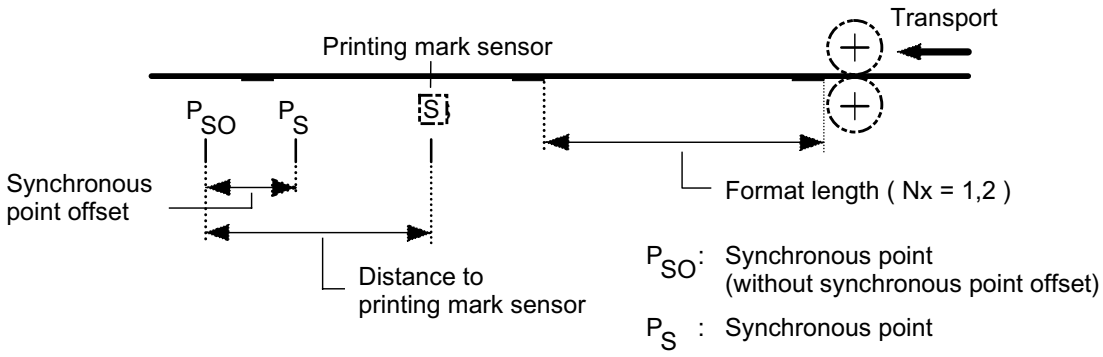


Figure 39: Printing mark control parameters

Before the SF commanding "Start" the participating drives according to Figure 13 must be brought into a defined starting position. Here it is possible to proceed as follows:

- Homing the cutter drive to the position which is wanted at the time of the zero passage of the table of the transport drive. (At master offset angle = 0", this position corresponds to the cutting position.)
- Homing the transport drive in relation to the mark, e.g. in that the sensor signal is switched to the reference cam input.
  If the "printing mark sensor distance" is known, then this is used as reference offset value (ID 150) in the course of homing. (If work is done with "coupling tables", then for determining the reference offset value the travel in the course of "coupling" must be subtracted from the "printing mark sensor distance".)

  Remarks:
  If the "printing mark sensor distance" is not input as system variable, then it can be determined on commissioning by homing the slave axis (transport drive) in relation to the mark and subsequent further movement of the transport drive. In this case the mark must be moved into the position wanted for the zero passage of the table (cutting position). The travel length corresponds to the "printing mark sensor distance".

3.10.4.4 Setting on the master position

"Setting on the master position" is a special function within the scope of the XFIPW functionality (cf. Section 3.10.3.2: SFKMD fct, Bit3 =1). It facilitates the start of table processing at an arbitrary master position. The master position is input as master offset angle within the scope of start commanding. On start commanding "Setting onto the master position" the slave axis is not moved. It is rather assumed that the slave axis is already located at the position assigned by the table (cf. Section 3.10.5.1).

Remarks: This position can be determined e.g. with the commanding function "Read value" (cf. Section 3.10.5.3; or Section 3.10.6.3, SFKMD code = 6).

3.10.4.5 Retriggering after movement start

With the exception of the cycle table processing in the operating modes 2..5, the movement start is always started by means of a binary input signal E (E1) (cf. Section 3.10.3.1 or 3.10.3.2).

It is possible to select by means of SFKMD fct, Bit4 whether "Retriggering after movement start" should take place or nor (cf. Section 3.10.3.2). The following situation results corresponding to Figure 40:

- SFKMD fct, Bit4 = 0: No "Retriggering after movement start" possible. This means:

After acknowledgement of the movement start by the output signal A1 (A1 = 0), a renewed start edge is accepted again at E1 (E1: 0→1) only after the current movement has come to an end (A1 = 1).

- SFKMD fct, Bit4 = 1: "Retriggering after movement start" possible. This means:

After acknowledgement of the movement start by the output signal A1 (A1 = 0), a renewed start edge at E1 (E1: 0→1) remains stored. A renewed movement start is arranged for immediately with the end of the current movement and "E1 = 1". ("A1 = 0" is retained.)

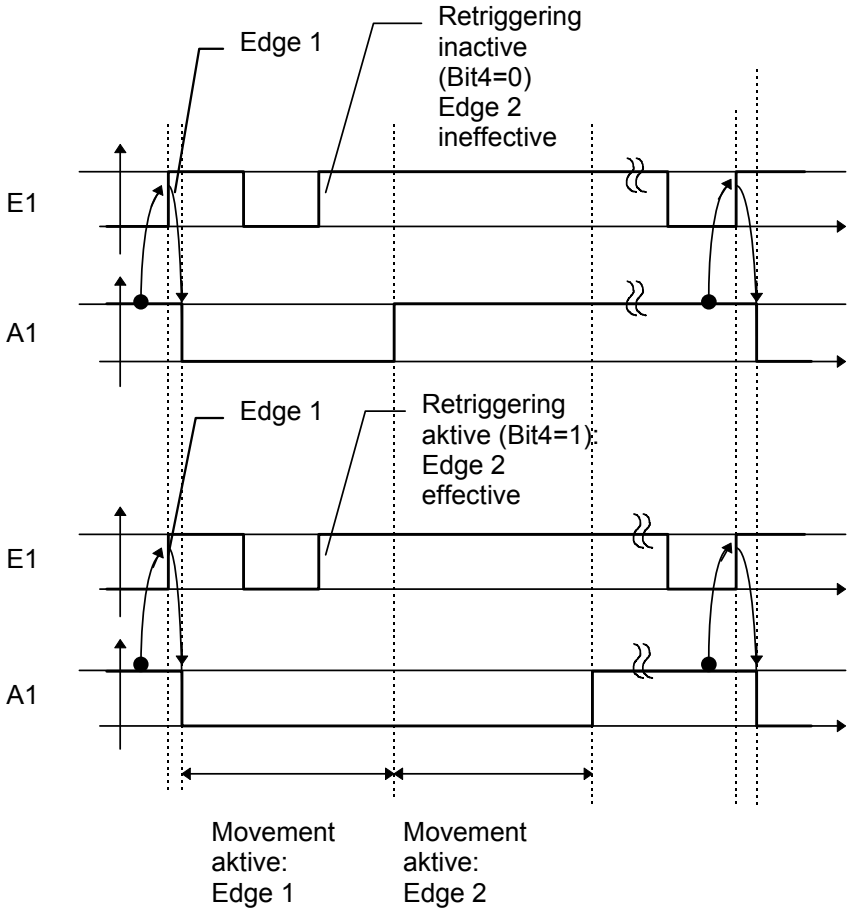


Figure 40: Principle of the "Retriggering after movement start" function

3.10.5 SF commanding

3.10.5.1 Commanding "Start"

SFKMD code = 1 (cf. Section 3.10.6.3)

After commanding "Start" the XFIPW starts with the execution of its cyclic function.

If "Bit 3 = 0" is set at commanding "Start" in the commanding function ("without setting on") (commanding DB, DL 0; cf. Section 3.10.6.3), the XFIPW behaves like the FIPW (cf. SF FIPW; SF type = 1).

If "Bit 3 = 1" is set at commanding "Start" in the commanding function ("with setting on"), then the XFIPW behaves as follows:

- At the start the XFIPW-internal slave position is set on the position assigned to the "master offset angle". This means that all internal values are set as if the slave would be moved to this point by a master movement.
- The slave drive is **not** moved in this case.
- All further slave movements are calculated starting from this point.

The "Setting on" function is intended to put the slave after switching on the drive into the same internal condition that it had before switching off the drive.

3.10.5.2 "Value New" commanding

SFKMD code = 5 (cf. Section 3.10.6.3)

With "Value new" commanding the following parameters concerning the printing mark control can be changed "online" ("online" = while the SF is started):

- Format length (DW 18)
- Printing mark sensor distance (DD 20)
- Synchronous point shift (DW 22)
- Valid range (DW23)
- Start angle correction range (DW24)
- Length correction range (DW 25)
- MD address correction value (DW 26)
- Correction weighting (DR 27)
- Correction counter (DL 27)

3.10.5.3 "Read value" commanding

SFKMD code = 6 (cf. Section 3.10.6.3)

For "Read value" commanding the same assignment of the data blocks as for "Start" commanding is necessary. "Read value" commanding is permissible only in the "Reset" state.

"Read value" commanding performs the following function:

The slave position is calculated at the master offset angle value (DW 12). The calculation refers to the 0-point of the 1st table. The calculated value is filed in DD 32 in the commanding block.

3.10.6 User interface of the XFIPW

3.10.6.1 Prerequisites and marginal conditions

Expedient settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32809):

- BA command value source = 3C (hexadecimal; commanding interface)
- Position control without following error compensation (SAK is implemented by the SF if required), synchronous ratio (ID 32892, ID 32893) is effective:
  ⇒ SF sink = 16-bit command value source
  Example: ID 32800 = 3C0004
- Position control with fine interpolation (if required):
  ⇒SF sink = 32-bit command value source
  Example: ID 32800 = 3C0404

Time mode		
Source address	Offset	**Meaning** / remarks
0	0	In the time mode not required
Distance mode		
Source address	Offset	**Meaning** / remarks
0	1,3,5,7	Config.-AZ message1, 2, 3, 4 (High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32) / permissible only for XFIPW **without** printing mark control and **without** synchronization on an external master drive
0	16,18,20, 22	Config.-AZ message1, 2, 3, 4 (Low and High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32) / permissible only for XFIPW **with a** printing mark control and/or on synchronization on an external master drive
1..8	3	Config.-AW message32 (Low Word) of AW1..8 / configurable by means of ID 32786; only position command or actual values are expedient
1..8	5	Position feedback value (Low Word) of AW1..8
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
130	0,2,4 ..30	Input range of the PS process image / EW 0, .. ,30
131	0,4,8.. 28	Input range of the PS process image / ED 0, .. ,28
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2, .., 15 / for logic operation with the corresponding SF0, 1, 2, .., 15

Time mode or distance mode		
Sink address	Offset	**Meaning**
1..8	4	16-bit command value source of AW1..8 / ID 32892, ID 32893 are effective
1..8	16	32-bit command value source of AW1..8 / fine interpolator through ID 32800.. ID 32809 can be used; ID 1 = ID 2 required
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
129	0,4,8.. 124	Flag range of the PS / MD 0, .. ,124
255	0	Internal sink for logic operation with further SF without output on an AW

Table 39: Settings of the XFIPW data holder interfaces (SF source/sink)

3.10.6.2 Interpolation point tables

The description of the distance-time or distance-distance profiles is in the form of interpolation point tables (Table 0 .. Table 7) which in each case are created as data block. Both Y tables (table form = 0) and XY tables (table form = 1) can be used.

Y tables:

Data double word	High word	Low word
00	Table form = 0 (Y table)	Interpolation number+1
02	1st interpolation point Y value	
04	2nd interpolation point Y value	
06	3rd interpolation point Y value	
..	..	
3998	1999th interpolation point Y value	
4000	2000th interpolation point Y value	

Total number: max. 4002 data words

Table 40: XFIPW/FIPZ interpolation point table (Y table)

Interpolation number+1 (DW 0)
- Meaning: Number of the table interpolation points + 1.
- Value range: 3..2001

Table form (DW 1)
- Meaning: Table form
- Value range: 0 ⇒ Y table (with equidistant point input regarding the X axis)

1st interpolation point Y value (DD 2)
- Meaning: 1st distance interpolation point of the table.
- Value range: 0 (the table must start with value "0"!)
- Unit: Increments

2nd .. 2000. interpolation point (DD 4 .. DD 4000)
- Meaning: 2nd .. 2000. distance interpolation point of the table.
- Value range: -2^{31} .. $+2^{31} - 1$
- Unit: Increments

Caution: The absolute amount of the value difference between 2 consecutive table values must be less than 32768! The data blocks (DB) assigned to the SF by SF initialization (FB 207) may not be deleted (ore newly generated)!

XY tables:

Data double word	High word	Low word
00	Table form = 1 (XY table)	Interpolation number+1
02	1st interpolation point X value (always 0)	
04	1st interpolation point Y value (always 0)	
06	2nd interpolation point X value	
08	2nd interpolation point Y value	
10	3rd interpolation point X value	
12	3rd interpolation point Y value	
..	..	
3994	999th interpolation point X value	
3996	999th interpolation point Y value	
3998	1000th interpolation point X value (X end value: Xme in distance mode Te in time mode)	
4000	1000th interpolation point Y value (Y end value: slave increments per master cycle or per cycle time)	

Total number: max. 4002 data words

Table 41: XFIPW interpolation point table (XY table)

Interpolation number+1 (DW 0)
- Meaning: Number of the interpolation points + 1.
- Value range: 3..1000

Table type (DW 1)
- Meaning: Table type
- Value range: 1 ⇒ XY table (with arbitrary point input regarding the X axis)

1st interpolation point X value (DD 2)
- Meaning: X-value 1st distance interpolation point of the table.
- Value range: 0 (the table must start with value "0"!)
- Unit: Distance mode: increments
  Time mode: 0.5 ms

1st interpolation point Y value (DD 4)
- Meaning: Y-value 1st distance interpolation point of the table.
- Value range: 0 (the table must start with value "0"!)
- Unit: Increments

.
.
.

1000th interpolation point X value (DD 3998)
- Meaning: X-value 1000th distance interpolation point of the table.
- Value range: 1 .. $+2^{31} - 1$
- Unit: Distance mode: increments
  Time mode: 0.5 ms

1000th interpolation point Y value (DD 4000)

- Meaning: Y-value 1000th distance interpolation point of the table.
- Value range: -2^{31} .. $+2^{31}-1$
- Unit: Increments

Caution: The absolute amount of the Y value difference between 2 consecutive table values must be less than 32768! The data blocks (DB) assigned to the SF by the SF initialization (FB 207) may not be deleted (or newly generated)!
The last interpolation point X value of a XY table determines the "Increments per revolution" (Xme). Analogously to Y tables, where Xme is determined by DD10 of the SF commanding DB it must apply that (cf. Section 3.10.6.3):
$50 \leq Xme \leq 2^{15}-1$

3.10.6.3 Structure and parameters of the DB for SF commanding

Data double word	High word		Low word	
	High byte	**Low byte**	**High byte**	**Low byte**
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		SAK factor	
04	Start table number		Total table number	
06	Working table cycles	MD addr. ext. sync.	Division exponent	
08	Multiplication factor			
10	Increments per revolution /cycle time (relevant only for Y tables)			
12	Reserved = 0		Master offset angle	
14	Reserved = 0		Start angle	
16	Reserved = 0		Stop angle	
18	Reserved = 0		Format length	
20	Printing mark sensor distance			
22	Valid range		Synchronous point shift	
24	Length correction range		Start angle correction range	
26	Correction counter	Correction weighting	MD addr. correction value	
28	Reserved = 0			
30	Reserved = 0			
32	Output value			

Total number: 34 data words

Table 42: XFIPW commanding DB

SF number (DR 0)

– Meaning: SF number under which a SF of the SF type 9 was initialized by means of FB 207.

– Value range: 0.. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)

– Value range: bit-coded:

– Bit 0 = 0: FIPW without printing mark control
= 1: FIPW with printing mark control

– Bit 1 = 0: Printing mark control correction after SAK
⇒ A following error arises during the correction value output.
= 1: Printing mark control correction before SAK
⇒ The nonlinearity of the reference input variable leads to increased unquiet.

– Bit 2 = 0: No synchronization on external master at SF commanding code "Start"
= 1: Synchronization on external master at SF commanding code "Start"

– Bit 3 = 0: Without setting on the master offset angle in the course of the SF commanding code "Start"
= 1: With setting on the master offset angle in the course of the SF commanding code "Start"

– Bit 4 = 0: Without retriggering after movement start by E1
= 1: With retriggering after movement start by E1

– Bit 5 = 0: Table change is possible only after working table processing
= 1: Table change is possible after every table processing

– Proposal: As a rule the higher system unquiet for a printing mark control correction after SAK is to be preferred; especially if the cutting time (zero point of the table) does not lie in the correction range.

SFKMD code (DR 1)

– Meaning: SF commanding code

–Value range: 0 (RESET): Reset of the SF
1 (START): Start of the SF (only permissible in the "Reset" state)
5: (VALUE NEW): For transfer current DMR parameters (only permissible in the "Started" state)
6 (WERT-LESEN): Calculate output value assigned to the master offset angle (only permissible in the "Reset" state).

SFKMD-BA (DL 1)

– Meaning: SF commanding operating mode (cf. Section 3.10.3.1 or 3.10.3.2).

– Value range:
2 Distance operating mode: cyclic table processing
3 Distance operating mode: cyclic table processing [1)]
26 Distance operating mode: start immediately with auto stop
27 Distance operating mode: start immediately with auto stop [1)]
82 Distance operating mode: clocking in/out with auto stop
83 Distance operating mode: clocking in/out with auto stop [1)]
98 Distance operating mode: clocking in/out
99 Distance operating mode: clocking in/out [1)]

4 Time operating mode: cyclic table processing
5 Time operating mode: cyclic table processing [1)]
132 Time operating mode: start immediately with auto stop
133 Time operating mode: start immediately with auto stop [1)]

84 Time operating mode: clocking in/out with auto stop
85 Time operating mode: clocking in/out with auto stop [1)]
100 Time operating mode: clocking in/out
101 Time operating mode: clocking in/out [1)]

[1)] with table set switch-over

SAK factor (DW 2)

- Meaning: Following error compensation error (cf. documentation: PS command set, Section "Position controller synchronization").
- Value range: 0: No following error compensation.
  1 .. $+2^{15}$-1: following error compensation error with:
  SAK factor = 7680000 / ID2 / ID104 + 128 (1 + 1 / ID2),
  if the input command value of the SF comes from the position feedback value of another AW (internal drive);
  SAK factor = 7680000 / ID2 / ID104 + 256,
  if the input command value of the SF comes from the pulse generator input (external drive).
  ID2 in ms; ID104 in rpm
- Example: ID 2 = 2ms, ID 104 = 1000 rpm, internal drive $\Rightarrow$ SAK = 4032

SF cycle time (DW 3)

- Meaning: Cycle time of the fast function; time grid in which the SF is called or in which command values are output; must be input corresponding to ID 2.
- Value range: 1..$+2^{15}$-1
- Unit: 0.5 ms
- Example: Value = 2 $\Rightarrow$ SF cycle time = 1 ms

Total table number (DW 4)

- Meaning: Total number of used tables per table set.
- Value range: 1..8

Start table number (DW 5)

- Meaning: Number of the tables to be used for the start process, commencing from Table 0 (per table set).
- Value range: 0..total table number - 1

Division exponent (DW 6)

- Meaning: Exponent to the base of 2, as division factor for the table value (0 = no division).
- Value range: 0..15

MD addr. ext. sync. (DR 7)

- Meaning: Flag double word address for interfacing the SF "COPY" with simultaneous printing mark control and synchronization on an external master drive (cf. Section 3.10.4.2 or Section 3.10.4.3).
- Value range: 0..124

Working table cycles (DL 7)

- Meaning: Number of working table processing cycles (in the scope of the operating modes with automatic termination of the movement function after movement start triggering).
- Value range: 0, 1 : Onetime processing of the working table
  2..255 : 2 to 255 times processing of the working table

Multiplication factor (DD 8)

– Meaning: Multiplication factor for the table value (1 ⇒ no multiplication; shorter SF execution time).
– Value range: -2^{15} ..$+2^{15}-1$

Increments per revolution / cycle time **(DD 10)**

– **Meaning**: *Y tables:* Distance mode: Number of the increments of the master encoder per revolution (= Modulo value Xme, master distance in which a table is processed).
Time mode: Cycle time (= Modulo value Te; time in which a table is processed).
XY table: None (the value is taken from the last interpolation point X value of the XY table).
– Value range: Distance mode: 50..$2^{15}-1$
Time mode: 1..($2^{15}-1$)
– Unit: Distance mode: increments
Time mode*:* 0.5 ms

Master offset angle (DW 12)

– Meaning: *Commanding "Start":* Offset value on which the input variable is set at SF commanding "Start". A lag of the slave axis compared with the master axis can be achieved by a negative offset value.
Commanding "Read value": Input value for which the output value should be calculated.
– Value range: Distance mode*:* 0 .. ± (number of increments per revolution - 1)
Time mode: 0 .. cycle time - 1
– Unit: Distance mode: increments
Time mode: 0.5 ms

Start angle (DW 14)

– Meaning: Range of the input variable within which there is "clocking in".
– Value range: Distance mode: 0 .. number of increments per revolution - 1
Time mode: 0 ..cycle time - 1
– Unit: Distance mode*:* increments
Time mode*:* 0.5 ms

Stop angle (DW 16)

– Meaning: Range of the input variable within which there is "clocking out".
– Value range: Distance mode: 0 .. number of increments per revolution - 1
Time mode: 0 ..cycle time - 1
– Unit: Distance mode: increments
Time mode*:* 0.5 ms

Format length (DW 18)

– Meaning: Standardization value for the material length between two cuts.
– Remarks: The format length in DW18 is solely a standardization value for the statement of printing mark sensor distance (DD20), synchronous point shift (DW22) and valid range (DW23). The actual format length which is moved through per master cycle (DW10) results from the drive movement, which is determined essentially by the working table. The format length in DW18 can e.g. be selected so that it corresponds to the value in 0.1 mm (see example below). However, the format length can also be standardized in 0.1 degrees by a value of e.g. 3600.
– Value range: 0 .. +32767
– Unit: e.g. 0.1 mm
– Example: Format length = 100 mm ⇒ value = 1000

Printing mark sensor distance (DD 20)

- Meaning: Distance from the printing mark sensor to the synchronous point (zero point of the working table) at synchronous point shift = 0 (cf. Figure 39).
- Value range: 0 ..+2^{31}-1
- Unit: e.g. 0.1 mm
- Example: Value = 10 ⇒ Distance from the printing mark sensor to the cutting position = 1 mm

Synchronous point shift (DW 22)

- Meaning: Shift of the synchronous point in the direction to the printing mark sensor (cf. Figure 39).
- Value range: 0 .. format length - 1
- Unit: e.g. 0.1 mm
- Example: Value = 10 ⇒ Shift of the synchronous point in the direction to the printing mark sensor = 1 mm

Valid range (DW 23)

- Meaning: Range about the command position of the printing mark (±) in which a valid printing mark is detected (cf. Figure 38: XM_{perm} = 2 x DW 23). At 0 a printing mark in the entire range is permitted.
- Remarks: The valid range refers to the output range of the XFIPW (slave position). The value "0" is not permissible in connection with RFPAK hardware. Select the value "format length / 2" for selecting the entire range!
- Value range: 0 .. format length / 2
- Unit: e.g. 0.1 mm
- Example: Value = 10 ⇒ Range in which the valid printing mark is detected = 1 mm

Start angle correction range (DW 24)

- Meaning: Angle position of the master at which the injection of the correction values of the printing mark control is started (cf. Figure 38: SK; 0 = synchronous point Pso = start of the working table).
- Remarks: The start angle correction range refers to the input range (master position). The correction window is determined by this parameter and the "Length correction range" parameter.
  From a control engineering viewpoint it is important that the acquisition of the printing mark signal does **not** coincide with the correction value output, since it otherwise leads to **control oscillations**! This means (cf. Figure 15) The printing mark feedback position (printing mark command position+ printing mark deviation dXM) must lie within the permitted printing mark deviation range Xm_{perm} (with: 0 < XM_{perm} < SK_{Slave}).
- Value range: 0 .. number of increments per revolution
- Unit: Increments

Length correction range (DW 25)

- Meaning: Length of the range in which the correction values of the printing mark control are output (cf. Figure 15).
- Value range: 0 .. number of increments per revolution - start angle correction range
- Unit: Increments

Remarks: Start angle correction range = 0 and length correction range = 0

⇒ Default setting:
Start angle correction range =
Number of increments per revolution * 3 / 4
Length correction range = number of increments per revolution * 1 / 8

MD addr. correction value (DW 26)

– Meaning: Flag double word address to which the correction value dXM (cf. Figure 15) is written by the SF with selected printing mark control.

– Value range:
0: No output of the correction value.
4..124: Output of the correction value in MD4..MD124

Remarks: The correction value is output in increments and refers to the slave axis (Y axis of the distance-distance table). If no printing mark is detected, then the value 0 is output.

Correction weighting k (DR 27)

– Meaning: The determined deviation of the printing mark is not compensated for completely, but weighted with the factor $F = 2^{-k}$: for $0 \leq k < 32$
(or $F = -2^{128-k}$: for $128 \leq k < 160$).

– Value range:
0: Complete correction (F = 1).
1..31: Partial correction ($F = 2^{-1} .. 2^{-31}$)
32: No correction (F = 0)
128: Complete correction (F= -1).
129..159: Partial correction ($F = -2^{-1} .. -2^{-31}$)

Remarks: An inversion of the control sense can be achieved by setting the most significant bit 7 (DR 27 >= 128) (negative sign).
A correction value output is suppressed by setting bit 5 (DR 27 = 32). However, the determined correction value can be displayed in the flag range independently of this through DW 26.

Correction counter n (DL 27)

- Meaning: Only the deviation of every nth valid printing mark is compensated for.
- Value range: 0, 1: Each printing mark deviation is compensated for.
  2..255: Only every nth printing mark deviation is compensated for (with: n = 2,..,255).

Output value (DD 32)

- Meaning: Data double word in which the slave position calculated on "Read value" commanding is transferred.
- Value range: -2^{31} .. $+2^{31}-1$
- Unit: Increments

DW/DD	Parameter	BA (distance-distance)				BA (distance-time)			
	- without table switch-over	2	26	82	98	4	84	100	132
	- with table switch-over	3	27	83	99	5	85	101	133
DW 02	SAK factor	x	x	x	x	x	x	x	x
DW 03	SF cycle time	x	x	x	x	x	x	x	x
DW 04	Total table number	1	1	x	x	1	x	x	1
DW 05	Start table number	0	0	0	x	0	0	x	0
DW 06	Division exponent	x	x	x	x	x	x	x	x
DR 07	MD addr. ext. sync.	X[1)]	X[1)]	X[1)]	x[1)]	0	0	0	0
DL 07	Reserve	0	0	0	0	0	0	0	0
DD 08	Multiplication factor	x	x	x	x	x	x	x	x
DD 10	Incr. per revolution	x	x	x	x	-	-	-	-
DD 10	Cycle time	-	-	-	-	x	x	x	x
DW 12	Master offset angle	x	0	x	x	0	0	0	0
DW 13	Reserve	0	0	0	0	0	0	0	0
DW 14	Start angle	x	0	x	x	0	0	0	0
DW 15	Reserve	0	0	0	0	0	0	0	0
DW 16	Stop angle	0	0	0	x	0	0	0	0
DW 17	Reserve	0	0	0	0	0	0	0	0
DW 18	Format length	x[2)]	x[2)]	x[2)]	x[2)]	-	-	-	-
..	..								
DW 25	Length correction calculation	x[2)]	x[2)]	x[2)]	x[2)]	-	-	-	-
DW 26	MD address correction value	x[2)]	x[2)]	x[2)]	x[2)]	-	-	-	-
DR 27	Correction weighting k	x[2)]	x[2)]	x[2)]	x[2)]	-	-	-	-
DL 27	Correction counter n	x[2)]	x[2)]	x[2)]	x[2)]	-	-	-	-
DD 28	Reserve	0	0	0	0	0	0	0	0
DD 30	Reserve	0	0	0	0	0	0	0	0
DD 32	Output value	x[3)]	x[3)]	x[3)]	x[3)]	x[3)]	x[3)]	x[3)]	x[3)]

x = value within the scope of the permissible limits
- = not defined

[1)] only in connection with the printing mark control and simultaneous synchronization on an external master drive and without table set switch-over

[2)] only in connection with the printing mark control and without table set switch-over

[3)] output value, only in connection with "Read value" SF commanding

Table 43: Dependence of the XFIPW parameters on the SFKMD operating mode

3.10.7 Example

The SF XFIPW should work in the distance operating mode "Cyclic table processing" (BA = 2) and at the "Start" begin ("Set on") at the slave position assigned to the master position 10000 (increments). The master axis is coupled through the AZ pulse generator input X32. The SF is operated in the main operating mode 0.

3.10.7.1 Initializing the XFIPW

;* DB for initializing the SF "XFIPW"

```
;
:KB 9       ;DR 0  SF type                 XFIPW
:KB 0       ;DL 0  SF number               SF0
:KB 0       ;DR 1  E/A-M mode              E/A mode
:KB 0       ;DL 1  Reserved
:KB 1       ;DR 2  Source address offset   Conf. AZ message 1 (High Word)
:KB 0       ;DL 2  Source address          AZ
:KB 4       ;DR 3  Sink address offset     16-bit command value source
:KB 1       ;DL 3  Sink address            AW 1
:KB 1       ;DR 4  Input bit mask          Bit 0
:KB 8       ;DL 4  Input byte address      E-Byte 8
:KB 1       ;DR 5  Output bit mask         Bit 0
:KB 8       ;DL 5  Output byte address     A-Byte 8
:KB 16      ;DR 6  DB number Tab0          DB16 = working table
:KB 0       ;DL 6  DB number Tab1          Not used
:KB 0       ;DR 7  DB number Tab2          Not used
:KB 0       ;DL 7  DB number Tab3          Not used
:KB 0       ;DR 8  DB number Tab4          Not used
:KB 0       ;DL 8  DB number Tab5          Not used
:KB 0       ;DR 9  DB number Tab6          Not used
:KB 0       ;DL 9  DB number Tab7          Not used
```

AMKASYN parameter setting:

- ID 32948 = 00000003 ⇒ AZ message 1 = pulse generator input AZ (terminal X32)
- ID 32800 = 3C0004 ⇒ Main operating mode 0 = position control

3.10.7.2 Commanding the XFIPW

;DB for commanding the SF "XFIPW"

```
;
:KB 0       ;DR 0  SF number               SF0
:KB 8       ;DL 0  SFKMD fct               Bit 3 = 1 (with setting on)
:KB 1       ;DR 1  SFKMD code              Start
:KB 2       ;DL 1  SFKMD-BA                Distance function "cyclic table processing"
:KF 0       ;DW 2  SAK                     No following error compensation
:KF 4       ;DW 3  SF cycle time           ID 2 = 2ms
:KF 1       ;DW 4  Total table number      1 table
:KF 0       ;DW 5  Start table number      0 Start tables
:KF 0       ;DW 6  Division exponent       0 (no division)
:KB 0       ;DR 7  Reserved
:KB 0       ;DL 7  Reserved
```

:KD 1	;DD 8	Multiplication factor	1 (no multiplication)
:KD 20000	;DD10	Increments per rev.	20000 increments per master cycle
:KF 10000	;DW12	Master offset angle	10000 increments = master start position
:KF 0	;DW13	Reserved	
:KF 0	;DW14	Start angle	0 increments (start only at table start)
:KF 0	;DW15	Reserved	
:KF 0	;DW16	Stop angle	0 increments (stop only at table end)
:KF 0	;DW17	Reserved	
:KD 0	;DD18	Format length	No printing mark control active
.	.	.	
.	.	.	
:KD 0	;DD30	Reserved	
:KD 0	;DD32	Output value	for SFKMD code = 6 ("Read value")

3.11 "SF APSF" User programmable fast function

SF type = 10 (is supported as from system software level AZ-PS4 V02.10)

The "SF APSF" forms the basis for a SF programmable by the user. The function of the SF is programmed in AWL by the user in the form of a function block (FB). Practically the entire AWL language extent is available to the user in this FB. However, an APSF is restricted to one FB, i.e. neither other AWL blocks nor AMK-specific function blocks can be selected.

3.11.1 Principle of "SF APSF"

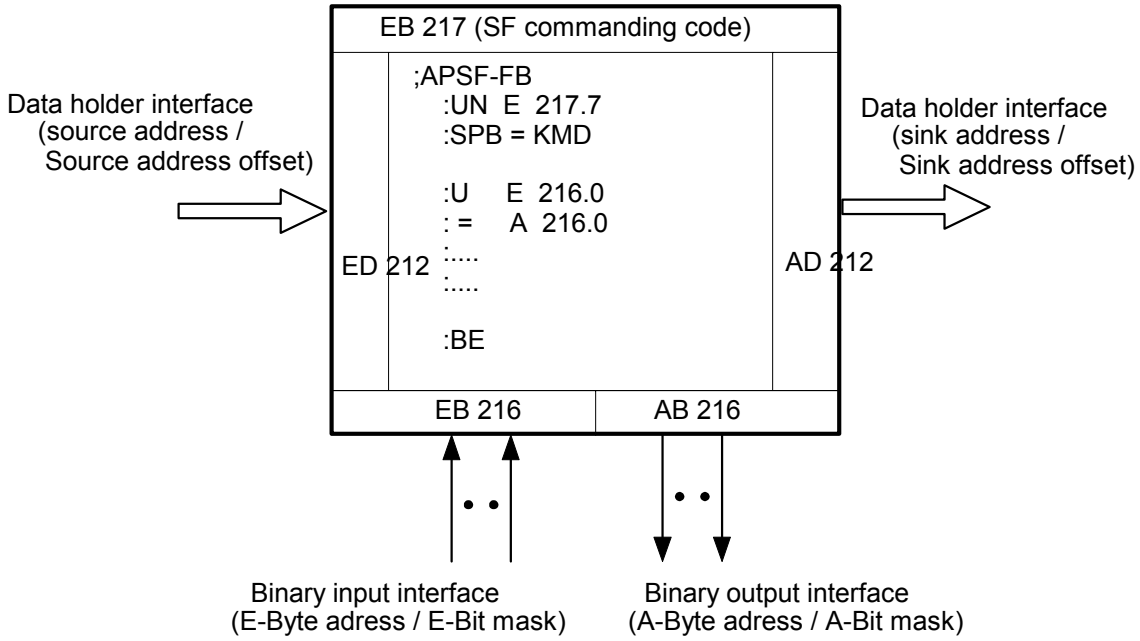


Figure 41: Principle of "SF APSF"

With the aid of the SF APSF a FB programmed by the user is processed in the cycle with all fast functions. In the FB the entire E/A/M area as well as data blocks, counters and timers can be accessed. Current E values can be read or A values output independently of the PS cycle time by a periphery direct access. It further applies that:
At the start of the SF the source and sink defined with the aid of FB 207 as well as the SF input/output byte and the SF commanding code are imaged automatically in special E/A areas (SF-PAE):

- ED 212: The current value of the SF source at the start of the SF.
- EB 216: The input byte defined for the SF.
- EB 217: The SF commanding code.
  If there is commanding, then this code is displayed in EB 217 for a SF cycle. If there is no commanding, then EB 217 has the value 255. With the aid of this input byte, certain initializations can be performed in the APSF-FB e.g. at commanding "Start" or at commanding "Reset" the speed input for a drive can be zeroed, for instance. The input byte 217 can assume the following values:

0	Commanding reset
1	Commanding start
255	No commanding

- AD 212: The current value of the SF sink at the start of the SF.
- AB 216: The current SF output byte at the start of the SF.

At the end of the SF the APSF-specific A range is transferred into the SF sink or the SF output byte automatically (SF-PAA):
- AD 212: The value to be transferred into the SF sink at the end of the SF.
- AB 216: The value to be transferred into the SF output byte at the end of the SF.
  In this case only n bits, starting from the output bit mask according to FB 207, are output. The number "n" of the bits to be output is defined at the commanding "Start" (cf. Section 3.11.3.2, number of output bits).

  Example Output bit mask: 8

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	1	0	0	0

  Number of the output bits: 3

  ⇒ The bits 3, 4 and 5 of the AB 216 are copied into the SF output byte.

The data block defined at the commanding "Start" (cf. Section 3.11.3.2, DB number) is activated at the beginning of the FB.

Different marginal conditions must be observed when programming FBs for the APSF:
- The average processing time of AWL command is approx. 5 µs for the APSF. The basic running time (running time without program running time) is approx. 25 µs. In order not to exceed the SF cycle time, these times should be observed especially when programming loops.
- Writing the same E/A/M and DB areas, both in the course of cyclic program processing and also by the APSF, must be avoided! Above all no bit command (S, R and =) may be performed on the same E/A/M byte addresses, since "Read-Modify-Write problems" can occur due to this, which can lead to sporadic undefined results.

3.11.2 Command set

All PS commands (cf. documentation "PS command set"), except for the PS command listed below, are available in the SF APSF. Use of the not available commands leads to running time errors during processing!

Operation	Operand	Description of function
Time functions		
SI	T	Starting a time with pulse at RLO 0->1
SV	T	Starting a time as lengthened pulse at RLO 0->1
SE	T	Starting a time as switch-on delay at RLO 0->1
SS	T	Starting a time as storing switch-on delay at RLO 0->1
SA	T	Starting a time as storing switch-off delay at RLO 1->0
R	T	Resetting a time at RLO = 1
Block functions		
SPA	OB/PB/FB	Unconditional block call (max. nesting depth = 10)
SPB	OB/PB/FB	Conditional block call at RLO = 1 (max. nesting depth =10)
E	DB	Generating/deleting a data block
Organizational functions		
STP		Stop after cycle end
STS		Stop immediately

3.11.3 AWL interface of the SF APSF

3.11.3.1 Prerequisites and marginal conditions

The settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32809) must be selected for die SF APSF depending upon the function realized in the FB. All sources and sinks possible within the scope of SF initialization are allowed (cf. documentation: AMK-specific function blocks; FB207).

3.11.3.2 Structure and parameters of the SF commanding DB

Data	High word		Low word	
double word	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		Reserved = 0	
04	DB number		FB number	
06	Reserved = 0		Number of output bits	
08	Reserved = 0			
10	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 44: APSF commanding DB

SF number (DR0)
- Meaning: SF call number under which a SF of the SF type 10 was initialized by means of FB 207.
- Value range: 0 .. 15

SFKMD fct (DL 0)
- Meaning: Currently not used.
- Value range: 0

SFKMD code (DR 1)
- Meaning: Code of the SF command.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): Start SF

SFKMD-BA (DL 1)
- Meaning: Currently not used.
- Value range: 0

SF cycle time (DW 3)
- Meaning: Currently not used.
- Value range: 0

FB number (DW 4)
- Meaning: Number of the function block which is processed in the scope of the APSF.
- Value range: 0 .. 63

DB number (DW 5)
- Meaning: Number of the data block which is activated at the start of the APSF.
- Value range: 0: No DB activated.
  1 .. 63: DB1 .. 63 activated.

Number of output bits (DW 6)
- Meaning: Number of the bits which are output in the scope of the APSF, starting from the output bit mask (cf. FB 207).
- Value range: 0 .. 8

3.11.4 Example

The speed of a not AMKASYN drive should be determined. If the input bit 0 of the SF input byte is "1", AW1 should be controlled with this speed. A FB which determines the speed from the distance increments is processed cyclically with the aid of the SF APSF. The incremental encoder is coupled through the AZ pulse generator input X32. The SF cycle time is 2 ms.

3.11.4.1 Initializing the APSF

```
;* DB for initializing the SF "APSF"
;
        :KB 10 ;DR 0    SF type  APSF
        :KB 0  ;DL 0    SF number                   SF0
        :KB 0  ;DR 1    E/A-M mode                  E/A mode
        :KB 0  ;DL 1    SF cycle time factor
        :KB 1  ;DR 2    Source address offset       Conf. AZ message 1 (High Word)
        :KB 0  ;DL 2    Source address              AZ
        :KB 16 ;DR 3    Sink address offset         32-bit command value source
        :KB 1  ;DL 3    Sink address                AW1
        :KB 1  ;DR 4    Input bit mask              Bit 0
        :KB 8  ;DL 4    Input byte address          E-Byte 8
        :KB 1  ;DR 5    Output bit mask             Bit 0
        :KB 8  ;DL 5    Output byte address         A-Byte 8
        :KB 0  ;DR 6    DB number Tab0              Not used
        :KB 0  ;DL 6    DB number Tab1              Not used
        :KB 0  ;DR 7    DB number Tab2              Not used
        :KB 0  ;DL 7    DB number Tab3              Not used
        :KB 0  ;DR 8    DB number Tab4              Not used
        :KB 0  ;DL 8    DB number Tab5              Not used
        :KB 0  ;DR 9    DB number Tab6              Not used
        :KB 0  ;DL 9    DB number Tab7              Not used
```

AMKASYN parameter setting:
ID 32948 = 00000003⇒ AZ message 1 = pulse generator input AZ (terminal X32)
ID 32800 = 3C0043 ⇒ Main operating mode 0 = speed control

3.11.4.2 Commanding the APSF

```
;DB for commanding the SF "APSF"
;
        :KB 0  ;DR 0    SF number                   SF0
        :KB 0  ;DL 0    SFKMD fct                   Not used
        :KB 1  ;DR 1    SFKMD code                  Start
        :KB 0  ;DL 1    SFKMD-BA                    Not used
        :KF 0  ;DW 2    Reserved
        :KF 0  ;DW 3    SF cycle time               Not used
        :KF 10 ;DW 4    FB number                   FB10
        :KF 20 ;DW 5    DB number                   DB20
        :KF 1  ;DW 6    Number of output bits       1 output bit
        :KF 0  ;DW7     Reserved
        :KD 0  ;DD8     Reserved
        :KD 0  ;DD10    Reserved
        .      .        .
        .      .        .
        :KD 0  ;DD30    Reserved
        :KD 0  ;DD32    Reserved
```

3.11.4.3 FB10 for APSF

```
        :UN     E       217.7   ;Query of the highest bits of the command code
        :SPB = M1               ;Branch if command active
        :UN     E       216.0   ;Command value input query active
        :SPB = M2               ;Branch if no command value input


        :L      ED      212     ;Current counter value
        :L      MD      24      ;Old counter value
        :-FD                    ;Current counter value – old counter value = incr/SF cycle time
        :WWD                    ;Convert integer word to integer double word (from AZ
                                ;PS4 V02.09 and APROS-V02.09)
; *********************************Convert integer word to integer double word
;       :T      MD      28      *in AZ-PSx version < 02.09, or APROS version < 02.09
;       :U      M       29.7    *
;       :SPB =M3                *
;       :L      MW      28      *
;       :SPA =M4                *
;                               *
;M3     :L      KF      -1      *
;       :T      MW      30      *
;       :L      MD      28      *
; *********************************
M4      :L      KF      30000   ;Convert into incr/min (at 2ms SF cycle time)
        :*FD
        :L      KF      2       ;Convert into 0.0001 rpm (at 20000 incr/rev.
                                 encoder resolution)
        :/FD
        :T      AD      212
        :L      ED      212
        :T      MD      24      ;Current counter value -> old counter value
        :BEA

M1      :U      E       217.0
        :SPB= M2                ;Branch if no reset command

        :L      KF      0       ;Speed 0 at reset or command value input inactive
        :T      AD      212
        :BEA                    ;End APSF

M2      :L      ED      212     ;Start initializings command for FB
        :T      MD      24      ;MD24 as flag of old counter value
        :L      KF      0       ;Speed 0 command value input inactive
        :T      AD      212

        :BE
```

3.12 "SF EPOS" Extended positioning

SF type = 11 (is supported as from system software level AZ-PS4 V02.10)

The SF "EPOS" enables fast positioning processes controllable through binary inputs.
In these positioning processes a distinction is made basically between the
- "Relative positioning" and
- "Substitutional positioning"

operating modes (cf. Course of the positioning and operating modes section).

The following extensions are supported as from system software level AZ-PS4 V02.13:

- Modulo positioning as extension of "Relative positioning" (cf. Section 3.12.1 or Section 3.12.4.2, SFKMD-BA, Bit 4))
- Acceleration override (cf. Section 3.12.4.2, DW17)

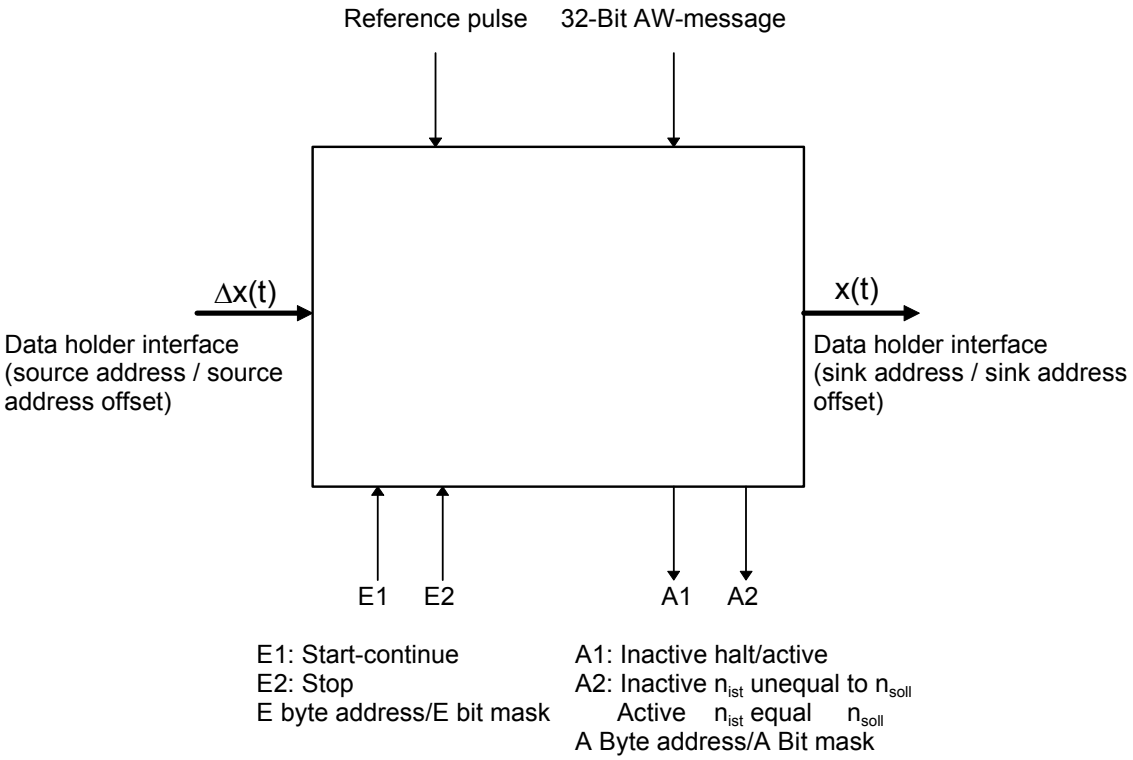


Figure 42: Principle of fast positioning

3.12.1 Principle of relative positioning

In the "**Relative positioning**" operating mode a drive is moved by a predetermined position command value (X_{comm}) relative to the momentary position (cf. Figure 43). In this case the velocity n_{comm} and the relative position command value x_{comm} are parameters which are transferred to the SF on commanding.

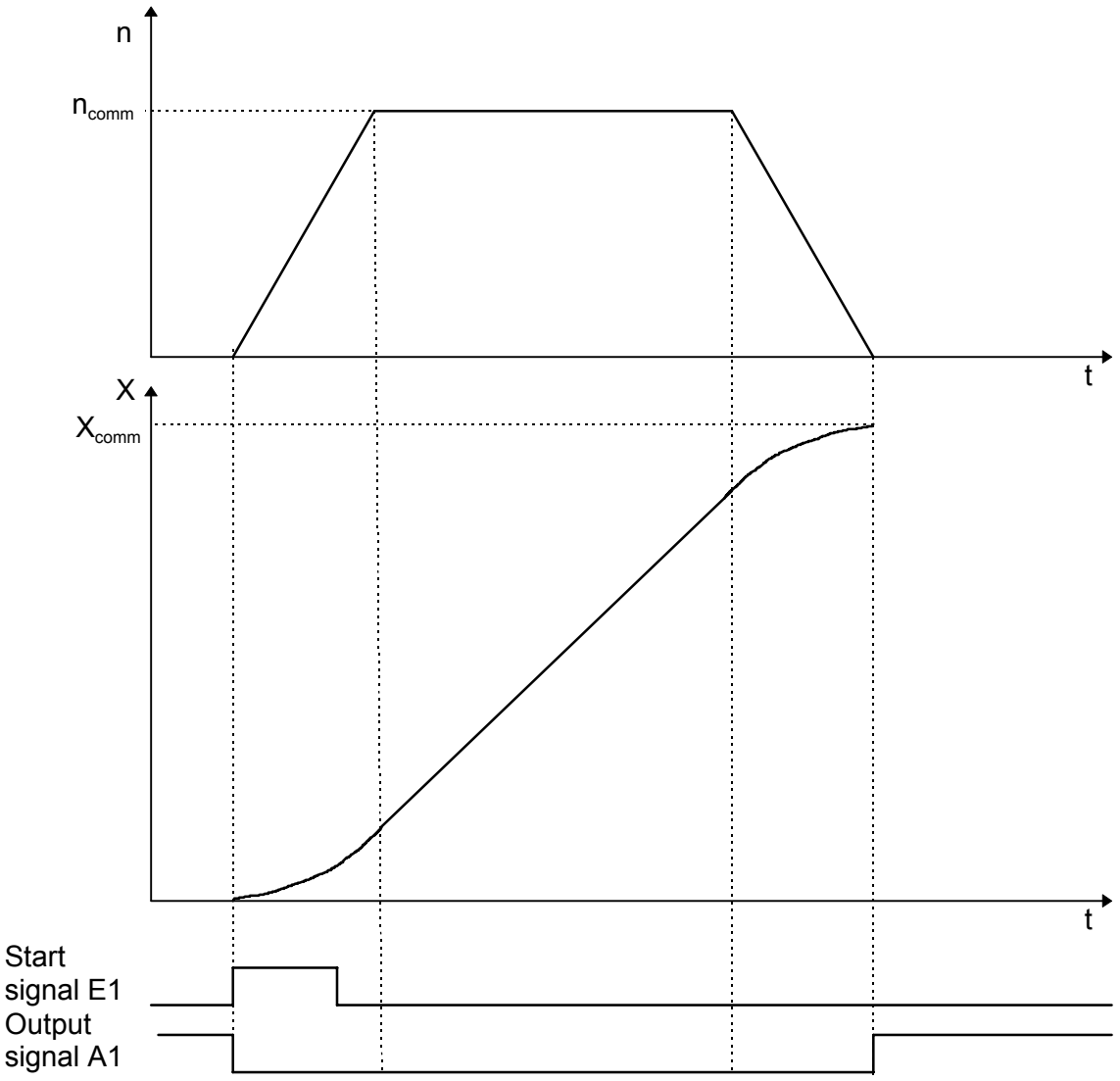


Figure 43: Course of "Relative positioning" without stop

In the "**Relative positioning with modulo positioning**" operating mode, a drive is moved by a predetermined modulo position command value (X_{comm}) as long as the input signal E1 = 1. From the time E1 = 0 it is positioned to the next possible modulo value (X_{comm}) (cf. Figure 44). In this case the velocity n_{comm} and the relative position command value x_{comm} are parameters which are transferred to the SF on commanding.

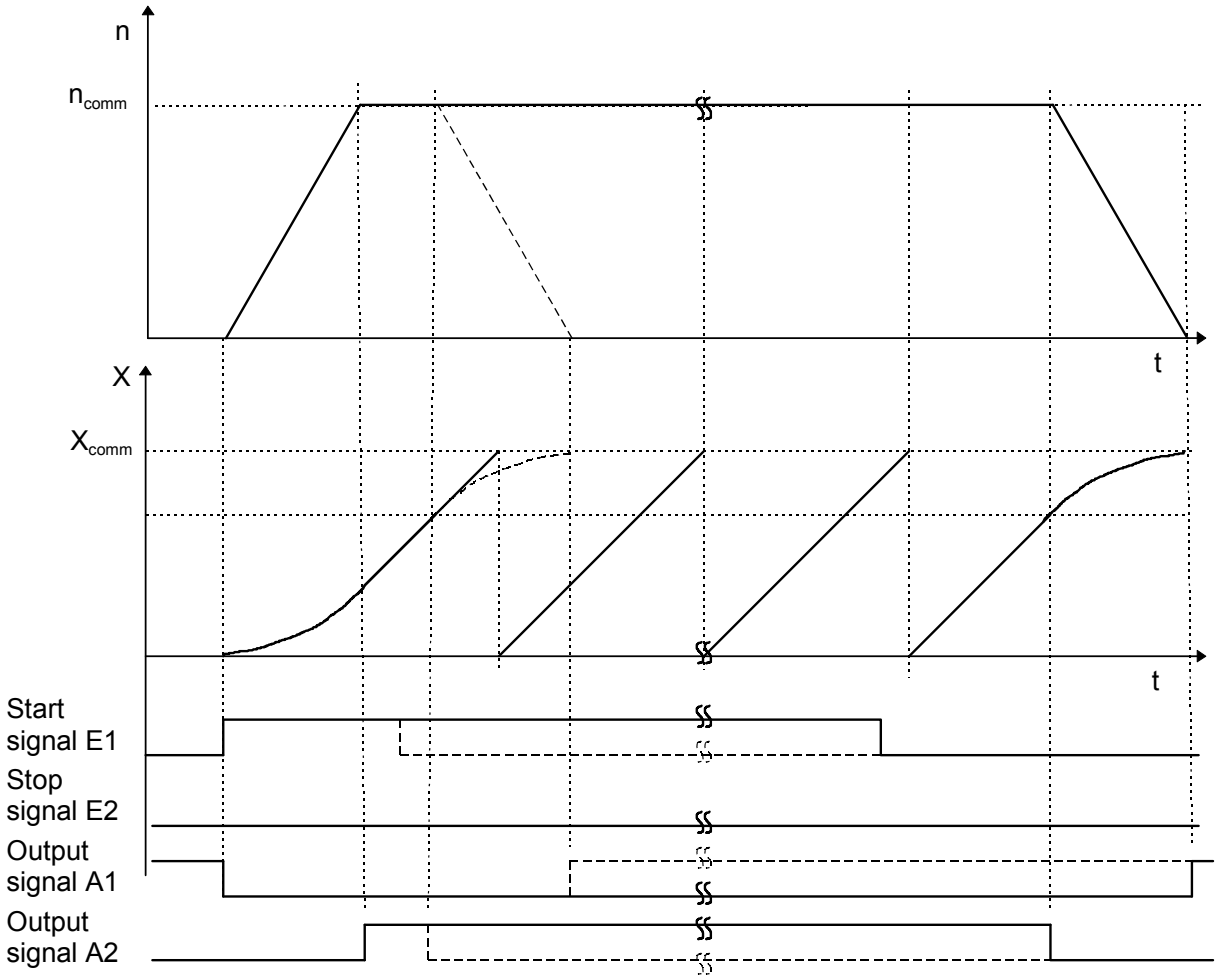


Figure 44: Course of "Modulo positioning" without stop

In relative positioning (Bit 1 = 0) and modulo positioning (Bit 4 = 1) the above characteristic results:

- After ending the ramp-up process (t_1):
  Output signal A2 is set (0 -> 1), since $n_{feedback}$ is equal to n_{comm}
- Up to the time of initiation of the ramp-down process ($\leq t_2$):
  Input signal E1 = 0: Ramping down and stopping the drive after reaching the modulo value (position command value).
  Output signal A2 is reset (1 -> 0), since $n_{feedback}$ is unequal to n_{comm}.
  Input signal E1 = 1: Continued running of the drive (no ramping down) with constant command speed n_{comm}.
- After the time of initiation of the ramp-down process($> t_2$):
  Input signal E1 = 0: Ramping down and stopping the drive after reaching the next modulo value (position command value).
  Input signal E1 = 1: Continued running of the drive (no ramping down).

3.12.2 Principle of substitutional positioning

In the "**Substitutional positioning**" operating mode a type of homing cycle is performed for a drive according to the following Figure 45 and Figure 46. In this case the drive is initially accelerated to a defined speed n_{comm}. The approach direction is defined by the sign of the speed parameter. After running over the reference signal, the position feedback value system of the drive is zeroed and the drive is positioned at a defined position command value. The reference sign to be processed must be fed into the inverter module as zero pulse (cf. Figure 47). If the distance defined as position command value is either shorter than the distance resulting from the braking ramp or opposite to the current direction of travel, then a distinction is made between two versions (cf. Section 3.12.3). Either the drive can be stopped at the defined end position without observation of the brake ramp or it is driven through the end position up to standstill and then positioned back on the end position (cf. Figure 46).

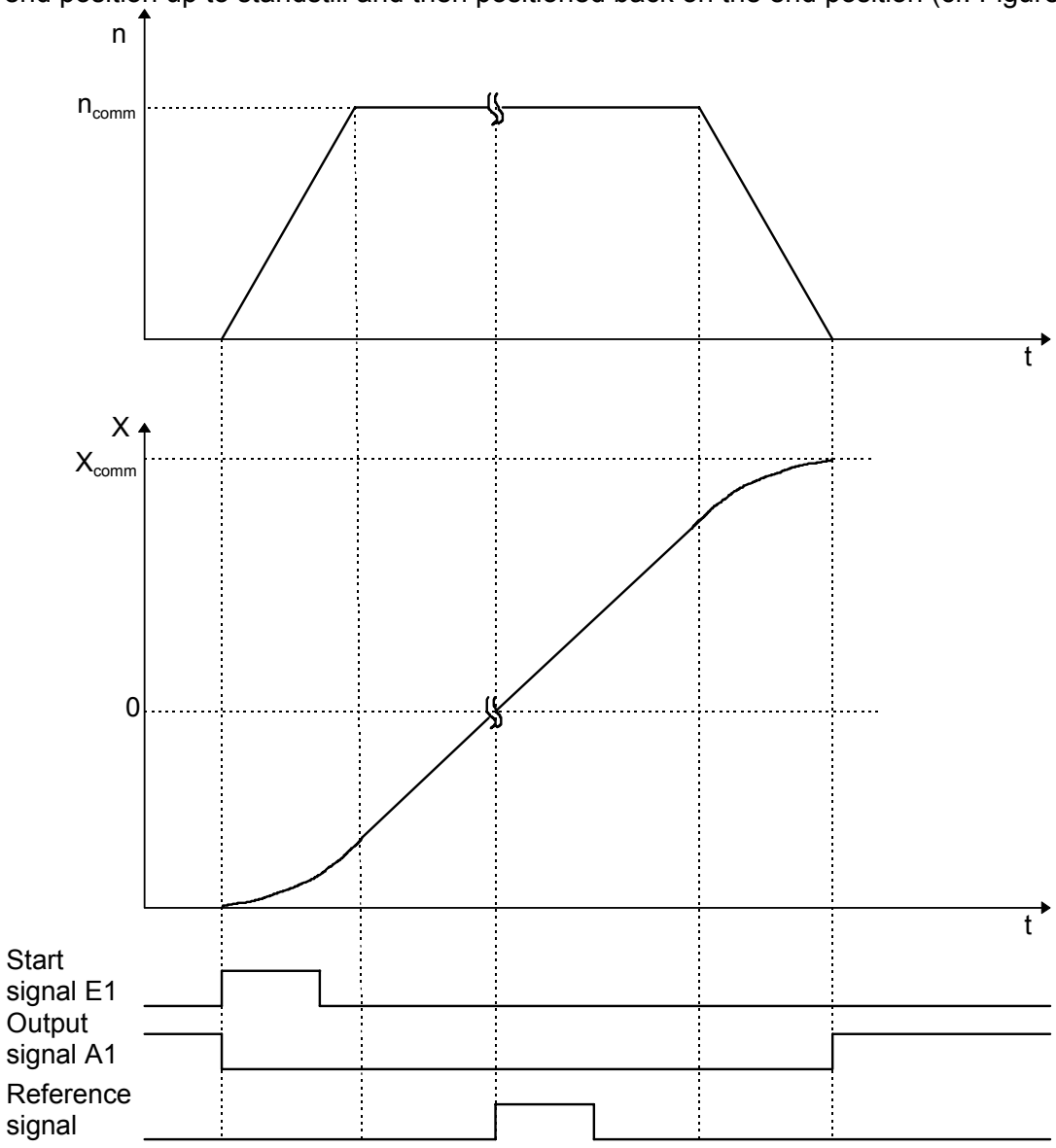


Figure 45: Course of "Substitutional positioning" without direction reversal

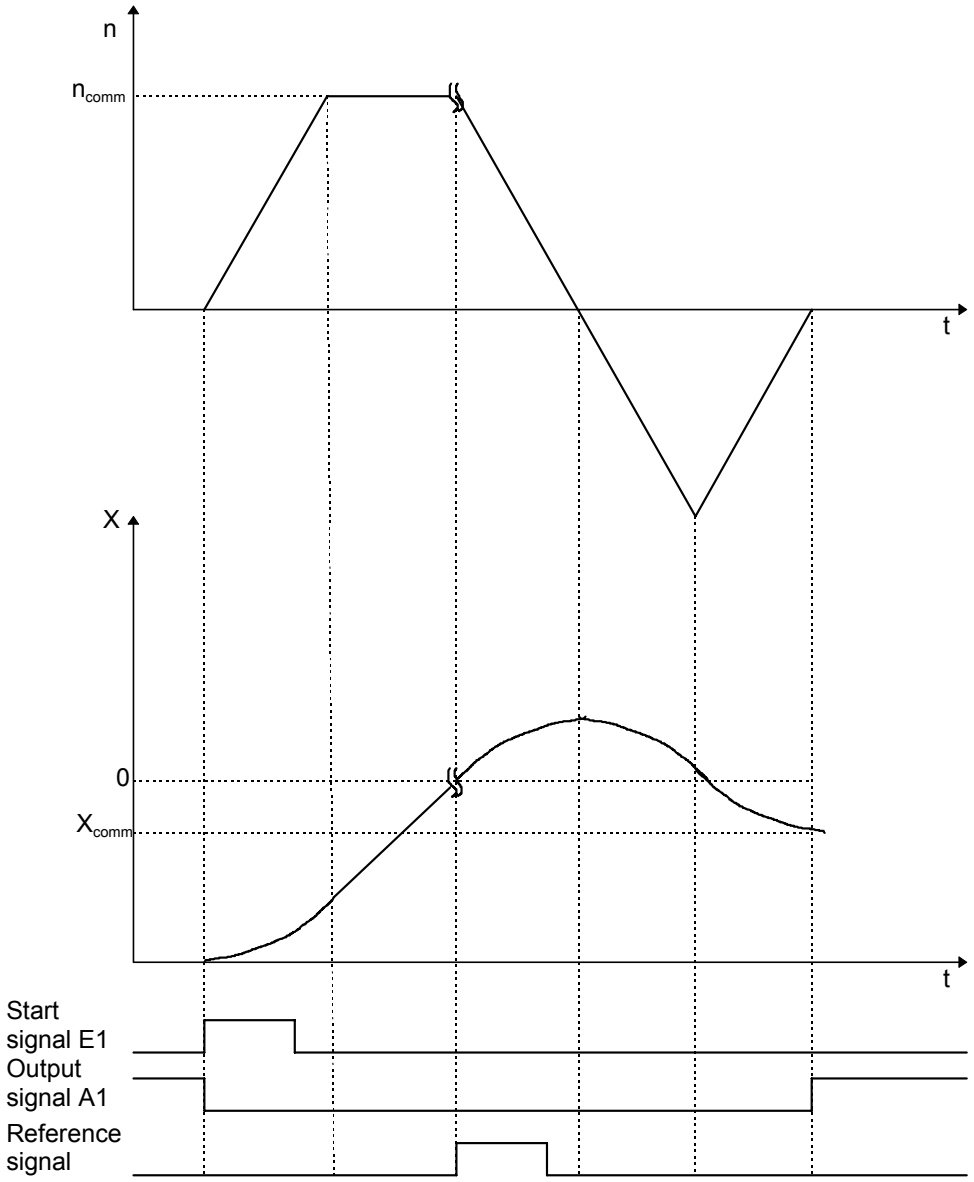


Figure 46: Course of "Substitutional positioning" with direction reversal

Remarks:

- The "Substitutional positioning" operating mode is available **only** with the following software levels:
  AZ: Version = AZ 0208 1897 3007 (**Caution:** Commanding function 16 = "AW special function" required!)
  AW: Version ≥ AW 0212 3397
  AZ-PS4: Version > AZ-PS4 0209 1197
- Before start of the SF "EPOS" in the "Substitutional positioning" operating mode, drive commanding with the commanding function 16 must be performed through FB201 (cf. Section 3.12.5.1).
- The SERCOS cycle time (ID2) must be selected ≥ 1 ms.
- The end position of the positioning may not be exactly at the reference signal (position command value ≠ 0), since otherwise the reference signal is already detected again at the start of renewed positioning and thus the positioning cannot be performed.
- The reference signal must be fed into the inverter module (AW) according to Figure 47.

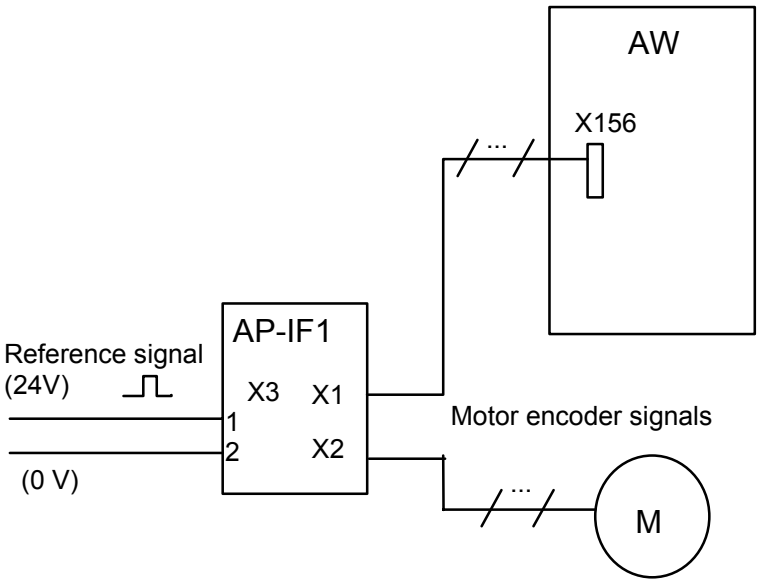


Figure 47: Connection of the reference signal to an AW

3.12.3 Course of the positioning and operating modes

After a positive edge change of the start signal E1, the positioning process starts in both operating modes and the output signal A1 is deleted (A1=0). The positioning process is interrupted at a positive edge change of the stop signal E2. The velocity change after a stop is made with an adjustable delay (SFKMD parameter "Delay on stop"). At standstill the output signal A1 becomes =1. The positioning process is continued by a renewed positive edge of the start signal. The change of the output values through an adjustable acceleration takes place both at the start and on braking to the end position (SFKMD parameter "Acceleration").
Apart from the possibility of defining the positioning velocity as SFKMD parameter, there is moreover the possibility of inputting the velocity depending upon input increments at the data holder input interface (cf. Section 3.12.4.1). The positioning process can be coupled with regard to velocity to a master axis by this.
With an "External velocity input" the same statements as for an "Internal velocity input" apply regarding the start signal E1.

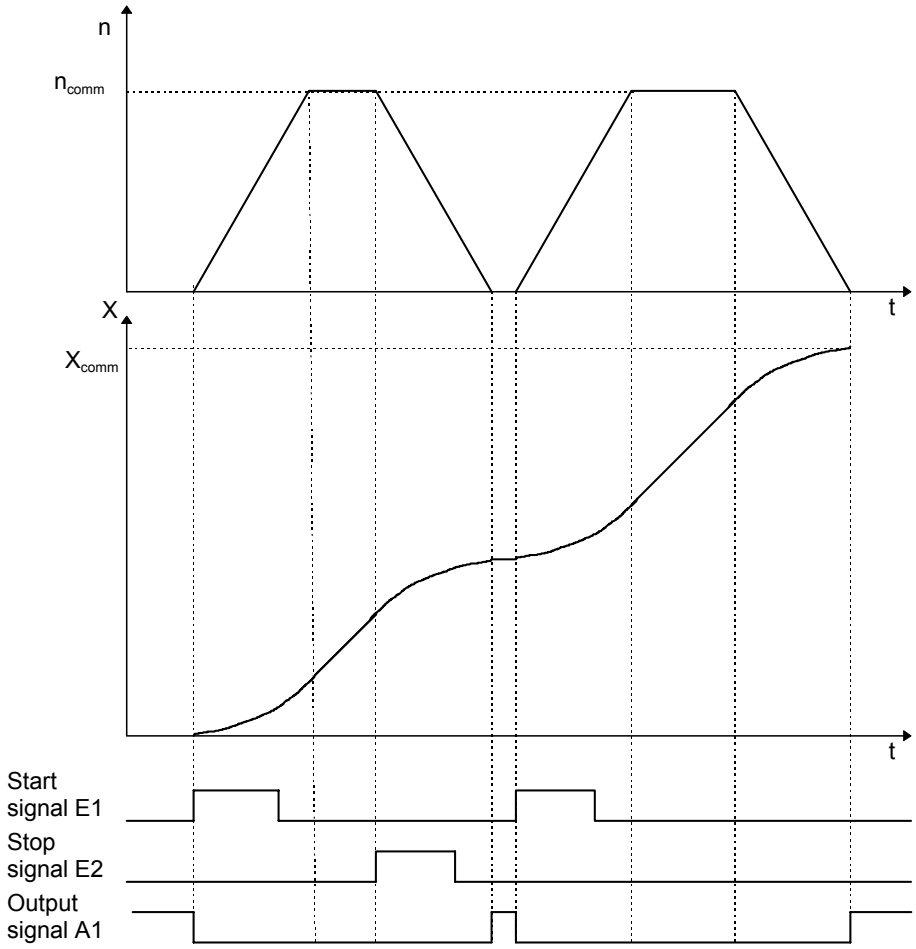


Figure 48: Course of "Relative positioning" with stop

The different operating modes are selected by means of SFKMD-BA within the scope of SF commanding (FB208), cf. Section 3.6.2.2.

Operating modes:

- Bit 0 "Internal velocity input / External velocity input":
  - On "Internal velocity input" the movement sequences displayed in the preceding figures result. The ramp height (velocity) and the ramp slope (acceleration) result from the SF command parameters.
  - On "External velocity input" the ramp height (velocity) is determined by an external input of distance increments (e.g. by a master drive or an EDG). The number of the distance increments per time interval results in this case in the velocity input.
    Remarks: The SF EPOS requires a suitable 16-bit source for this (e.g. Config.-AZ message1 configured on pulse generator input AZ by means of ID 32786).
    Different encoder resolutions can be adapted by reference to the SFKMD parameter "Encoder resolution" and "Encoder resolution ext. master".
- Bit 1 "Relative positioning"/"Substitutional positioning":
  Selection of the "relative" or "substitutional" positioning

- Bit 2 "Enable direction reversal":
  If in the "Substitutional positioning" operating mode the distance defined as position command value is shorter than the distance resulting from the brake ramp and the direction reversal is enabled, then the drive moves beyond the end position and is positioned back on this. In the other case the drive is stopped at the defined end position without observation of the brake ramp.
- Bit 3 (is evaluated only if Bit 4 = 0)
  "Enable of a renewed start signal with still running positioning":
  - If a renewed start signal is not enabled during still running positioning, then the start can take place only after ending the preceding positioning process (output signal A1 = 1).
  - If a renewed start signal is enabled during still running positioning, then one or several starts can also be triggered during positioning. The travel of the renewed positioning is added to the residual distance still remaining in the current positioning. If the sign of the travel of the current and of the renewed positioning are unequal, then the movement direction is reversed immediately. In this case the end position of the current positioning process is not reached.

  If the substitutional positioning operating mode is selected, a renewed start can **always** take place only after ending positioning.

- Bit 4 (modulo positioning: only valid within the scope of "Relative positioning")
  "Preventing the ramp-down process (except for stop ramp) and positioning enable of a renewed modulo value (travel) with still running positioning as well as setting output signal A2":
  - If at the time of initiating a ramp-down process the input signal E 1 = 1, there is no ramp down, but the drive continues to run (with $n_{feedback}$ equal to n_{comm}) up to the end of the current modulo value (travel) and then by a further modulo value
  - After ending a ramp-up process (then $n_{feedback}$ is equal to n_{comm}) output signal A2 is set (0 -> 1)
  - With initiation of a ramp-down process (then $n_{feedback}$ is unequal to n_{comm}) output signal A2 is reset (1 -> 0)
  - Bit 3 is not evaluated with bit 4 set.

It should further be observed:

- The speed ramp slope (acceleration) as well as other information are input by means of parameters in the course of SF commanding.
- A velocity override (0% .. approx. ±3200%) can be superimposed by means of a flag word configurable by parameters.
  Remarks: There is no value output at override = 0%!
- All velocity changes are made through a parameterizable acceleration (speed ramp).
  Exception: "Substitutional positioning"; if position command value is less than braking distance and "Direction reversal" is not enabled.
- An acceleration override (10% .. 100%) can be superimposed through a further flag word configurable by means of parameters (cf. Section 3.12.4.2; DW17). The override value is evaluated at every new start switch-on edge (0 -> 1) of input signal E1.
- The drive must be in the position control operating mode for the "Substitutional positioning" operating mode. The drive must be commanded before the first positioning by means of FB201 with the drive command "AW special function continuous homing" (FB 201: DL2 = 16, DL3 = 1, DW5 = 1; cf. Section 3.12.5.3).
- The following parameters can be changed while the SF is active with the aid of the "VALUE NEW" SF command:
  - Position command value (travel),
  - Velocity,
  - Acceleration,
  - Deceleration for stop.

  Acceleration and "Deceleration for stop" become effective immediately with the "VALUE NEW" commanding. The position command value and the velocity become effective only for a following positioning order (triggered by a renewed start edge at E1).

3.12.4 User interface of the SF EPOS

3.12.4.1 Prerequisites and marginal conditions

- Expedient settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32805):

BA command value source = 3C (hexadecimal; commanding interface)

Position control without following error compensation, synchronous ratio (ID 32892, ID 32893) is effective:

⇒ SF sink = 16-bit command value source

- Example: ID 32800 = 3C0004

Position control with fine interpolation (not with substitutional positioning; cf. Table 45):

⇒ SF sink = 32-bit command value source

- Example: ID 32800 = 3C0404

- In the parameter 32-bit AW message (ID 32786) the position feedback value + following error (ID33097) must be defined.
- Expedient settings of the EPOS data holder interfaces within the scope of FB 207:

Internal velocity input		
Source address	Offset	**Meaning** / remarks
0	0	Not required on internal velocity input
External velocity input		
Source address	Offset	**Meaning** / remarks
0	1,3,5,7	Config.-AZ message1, 2, 3, 4 (High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32)
1..8	3	Config.-AW message32 (Low Word) of AW1..8 / configurable by means of ID 32786; only position command or feedback values are expedient
1..8	5	Position feedback value (Low Word) of AW1..8
128	0,2,4 ..126	Flag range of the PS / MW 0, .. ,126
130	0,2,4 ..30	Input range of the PS process image / EW 0, .. ,30
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2 .. 7 / for logic operation with the corresponding SF1, 2, .. 7
Internal or external velocity input		
Sink address	Offset	**Meaning**
1..8	4	16-bit command value source of AW1..8 / ID 32892, ID 32893 are effective
1..8	16	32-bit command value source of AW1..8 / fine interpolator (FIPO) through ID 32800.. ID 32809 can be used; ID 1 = ID 2 required (FIPO not with "Substitutional positioning" BA; e.g. ID 32800=3C0004)
128	0,2,4 .. 126	Flag range of the PS / MW 0, .. ,126 (not "Substitutional positioning" BA)
129	0,4,8 .. 124	Flag range of the PS / MD 0, .. ,124 (not "Substitutional positioning" BA)
255	0	Internal sink for logic operation with further SF without output on an AW (not "Substitutional positioning" BA)

Table 45: Settings of the EPOS data holder interfaces (SF source/sink)

3.12.4.2 Structure and parameters of the SF commanding DB

Data	High word		Low word	
double word	**High byte**	**Low byte**	**High byte**	**Low byte**
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		Reserved = 0	
04	Position command value (travel)			
06	Velocity			
08	Acceleration			
10	Deceleration at stop			
12	Drive encoder resolution			
14	Ext. master encoder resolution in ext. command value input BA			
16	Accel. override address		Velocity override address	
18	Reserved = 0			
20	Reserved = 0			
22	Reserved = 0			
24	Reserved = 0			
26	Reserved = 0			
32	Reserved = 0			

Total number: 34 data words

Table 46: EPOS commanding DB

SF number (DR0)

- Meaning: SF number under which a SF of the SF type 11 was initialized by means of FB 207.
- Value range: 0 .. 15

SFKMD fct (DL 0)

- Meaning: Not used.
- Value range: 0

SFKMD code (DR 1)

- Meaning: Code of the SF command.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): Start SF
  5 (VALUE NEW): Transfer of new parameters to the active SF

SFKMD-BA (DL 1)

- Meaning: Selection of the operating mode.
- Value range: 0 .. 31
  bit-coded:
  Bit 0 = 0: Internal velocity input
  Bit 0 = 1: External velocity input
  Bit 1 = 0: "Relative positioning"
  Bit 1 = 1: "Substitutional positioning"
  Bit 2 = 0: No direction reversal
  Bit 2 = 1 Direction reversal enable
  Bit 3 = 0: No start if a positioning active (no retriggering)
  Bit 3 = 1: (is only evaluated at Bit 4 = 0)
  renewed start also permitted during active positioning (retriggering possible)

Bit 4 = 0: No setting of the output signal A2 and no prevention of the ramp-down process or no travel extension (modulo positioning)
Bit 4 = 1: (Modulo positioning: only appropriate for "Relative positioning")
Retriggering after Bit 3 = 1 not effective
Setting output signal A2:
as soon as $n_{feedback}$ is equal to n_{comm}: A2 = 1
as soon as $n_{feedback}$ is unequal to n_{comm}: A2 = 0
with set input signal E1 (= 1) at the time of initiating a ramp-down process:
Preventing the ramp-down process (except for stop ramp) and positioning enable of a renewed modulo value (travel)

SF cycle time (DW 3)

- Meaning: Time in which the SF is called cyclically. (This time is determined by ID 2 = SERCOS cycle time)
- Value range: 1 to 131 In the "Relative positioning" operating mode
  2 to 18 In the "Substitutional positioning" operating mode
- Unit: 0.5 ms
- Example: Value = 2 $\Rightarrow$ SF cycle time = 1 ms

Position command value (travel) (DD 4)

- Meaning: "Relative positioning": increments which are output per positioning
  "Substitutional positioning": increments which are output related to the reference signal
- Value range: $-2^{31}..+2^{31}-1$
- Unit: Increments

Velocity (DD 6)

- Meaning: Velocity during positioning. In the "Relative positioning" operating mode only the absolute value of the velocity is of importance. In the "Substitutional positioning" operating mode the sign of the velocity determines the approach direction.
- Value range: $1..+2^{31}-1$ In the "Relative positioning" operating mode
  $-2^{31}..-1, +1..+2^{31}-1$ In the "Substitutional positioning" operating mode
- Unit: 0.0001 rpm

Acceleration (DD 8)

- Meaning: Acceleration or deceleration value.
- Value range: $1..+10^8$
- Unit: 0.001 revolutions/s^2

Deceleration at stop (DD 10)

- Meaning: Deceleration value at stop.
- Value range: (DD 8) $..+10^8$
- Unit: 0.001 revolutions/s^2

Drive encoder resolution (DD 12)

- Meaning: Encoder resolution of the drive which should be positioned.
- Value range: 1 .. $+2^{31}$-1
- Unit: incr

Ext. master encoder resolution in "Ext. command value input" BA (DD 14)

- Meaning: Acceleration or deceleration value.
- Value range: 1 .. $+2^{31}$-1
- Unit: incr

Velocity override address (DW 16)

- Meaning: Flag word address which is used for forming a velocity override.
  Remarks: An override value of 1024 corresponds to 100%. The input range for the override value is 0 .. +32767 (0 .. approx. 3200%). There is no value output at an override value of 0!
- Value range: 0: No velocity override function.
  2, 4, 6, ..,126: Flag word address with regard to the velocity override function.
  Remarks: MW address 1, 3, .., 127 acts like the next lower even MW address (0, 2, .., 126)

Acceleration override address (DW 17)

- Meaning: Flag word address which is used for forming an acceleration override.
  Remarks: An override value of 1024 corresponds to 100%. The input range for the override value is 0 .. +32767, however there is a limitation to minimum 10% and maximum 100%. Values from 0 to 101 are set internally to 102 (10%) and values above 1024 to 1024 (100%).
  The override value is effective only with every new start switch-on edge (0 -> 1) of the input signal E1.
- Value range: 0: No acceleration override function.
  2, 4, 6, ..,126: Flag word address with regard to the acceleration override function.
  Remarks: MW address 1, 3, .., 127 acts like the next lower even MW address (0, 2, .., 126)

3.12.5 Examples

The drive 1 (AW1) should be positioned from movement to a certain position after a reference signal. In this case the drive movement should be started with a signal and can be stopped or continued at any time. A direction reversal may not take place. Before the start of the SF "EPOS" in the "Substitutional positioning" operating mode, drive commanding with the commanding function 16 must be performed through FB201 (cf. remarks on Section 3.12.2).

3.12.5.1 Drive commanding

```
; DB for the drive commanding through FB201
;
:KB 0       ;DR0  Drive identifier              AW1
:KB 0       ;DL0  Commanding mode               Without change KMD_VAR
:KB 0       ;DR 1 E/A-M mode                    E/A
:KB 0       ;DL 1 SF cycle time factor          Default = 1
:KB 1       ;DR2  Commanding code               Start
:KB 16      ;DL2  Commanding function           AW special function
:KB 0       ;DR3  Commanding operating mode     Not used
:KB 1       ;DL3  Parameter bit mask            Commanding variable1
:KF 0       ;DW4  Reserved                      Not used
:KF 1       ;DW5  Special function code         Continuous homing
:KD 0       ;DD6  Commanding variable2          Not used
:KD 0       ;DD8  Commanding variable3          Not used
:KD 0       ;DD10 Commanding variable4          Not used
:KD 0       ;DD12 Commanding variable5          Not used
:KD 0       ;DD14 Commanding variable6          Not used
```

3.12.5.2 Initializing the SF EPOS

```
; DB for initializing the SF "EPOS" (SF extended positioning) through FB207
;
:KB 11      ;DR0  SF type               EPOS
:KB 0       ;DL0  SF number             SF0
:KB 0       ;DR1  E/A-M mode            E/A
:KB 0       ;DL1  SF cycle time factor  Default (=1)
:KB 0       ;DR2  Source adr. offset    Not used
:KB 0       ;DL2  Source address        Not used
:KB 4       ;DR3  Sink address offset   16-bit command value source
:KB 1       ;DL3  Sink address          AW1
:KB 16      ;DR4  E bit mask            E-Bit 4 = Start continue input (E1)
            ;                           E-Bit 5 = Stop input (E2)
:KB 8       ;DL4  E byte address        EB 8
:KB 16      ;DR5  A bit mask            A-Bit 4 = Inactive stop/active output (A1)
:KB 8       ;DL5  A byte address        AB 8
:KB 0       ;DR6  Tab0 DB No            Not used
:KB 0       ;DL6  Tab1 DB No            Not used
:KB 0       ;DR7  Tab2 DB No            Not used
:KB 0       ;DL7  Tab3 DB No            Not used
:KB 0       ;DR8  Tab4 DB No            Not used
:KB 0       ;DL8  Tab5 DB No            Not used
:KB 0       ;DR9  Tab6 DB No            Not used
:KB 0       ;DL9  Tab7 DB No            Not used
```

3.12.5.3 Commanding the SF EPOS

```
; DB for commanding the SF "EPOS" (SF extended positioning) through FB208
;
:KB 0          ;DR0  SF number                SF0: EPOS corresponds to SF-Init.
:KB 0          ;DL0  SFKMD fct                Not used
:KB 1          ;DR1  SFKMD code               Start
:KB 2          ;DL1  SFKMD-BA                 Internal velocity input
               ;                              Substitutional positioning
               ;                              No direction reversal
               ;                              No retriggering
:KF 0          ;DW2  Reserved
:KF 2          ;DW3  SF cycle time            1 ms
:KD 20000      ;DD4  Position command value   20000 incr
:KD 1000000    ;DD6  Velocity                 100 rpm
:KD 200000     ;DD8  Acceleration             200 rev./ss
:KD 800000     ;DD10 Deceleration at stop     800 rev./ss
:KD 20000      ;DD12 Drive encoder resolution 20000 incr
:KD 0          ;DD14 Ext. master encoder res. Not relevant
:KF 0          ;DW16 v override address       No velocity override
:KF 0          ;DW17 b override address       No acceleration override
:KD 0          ;DD18 Reserved
:KD 0          ;DD20 Reserved
:KD 0          ;DD22 Reserved
:KD 0          ;DD24 Reserved
:KD 0          ;DD26 Reserved
:KD 0          ;DD28 Reserved
:KD 0          ;DD30 Reserved
:KD 0          ;DD32 Reserved
```

3.13 "SF CAM" Cam controller

SF type = 12

The "SF CAM" allows a configurable output of maximum 8 binary signals (tracks) as function of a SF source (e.g. distance information) in the form of a cam controller. This means the signal states of the binary outputs can be determined by means of a cam table (a data block) e.g. depending upon position values. Moreover, analogously to the SF BINEA, there is the possibility of the Boolean logical operation of these signals with one binary input signal in each case.
In contrast to the SF BINEA, all switching points (cams) can be defined independently of one another in the cam table of the SF CAM. Further, all parameters of the cam table can be changed online, i.e. while the SF is started.
As from version AZ-PS4 V02.13 a hysteresis characteristic can be selected per track (cf. Section 3.13.2.2).

3.13.1 Principle of "SF CAM"

The SF CAM comprises the structure shown in Figure 28. The forming regulation for generating the internal variable x' results due to the SFKMD-BA as follows:

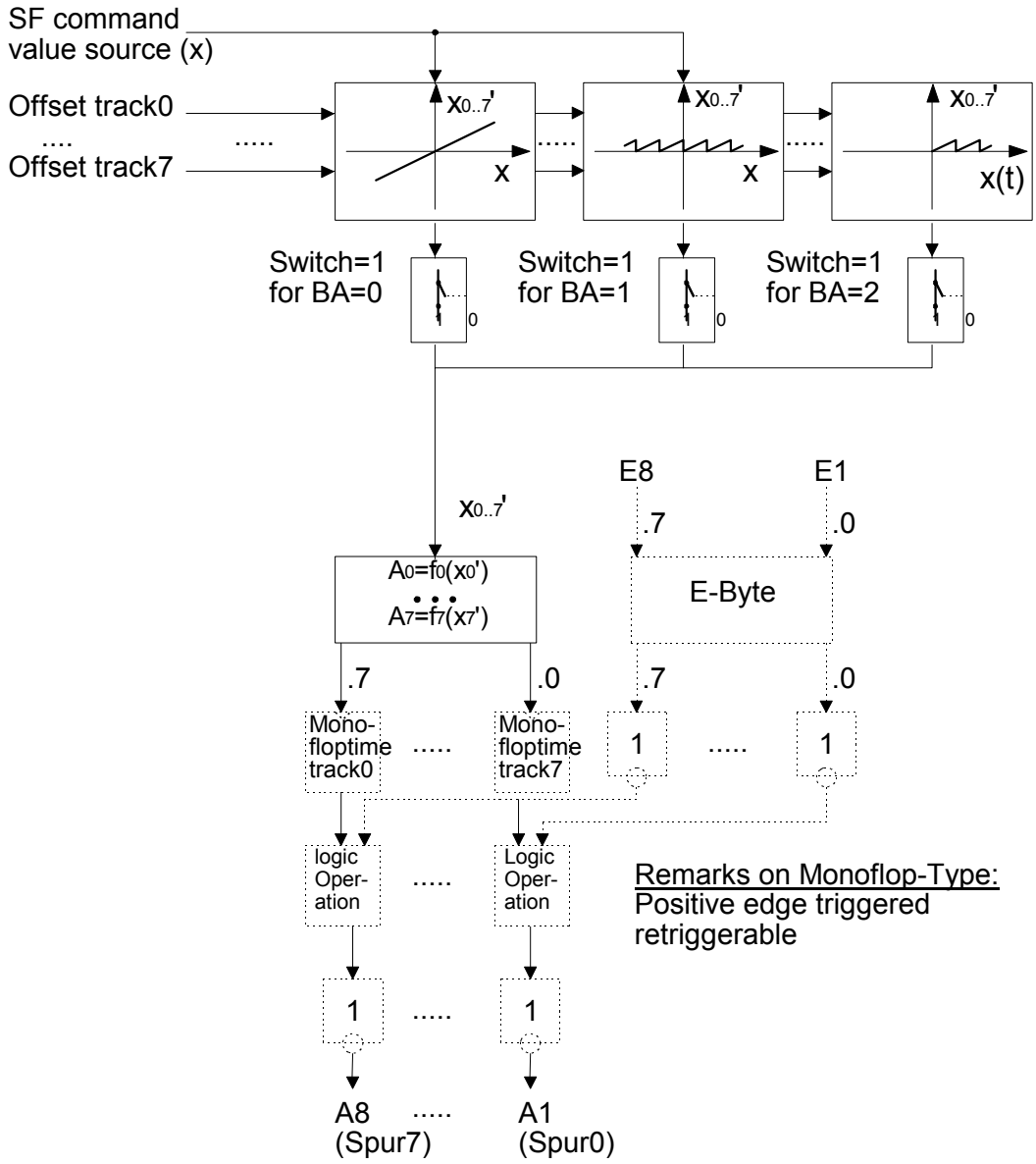
Operating modes:
- *"Absolute feedback value input"(BA = 0):* The SF source information (x) is treated as 32-bit signed fixed point number (32-bit integer value). Overshooting at the travel end is limited.
- *"Incremental feedback value input" (BA = 1):* The SF source information (x) is treated as 16-bit signed fixed point number (16-bit integer value). The feedback value differences of two consecutive source informations are summed to a positive 32-bit value by the SF. On exceeding a configurable modulo value (cf. Section 3.9.2.2, DD14; e.g. increments per revolution) a renewed start is made at value 0 (modulo counting).
- *"Time mode" (BA = 2):* This operating mode works analogously to the "Incremental feedback value input". The sole difference is that the feedback value input (x) is not derived from a SF source value, but from a cycle time that can be input in the cam table (cf. Section 3.13.3.3, DW0).

The dashed parts according to Figure 28 can be configured individually by means of the SF commanding DB parameters "Mode track0 .. Mode track7" per track (binary output) (cf. Section 3.9.2.2).

The cam table DB header parameters
- Feedback value offset,
- Dead time,
- Monoflop time,

facilitate while the SF is started (online) per track

- a shift of the SF source information by an additive part,
- input of a dead time to be compensated,
- input of the monoflop time constant, if a monoflop was configured for this track.



BA	SFKMD-operating mode	$A_i=f_i(x_i')$	with i=0..7: corresponding to the cam
E1..E8	Logical input 1.. 8		Definition of track i according to
A1..A8	Logical output 1 .. 8 (Track0 .. Track7)		The cam table and the x_i position

Figure 49: Principle of the "SF CAM"

The formation of the absolute feedback value offset per track is based on the summation of the offset differences of the relevant offset track X values of the cam table (cf. Section 3.13.3.3, DW8..DW15). The absolute amount of the value change per SF cycle must be less than 2^{15} in this case! In the "Absolute feedback value input" operating mode (0) the value changes are summed to form a 32-bit variable. In the "Incremental feedback value input" and "time mode" operating modes (1,2) the value changes are summed to the modulo value (cf. Figure 28). The current offset can be checked by means of the SF sink (cf. Section 3.13.2.1) and the track selection through the cam table (cf. Table 49, DR1).

The switching points of the maximum 8 tracks can be defined in the cam table by inputting the cam switch-on/off position. A maximum of 56 cams can be distributed arbitrarily over the 8 tracks. The subdivision of the cams per track is determined in the course of SF commanding (cf. Section 3.9.2.2, DR6..DL9). The switching positions of the cams in the cam table (cf. Section 3.13.3.3, DD32/DD34, ...) can be changed online, i.e. while the SF is started.

3.13.2 AWL interface of the SF CAM

3.13.2.1 Prerequisites and marginal conditions

The settings of the drive basic system operating mode (cf. documentation: Parameters; ID 32800..32809) are without significance for the SF CAM. Only a flag word for displaying the current offset shift comes into question as SF sink.

Absolute feedback value input		
Source address	**Offset**	**Meaning / remarks**
1..8	19	Config.-AW message32 of AW1..8 / configurable by means of ID 32786; only position command or feedback values are expedient
1..8	21	32-bit position feedback value of AW1..8
129	0,4,8.. 124	Flag double word range of the PS / MD 0, .. ,124
131	0,4,8.. 28	Input double word range of the PS process image / ED 0, .. ,28
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2 .. 15 (for logic operation with the corresponding SF1, 2, .. 15)
Incremental feedback value input		
Source address	**Offset**	**Meaning / remarks**
0	1,3,5,7	Config.-AZ message1, 2, 3, 4 (High Word) / configurable by means of ID 32948; e.g. on pulse generator input AZ (terminal X32)
1..8	3	Config.-AW message32 (Low Word) of AW1..8 / configurable by means of ID 32786; only position command or feedback values are expedient
1..8	5	32-bit position feedback value (Low Word) of AW1..8
128	0,2,4 ..126	Flag word range of the PS / MW 0, .. ,126
130	0,2,4 ..30	Input word range of the PS process image / EW 0, .. ,30
255	0,1,2 .. 7	Sink of the SF with the number 0, 1, 2 .. 15 (for logic operation with the corresponding SF1, 2, .. 15)

Time mode		
Source address	**Offset**	**Meaning / remarks**
0	0	Not required in the time mode
Absolute / incremental feedback value input or time mode		
Sink address	**Offset**	**Meaning**
0	0	No sink required
129	0,4,8.. 124	Flag double word of the PS / MD 0, .. ,124; for controlling the offset shift per track (with selection of the track in the cam table)

Table 47: Settings of the SF CAM data holder interfaces (SF source/sink)

3.13.2.2 Structure and parameters of the SF commanding DB

Data double word	High word		Low word	
	High byte	Low byte	High byte	Low byte
00	SFKMD-BA	SFKMD code	SFKMD fct	SF number
02	SF cycle time		Reserved = 0	
04	Reserved = 0		Dead time mean factor	
06	Cam track3	Cam track2	Cam track1	Cam track0
08	Cam track7	Cam track6	Cam track5	Cam track4
10	Mode track3	Mode track2	Mode track1	Mode track0
12	Mode track7	Mode track6	Mode track5	Mode track4
14	Modulo value			
16	Hysteresis track1		Hysteresis track0	
18	Hysteresis track3		Hysteresis track2	
20	Hysteresis track5		Hysteresis track4	
22	Hysteresis track7		Hysteresis track6	
24	Reserved = 0			
..	..			
32	Reserved = 0			

Total number: 34 data words

Table 48: CAM commanding DB

SF number (DR0)
- Meaning: SF call number under which a SF of the SF type 12 was initialized by means of FB 207.
- Value range: 0 .. SF-Nr-Max (cf. "Abbreviations and designations")

SFKMD fct (DL 0)
- Meaning: Number of additional functions.
- Value range: Reserved = 0

SFKMD code (DR 1)
- Meaning: Code of the SF command.
- Value range: 0 (RESET): SF resetting into basic status
  1 (START): Start SF

SFKMD-BA (DL 1)

– Meaning: Selection of the operating mode.
– Value range: 0: Absolute feedback value input
1: Incremental feedback value input
2: Time mode

SF cycle time (DW 3)

– Meaning: Time Tsf in which the SF is called cyclically. (This time is determined by ID 2 = SERCOS cycle time.)
– Value range: 1 to +131
– Unit: 0.5 ms
– Example: Value = 2 ⇒ SF cycle time Tsf = 1 ms

Dead time mean factor (DW 4)

– Meaning: In the course of the dead time compensation an offset (lead) depending upon the current velocity of the binary information is performed. For damping the influence of velocity changes, a mean value is formed over several velocity values. The dead time mean factor determines the number of the SF cycles (velocity values) over which the mean value is formed.
– Value range: 0 .. 30000
0: Default value (⇒ 20 SF cycles)
1: No mean value formation
Otherwise: Number of the SF cycles over which the mean value is formed.
– Unit: SF cycles

Cam track0 .. Cam track7 (DR 6 .. DL9)

– Meaning: Number of cams per track0 .. track7. (In this way the structure of the cam table is determined)
– Value range: 0..56
0: The track is not used (has no cams).
1..56: 1..56 cams are planned for the track.
– Unit: Cams per track in the cam table.
– Remarks: The sum of all cams of all tracks may be maximum 56! Excess cams can also be deactivated in that switching on/off point have the same value (cf. Section 3.13.3.3).
For running time reasons only as many cams per track should be configured as necessary. Further only so many tracks should be configured as necessary; in this case the tracks should be occupied starting from track0.

Mode track0 .. Mode track7 (DR 10 .. DL13)

– Meaning: Mode in which track0 .. track7 is operated.
– Value range: bit-coded
– Bit 0 = 1: The output bit of the track is inverted
– Bit 1 = 1: The input bit of the track is inverted
– Bit 3/2 = 0/0: No logic operation with the input bit of the track
= 0/1: AND operation with the input bit of the track
= 1/0: OR operation with the input bit of the track
– Bit 4 = 0: Direct output of the track information.
= 1: Monoflop mode; i.e. the track information change "0"→"1" triggers a retriggerable monoflop with the track-dependent time constant according to the cam table (cf. Section 3.13.3.3).
– Bit 5 = 1: The output bit of the track is switched off (is not updated)

– Example: Value = 0 ⇒ Pure cam controller:
- No A bit inversion,
- No E bit inversion,
- No logic operation with the input bit of the track,
- The current cam state determines the track output
- The output bit of the track is output

Modulo value (DD14)

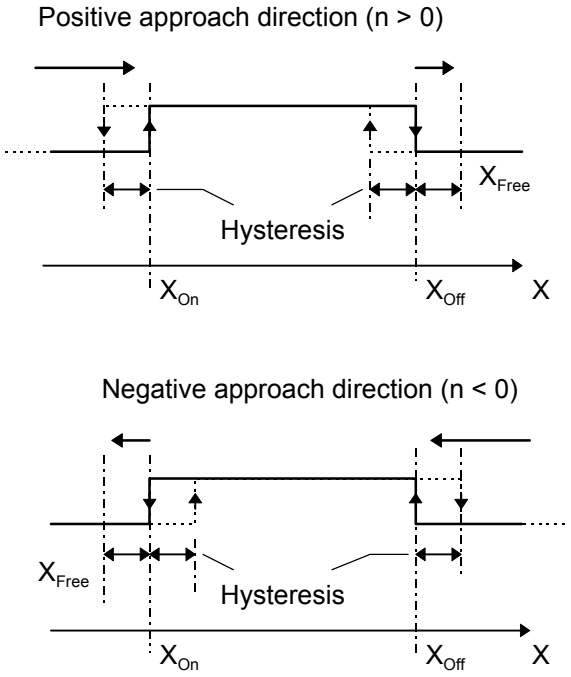
– Meaning: x value (or X' value) according to Figure 28, at which it is renewed started with value "0" in the "Incremental feedback value input" and "time mode" operating modes.
– Value range: $0..2^{30}-1$
– Unit: Increments
– Example: 20000 ⇒ per revolution; at an input encoder resolution of 20000 increments/revolution.

Hysteresis track0 .. Hysteresis track7 (DW16 .. DW23)

– Meaning: Hysteresis (H), with which the switch-on and off edge (X_{On} , X_{Off}) of a cam signal of the track0 (.. track7) is affected.
– Value range: 0: No hysteresis
1..65535: Hysteresis active
– Unit: 100 increments
– Example: 10 ⇒ Hysteresis = 1000 increments.
– Remarks: In connection with a dead time compensation, the hysteresis must be selected greater than the dead time compensation distance X_{tot}, whereby: $X_{tot} = T_{tot} * n * G / 60000$ (with: X_{tot} = dead time compensation distance in increments, T_{tot}= dead time in milliseconds, n = speed in revolutions/minute, G = encoder resolution in increments/revolution).

The following must apply in the "Incremental feedback value input" operating mode:
if $X_{Off} > X_{On}$: $H <$ modulo value - $(X_{Off} – X_{On})$;
if $X_{Off} < X_{On}$: $H < (X_{On} - X_{Off})$.

Caution: For reasons of computer loading, the hysteresis formation should be deselected (value = 0) for tracks for which no hysteresis is required.



The above figures show the principle of hysteresis formation (X_{On}, X_{Off} according to cam table):
- For positive approach direction (n > 0: X becoming larger).
- For negative approach direction (n < 0: X becoming smaller).

The following characteristic results for a "Positive approach direction":
- Proceeding from a position $X < X_{On}$, the cam information "0" is output.
- As from the position $X \geq X_{On}$ the cam information "1" is output.
- On turning back to the position $X \geq X_{On}$ - H (hysteresis) the cam information "1" is retained. (On further turning back the cam information "0" is output.)
- On turning forwards the cam information "0" is output from the position $X \geq X_{Off}$.
  - If the drive is turned back before reaching the position $X = X_{Free} = X_{Off} + H$ up to the position $X \geq X_{Off}$ - H (hysteresis), then the cam information "0" is retained. (On further turning back the cam information "1" is output.)
  - If after reaching the position $X \geq X_{Free}$ the drive is turned back, then the cam signal is formed according to the "Negative approach direction".

The following characteristic results for a "Negative approach direction":
- Proceeding from a position $X \geq X_{Off}$, the cam information "0" is output.
- As from the position $X < X_{Off}$ the cam information "1" is output.
- On turning forwards to the position $X < X_{Off} + H$ (hysteresis) the cam information "1" is retained. (On further turning forwards the cam information "0" is output.)
- On turning back the cam information "0" is output as from the position $X < X_{On}$.
  - If the drive is turned forwards before exceeding the position $X = X_{Free} = X_{On} - H$ up to the position $X < X_{On} + H$ (hysteresis), then the cam information "0" is retained. (On further turning forwards the cam information "1" is output.)
  - If after reaching the position $X < X_{Free}$ the drive is turned forwards, then the cam signal is formed according to the "Positive approach direction".

Switching over between hysteresis formation for positive (or negative) approach direction thus occurs if the cam is run over by at least the hysteresis amount (or the hysteresis amount+1). This means the position X_{Free} was reached (or exceeded). (In the direction in which the cam was approached.)

3.13.2.3 Structure of the cam table

Data double word	High word		Low word
00	Reserved = 0	Track selection	Cycle time
02	Reserved = 0		
04	Reserved = 0		
06	Reserved = 0		
08	Offset track1		Offset track0
10	Offset track3		Offset track2
12	Offset track5		Offset track4
14	Offset track7		Offset track6
16	Dead time track1		Dead time track0
18	Dead time track3		Dead time track2
20	Dead time track5		Dead time track4
22	Dead time track7		Dead time track6
24	Monoflop time track1		Monoflop time track0
26	Monoflop time track3		Monoflop time track2
28	Monoflop time track5		Monoflop time track4
30	Monoflop time track7		Monoflop time track6
32	Cam0 track0-On position [1)]		
34	Cam0 track0-Off position [1)]		
36	Cam1 track0-On position [1)]		
38	Cam1 track0-Off position [1)]		
40	Cam0 track1-On position [1)]		
42	Cam0 track1-Off position [1)]		
44	Cam1 track1-On position [1)]		
46	Cam1 track1-Off position [1)]		
48	Cam0 track2-On position [1)]		
..	..		
86	Cam1 track6-Off position [1)]		
88	Cam0 track7-On position [1)]		
90	Cam0 track7-Off position [1)]		
92	Cam1 track7-On position [1)]		
94	Cam1 track7-Off position [1)]		
..	..		

Total number: max. 256 data words

Table 49: Cam table DB

Remarks for [1)]: The cam on/off position points must be entered in the cam table DB commencing from DD32. The order is beginning from track0 to track7. The number of the cams per track must be taken into account (according to cam track0 .. cam track7, DR6 .. DL9; cf. Section 3.13.3.2). The above example according to Table 49 shows a configuration with 8 tracks of 2 cams.

Cycle time **(DW 0)**

- Meaning: Cycle time which with the cam table is processed in the time mode (SFKMD-BA = 2) within the modulo limit.
- Value range (time mode):
  SF cycle time .. 2^{15}-1
- Unit: 0.5 ms
- Example: Value = 1000 ⇒ Cycle time = 500 ms

Track selection (DR 1)

- Meaning: Selection of the track the current offset of which is output by means of the SF sink (cf. Section **Fehler! Verweisquelle konnte nicht gefunden werden.**).
- Value range: 0..7
- Example: Value = 0 ⇒ Track = Track0

Offset track0 .. Offset track7 (DW 8 .. DW15)

- Meaning: Feedback value offset per track which is calculated additively to the SF source value.
- Value range: -2^{15} .. 2^{15} -1
- Unit: Increments
- Remarks: The absolute amount of the value change per SF cycle must be less than 2^{15}! In the "Absolute feedback value input" operating mode the value changes are summed to form a 32-bit variable. In the "Incremental feedback value input" and "time mode" operating modes the value changes are summed modulo with the modulo value.

Dead time track0 .. Dead time track7 (DW 16 .. DW23)

- Meaning: Dead time per track which is compensated for by velocity proportional lead of the track.
- Value range: SF cycle time .. 2^{15}-1
  0: No dead time compensation
  Otherwise: Dead time
- Unit: 0.5 ms
- Example: Value = 20 ⇒ Dead time = 10 ms
- Remarks: The dead time compensation is provided with an inaccuracy of up to 1ms due in principle to the asynchronous output of the binary signals in the 1ms grid.

Monoflop time track0 .. Monoflop time track7 (DW 24 .. DW31)

- Meaning: Monoflop time constant per trackX which, on selection by mode trackX, bit 4, is effective at the series connected monoflop of the track (cf. Section 3.13.3.2).
- Value range: SF cycle time .. 2^{15}-1
- Unit: 0.5 ms
- Example: Value = 200 ⇒ Monoflop time = 100 ms

CamX trackY-On position (DD 32, DD 36, .. ,DD252)

- Meaning: Position from which the track information "1" is set.
- Value range: -2^{31} .. 2^{31}-1
- Unit: Increments

CamX trackY-Off position (DD 34, DD 38, .. ,DD254)

- Meaning: Position from which the track information "0" is set.
- Value range: -2^{31} .. $2^{31}-1$
- Unit: Increments

Remarks: The camX trackY on/off positions must be entered in the cam table starting from DD32. The order is beginning from track0 to track7. The number of the cams per track must be taken into account (according to cam track0 .. cam track7, DR6 .. DL9; cf. Section 3.13.3.2).

The value range of the cams comprises the full 32-bit range. However, the position of the track can use this range only in the "Absolute feedback value input" operating mode. In the "Incremental feedback value input" and "time mode" operating modes, solely the value range "0, .., modulo value" is reached.

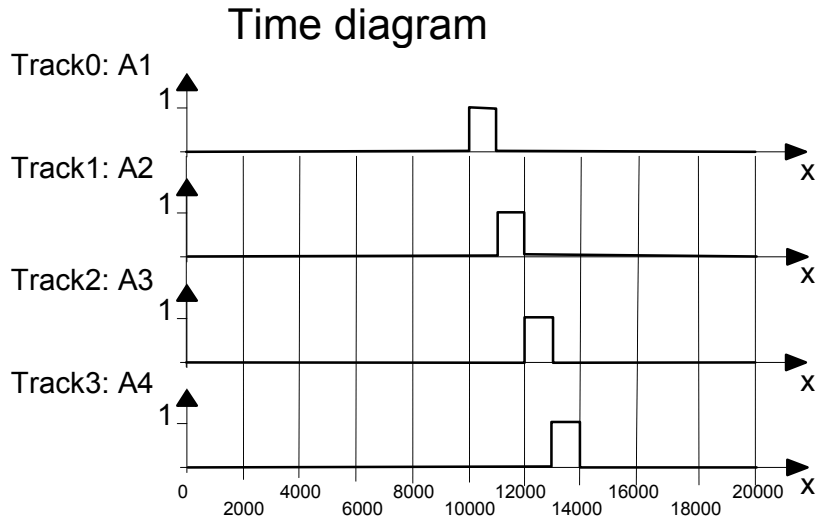
Cam of a track the on/off positions of which overlap act like one cam over the common on/off range.

Cams of a track with the same on/off position have no influence on the track information (are inactive).

All parameters of the cam table can be overwritten online, i.e. while the SF is started!

3.13.3 Example

Depending upon the position feedback value AW1 (x) the following signal profile regarding binary output A1..A4 must be realized (A1..A4 should be output on binary output A 1.0 .. A 1.3. For subsequent insertion of a further cam per track0..3, 2 cams per track0..3 must be configured in the cam table.



A1..4 Binary output 1..4
x SF source information (e.g. position feedback value increments)

Cam0 (Spur0): {10000, 11000}
Cam0 (Spur1): {11000, 12000}
Cam0 (Spur2): {12000, 13000}
Cam0 (Spur3): {13000, 14000}

Figure 50: Signal profile A1 / A2

3.13.3.1 Initializing the SF CAM

;DB for SF initialization (SF-Nr = 0)

;Header parameter

:KB 12	;(DR0) SF type	12 = CAM
:KB 0	;(DL0) SF number	0 = SF 0
:KB 0	;(DR1) E/A-M mode	0 = E/A
:KB 0	;(DL1) Cycle time factor ;	0: corresponds to factor = 1: i.e. cycle time = time according to ID 2

```
;Source/sink definition parameters
:KB 5       ;(DR2) Source adr. offset     5  = 32-bit position feedback value (Low Word)

:KB 1       ;(DL2) Source address         1 = AW1

:KB 0       ;(DR3) Sink address offset    DL3 = 0: 0 (no sink assignment)

:KB 0       ;(DL3) Sink address           0  = AZ

;Binary E/A definition parameters
:KB 1       ;(DR4) E bit mask             1 (corresponds to input bit x.0
            ;                                with x corresponding DL4 and DR1)
:KB 1       ;(DL4) E byte address         (depending upon DR1)
            ;                             DR1 = 0: 1 (corresponds to EB 1)
:KB 1       ;(DR5) A bit mask             1, (corresponds to output bit y.0
            ;                                 with y corresponding DL5 and DR1)
:KB 1       ;(DL5) A byte address         (depending upon DR1)
            ;                             DR1 = 0: 1  (corresponds to AB 1)

;Table definition parameters
:KB 56      ;(DR6) Tab0 DB No             DB 56 = Cam table
:KB 0       ;(DL6) Tab1 DB No             0..63 (0 -> no Tab1)
:KB 0       ;(DR7) Tab2 DB No             0..63 (0 -> no Tab2)
:KB 0       ;(DL7) Tab3 DB No             0..63 (0 -> no Tab3)
:KB 0       ;(DR8) Tab4 DB No             0..63 (0 -> no Tab4)
:KB 0       ;(DL8) Tab5 DB No             0..63 (0 -> no Tab5)
:KB 0       ;(DR9) Tab6 DB No             0..63 (0 -> no Tab6)
:KB 0       ;(DL9) Tab7 DB No             0..63 (0 -> no Tab7)
```

3.13.3.2 Commanding the SF CAM

;Prototype DB for SF-CAM commanding (SF-Nr = 0)

```
;Standard parameters
:KB 0       ;(DR0) SF number              0 (CAM corresponds to SF-Init.: DR0=8)

:KB 0       ;(DL00) SFKMD fct

:KB 1       ;(DR01) SFKMD code            1 = Start

:KB 1       ;(DL01) SFKMD-BA              1   = Incremental feedback value input

;Time parameters
:KF 0       ;(DW02) Reserved
:KF 2       ;(DW03) SF cycle time         2 * 0.5 ms (corresponds to ID2: e.g. 1 ms)

;Dead time mean factor
:KF 0       ;(DW04) Dead time mean fact.  0 (default = 20 SF cycles)
:KF 0       ;(DW05) Reserved

:KB 2       ;(DR06) cam track0            2 = 2 cams per track0
:KB 2       ;(DL06) cam track1            2 = 2 cams per track1
:KB 2       (DR07) cam track2             2 = 2 cams per track2
```

```
:KB 2       ;(DL07) cam track3          2 = 2 cams per track3
:KB 0       ;(DR08) cam track4          0 = No cam (Track4 inactive)
:KB 0       ;(DL08) cam track5          0 = No cam (Track5 inactive)
:KB 0       ;(DR09) cam track6          0 = No cam (Track6 inactive)
:KB 0       ;(DL09) cam track7          0 = No cam (Track7 inactive)

:KB 0       ;(DR10) Mode track0         Bit0 = 0    : Do not invert output bit
            ;                           Bit1 = 0    : Do not invert input bit
            ;                           Bit3,2 = 0,0: No logic operation (track bit with E bit)
            ;                           Bit4 = 0    : No monoflop mode
            ;                           Bit5 = 0    : A bit active
:KB 0       ;(DL10) Mode track1         (analogous to Mode track0)
:KB 0       ;(DR11) Mode track2         (analogous to Mode track0)
:KB 0       ;(DL11) Mode track3         (analogous to Mode track0)
:KB 0       ;(DR12) Mode track4         (analogous to Mode track0)
:KB 0       ;(DL12) Mode track5         (analogous to Mode track0)
:KB 0       ;(DR13) Mode track6         (analogous to Mode track0)
:KB 0       ;(DL13) Mode track7         (analogous to Mode track0)

;Modulo value for "Incremental feedback value input" and "time mode" operating mode
:KD 20000   ;(DD14) Modulo value        DL1 = 1: 0..2^30-1(increments)

:KF 0       ;(DW16) Hysteresis track0   0: No hysteresis
            ;                           x: Hysteresis = x * 100 increments
:KF 0       ;(DW17) Hysteresis track1
:KF 0       ;(DW18) Hysteresis track2
:KF 0       ;(DW19) Hysteresis track3
:KF 0       ;(DW20) Hysteresis track4
:KF 0       ;(DW21) Hysteresis track5
:KF 0       ;(DW22) Hysteresis track6
:KF 0       ;(DW23) Hysteresis track7
:KD 0       ;(DD24) Reserved
:KD 0       ;(DD26) Reserved
:KD 0       ;(DD28) Reserved
:KD 0       ;(DD30) Reserved
:KD 0       ;(DD32) Reserved
```

3.13.3.3 Cam table of the SF CAM

;Prototype DB of a cam table for SF "CAM"

```
;Remarks:
;- 1: The configuration of the table rump (from DD32) is determined by the
;     configuration of the cams per track (DR6..DL9; on SF commanding).
;     The total number of the cams may result in a maximum of 56.
;- 2: All table parameters can be changed online.
;- 3: The offset is formed from the offset changes after SF commanding
;     "Start" (by summation of the changes). The change per SF cycle time
;     may be maximum -2^15..+2^15-1.
;- 4: Cams with the same switching on and off point are ignored
;     (the cam is inactive).
```

```
;Adaptations to be made in principle
;DW00  Cycle time in "Time" operating mode
;DD32.. Cam on/off points

;Table header:
:KF 10000  ;DW00 Cycle time          0..2^15-1 (0.5 ms; e.g. 5s)
:KB 0      ;DR00  Track selection    0..7 (for offset display by SF sink)
:KB 0      ;DL01   Reserved
:KD 0      ;DD02  Reserved
:KD 0      ;DD04  Reserved
:KD 0      ;DD06  Reserved

;Offset per track
:KF 0      ;DW08  Offset track0      0..2^16-1: cf. Note 3 above
:KF 0      ;DW09  Offset track1      0..2^16-1: cf. Note 3 above
:KF 0      ;DW10  Offset track2      0..2^16-1: cf. Note 3 above
:KF 0      ;DW11  Offset track3      0..2^16-1: cf. Note 3 above
:KF 0      ;DW12  Offset track4      0..2^16-1: cf. Note 3 above
:KF 0      ;DW13  Offset track5      0..2^16-1: cf. Note 3 above
:KF 0      ;DW14  Offset track6      0..2^16-1: cf. Note 3 above
:KF 0      ;DW15  Offset track7      0..2^16-1: cf. Note 3 above

;Dead time per track
:KF 0      ;DW16  Dead time track0   0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW17  Dead time track1   0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW18  Dead time track2   0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW19  Dead time track3   0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW20  Dead time track4   0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW21  Dead time track5   0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW22  Dead time track6   0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW23  Dead time track7   0..2^16-1 (time in 0.5 ms)

;Monoflop time per track
:KF 0      ;DW24  Time track0        0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW25  Time track1        0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW26  Time track2        0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW27  Time track3        0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW28  Time track4        0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW29  Time track5        0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW30  Time track6        0..2^16-1 (time in 0.5 ms)
:KF 0      ;DW31  Time track7        0..2^16-1 (time in 0.5 ms)

;Table rump:
;Cam0 (track0)                      active
:KD 10000  ;DD32  in point           -2^31..+2^31-1
:KD 11000  ;DD34  out point          -2^31..+2^31-1
;Cam1 (track0)                      inactive
:KD 0      ;DD36  in point           -2^31..+2^31-1
:KD 0      ;DD38  out point          -2^31..+2^31-1

;Cam0 (track1)                      active
:KD 11000  ;DD40  in point           -2^31..+2^31-1
:KD 12000  ;DD42  out point          -2^31..+2^31-1
;Cam1 (track1)                      inactive
:KD 0      ;DD44  in point           -2^31..+2^31-1
:KD 0      ;DD46  out point          -2^31..+2^31-1
```

;Cam0 (track2)		active
:KD 12000	;DD48 in point	$-2^{31}..+2^{31}-1$
:KD 13000	;DD50 out point	$-2^{31}..+2^{31}-1$
;Cam1 (track2)		inactive
:KD 0	;DD52 in point	$-2^{31}..+2^{31}-1$
:KD 0	;DD54 out point	$-2^{31}..+2^{31}-1$
;Cam0 (track3)		active
:KD 13000	;DD56 in point	$-2^{31}..+2^{31}-1$
:KD 14000	;DD58 out point	$-2^{31}..+2^{31}-1$
;Cam1 (track3)		inactive
:KD 0	;DD60 in point	$-2^{31}..+2^{31}-1$
:KD 0	;DD62 out point	$-2^{31}..+2^{31}-1$
;(Track4..7)		inactive by SF commanding

4 Generating tables

Different possibilities exist for generating function tables:

- Manual generation of the data block through APROS editor
- Online generation through user program by
  - Table calculation block FB 210 (cf. documentation: AMK-specific function blocks; table value calculation),
  - User-specific calculation; e.g. using FB 211 (cf. documentation: AMK-specific function blocks; floating point arithmetic).

5 Impressum

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- System configuration and application
- Description of problem and presumed cause of failure
- Diagnostic message (error code)

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