AMK

AMKASYN

VARIABLE SPEED DRIVES

AMKASYN

System KU

SERCOS interface® Slave documentation

PRELIMINARY

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Contents

1 General

By using the extension options KU-SC1 or KU-SC2, the single drive unit KU becomes a SERCOS interface® Slave. This slave is based on the SERCOS interface® Version V 1.02. The system interface standards DIN EN / IEC 61491 form a further basis.

The KU fulfils the following compatibility classes:

- Class B closed loop position control, speed control and torque control
- Class C
- Communication cycle time at least 0.5 ms, range 2 (in steps of 0.5 ms)
- Additional functions
  - Actual Position Value slave
  - Parameter set switch-over
  - Measuring probe cycle stage 1 (one measuring probe)
  - Torque threshold Md_x
  - Spindle positioning (only absolute positioning ID 153)
  - External encoder

The KU operating system has been extended compared with the KU version 30/99 with regard to the SERCOS interface® functionality in the following points:

- The real-time control and real-time status bits are supported
- The IPOSYNC control bit is evaluated
- The list ID 21 invalid operating data CP2 is supported
- The list ID 16 and ID 24 can be filed in the EEPROM
- SERCOS interface® control word bit 13 (Drive Stop) is evaluated
- SERCOS interface® control word bit 14 (Drive Enable) produces an immediate torque cut-off at a 1→0 edge
- The times for Command Value Valid (ID 8) and Feedback Acquisition (ID 7) can be set differently
- The Drive Controlled Homing Cycle command ID 148 is executed as Homing Acceleration with ID 42. The bits 5, 6 and 7 in the Homing Cycle Parameter ID 147 are evaluated
- The baud rate of 4 Mbit/s is supported
- Zero bit stream, continuous light and various terminal outputs can be activated for test purposes

Since various extensions result compared with the previous software levels, a CLASS C compatibility switch has been defined (ID 32941 bit 5):
ID 32941 bit 5 = 0: KU software compatible to the previous software levels (default)
ID 32941 bit 5 = 1: KU software compatible to Class C

The following functions are influenced by setting ID 32941 bit 5:

- SERCOS interface® control word bit 13 (Drive Stop) is evaluated (cf. Section 5.1)
- SERCOS interface® control word bit 14 (Drive Enable) produces an immediate torque cut-off at a 1→0 edge (cf. Section 5.1)
- The times for Command Value Valid (ID 8) and Feedback Acquisition (ID 7) can be set differently (cf. Section 2.4)
- The Drive Controlled Homing Cycle command ID 148 is executed as Homing Acceleration with ID 42 (cf. Section 4.1.4)
- The bits 5, 6 and 7 in the Homing Cycle Parameter ID 147 are evaluated (cf. Section 4.1.4)
- The status of the reference point switch is not displayed automatically in the real-time status bit 1 in the homing cycle with external command values. The allocation of the real-time status bit must be configured in ID 305.

2 Initialization

The following parameters are available for determining the device type and the versions:

ID 140 Control unit type
The device type stands in the operating datum with the following structure:

KUxx
| |
| Control unit power class
AMKASYN System

ID 142 Application type
The user can file the application type of the drive in this list. Max. 16 bytes are available for the entry, the entry is made in ASCII.

ID 30 Manufacturer's version
The current KU software version stands in the operating datum with the following structure:

KU 0200 3099 0000
| | |
| | |
| | Addition code:0000 - Standard, xxxx special version
| Week/year
Software version

ID 143 SERCOS interface® version
The version of the SERCOS interface® specification stands in the operating data.
Definitions:
-SERCOS specification German Edition 5/90 V 1.00
-SERCOS specification English Edition 4/91 V 1.01
-SERCOS-update German/English Edition 9/91 V 1.02

2.1 Communication Phase 2 operating data

The following operating data must be transferred in the Communication Phase 2 (cf. list Ident number 18):

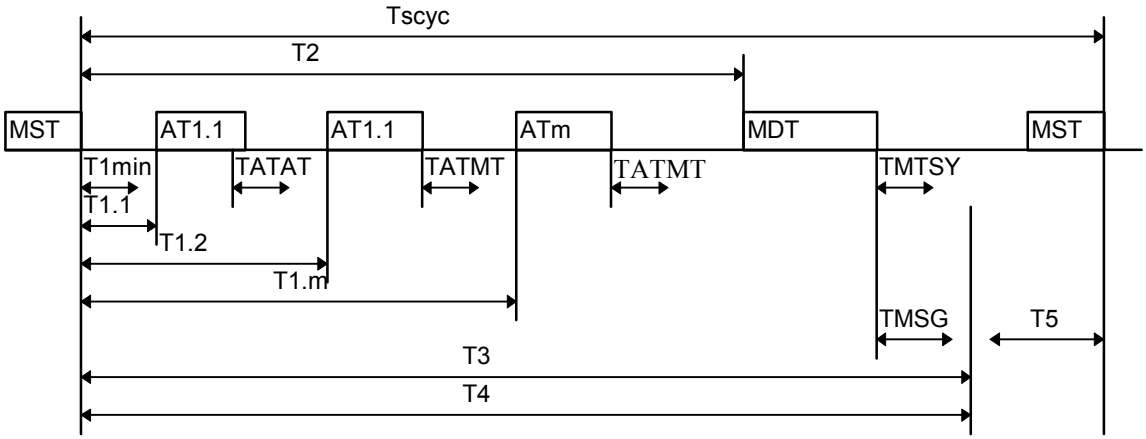
ID	Designation
2	SERCOS Cycle Time (Tscyc)
6	AT Transmission Starting Time T1
9	Beginning Address in Master Data Telegram
10	Length of Master Data Telegram
15	Telegram Type Parameter
16	Custom Amplifier Telegram Configuration List (only necessary if ID15 == 7)
24	Master Data Telegram Configuration List (only necessary if ID15 == 7)
89	MDT Transmit Starting Time (T2)

The operating data from ID 18 can also be filed in the database of the KU module. Thus the transmission of these operating data is not required in Phase 2 (CP2).

2.2 Communication Phase 3 operating data

No operating data have to be transferred in Communication Phase 3
(cf. list Ident number 19).

2.3 Time parameter settings



Minimum AT Transmit Starting Time T1min		ID 00003
Transmit/Receive Transition Time	TATMT	ID 00004
Transmit to Transmit Recovery Time	TATAT	ID 00087
Receive to Receive Recovery Time	TMTSY	ID 00088
Command Value Transmit Time	TMTSG	ID 00090
Minimum Feedback Acquisition Time	T5	ID 00005
SERCOS Cycle Time	Tscyc	ID 00002
AT Transmission Starting Time	T1	ID 00006
Feedback Acquisition Starting Time	T4	ID 00007
MDT Transmit Starting Time	T2	ID 00089
Command Valid Time T3		ID 00008

2.3.1 ID 2 SERCOS Cycle Time

The SERCOS Cycle Time defines the intervals during which the cyclic data are transferred. The cycle time is transferred in the Communication Phase 2 and becomes active starting from Communication Phase 3.
The minimum cycle time in the KU is 500µs.
Moreover the value determines other further system-internal functions (see KU parameter description).

2.3.2 ID 3 Minimum AT Transmit Starting Time (T1min)

Indicates the time requirement of the Slave between the end of the reception of the Master Synchronization Telegram and the start of transmission of the Drive Telegram. The time T1min is read by the Master during Communication Phase 2 in order to calculate the time of transfer of AT Transmission Starting Time T1 (ID 6).

2.3.3 ID 4 Transmit/Receive Transition Time (TATMT)

The time required by the Slave to switch from transmitting the Drive Telegram to receiving the Master Data Telegram. The time TATMT is read by the Master during Communication Phase 2 in order to correctly calculate the time of transmission of the Drive Telegrams T1 (ID 6).

2.3.4 ID 5 Minimum Feedback Acquisition Time (T5)

The time required by a drive between the start of Feedback Acquisition and the end of the Master Synchronization Telegram. The Master reads the time T5 during Communication Phase 2 in order to synchronize the measurement times of the Feedback Acquisition Time T4 (ID 7) appropriately for all drives.

2.3.5 ID 87 Transmit to Transmit Recovery Time (TATAT)

The time required between two Drive Telegrams when sent by the same Slave. The time TATAT is read by the Master during Communication Phase 2 in order to correctly calculate the time of transfer of a Drive Telegram T1 (ID 6).

2.3.6 ID 88 Receive to Receive Recovery Time (TMTSY)

Recovery time of the Slave after reception of a Master Data Telegram to switch over to receive the next Master Synchronization Telegram. The Master reads this time during Communication Phase 2 to ensure that the interval will be sufficient between the end of the Master Data Telegram and the beginning of the Master Synchronization Telegram.

2.3.7 ID 90 Command Value Transmit Time (TMTSG)

The time required by the Slave to make command values available for a drive after receipt of a Master Data Telegram. This time is read by the Master during Communication Phase 2 in order to correctly calculate the Command Valid Time T3 (ID 8).

2.3.8 ID 89 MDT Transmit Starting Time (T2)

The MDT Transmit Starting Time determines when the Master must send its Master Data Telegram during Communication Phases 3 and 4, following the Master Synchronization Telegram. This parameter is transferred by the Master to the Slave during Communication Phase 2 and becomes active during Communication Phase 3.

2.3.9 ID 6 AT Transmission Starting Time (T1)

The AT Transmission Starting Time determines when the Slave must send its Drive Telegram during Communication Phases 3 and 4, following the Master Synchronization Telegram. This parameter is transferred by the Master to the Slave during Communication Phase 2.

2.3.10 ID 7 Feedback Acquisition Starting Time (T4)

The Acquisition Starting Time of the feedback as determined by the Master after the Master Synchronization Telegram. In this way the Master declares a default Acquisition Time for feedback for all drives that work in coordination with each other. This ensures synchronized data acquisition of feedback for the appropriate drives. Section 2.4 must be observed in the setting of ID 7.

2.3.11 ID 8 Command Valid Time (T3)

The Command Valid Time determines the time at which the drive is allowed to access new command values after the completion of a Master Synchronization Telegram. In this way the Master provides the Command Valid Time for command values among all coordinated drives. Section 2.4 must be observed in the setting of ID 8.

2.4 Setting of ID 7, ID8

A special feature of the KU SERCOS interface® Slave is the setting of ID 7 Feedback Acquisition Starting Time (T4) and ID 8 Command Valid Time (T3).
T3 and T4 cannot be set independently of one another. The following applies depending upon the compatibility bit ID 32941 bit 5:

ID 32941 Bit 5 = 0
No different times for Feedback Acquisition (T4) and Command Value (T3) can be realized. Therefore the measuring time of the Feedback Acquisition T4 coincides as default with the Command Value Valid time T3. T4 = T3, independently of the value specified for T4. When determining T3, the "Minimum Feedback Acquisition Time" (T5) must be taken into account in addition (T3 < Tscyc - T5).

ID 32941 Bit 5 = 1
Only values for T3 and T4 can be realized for which the following applies:

|T3 - T4| = n * 0.5 ms with n = 0,1,2 ...

If this condition cannot be complied with for T3 and T4, it is possible to select by parameterization whether T3 or T4 is realized exactly. The following apply for:

ID32941 Bit 29 = 0 (default)	T3 is realized corresponding to the specification, T4 is shifted to the next 0.5 ms limit
ID32941 Bit 29 = 1:	T4 is realized corresponding to the specification, T3 is shifted to the next 0.5 ms limit

A further possibility is the independent calculation of a value for T3 and T4 by the KU. With ID 32941 bit 30 = 1 (cf. Section 8.2), 20µs after end of MDT are set for T3 and T4 independently of the preset values.

3 Cyclic data transmission, configuration of telegrams

3.1 Selection of the telegram

In SERCOS interface® Slave it is possible to choose with the aid of the telegram type parameter between Preconfigured Telegrams and Custom telegrams. The determined telegram type is not activated in the Master and in the Slave until Communication Phase 3.
In the KU SERCOS interface® Slave there are so-called User Telegrams (cf. Section 3.5) apart from the Preconfigured Telegrams and the Custom telegrams according to SERCOS standard. These User Telegrams are further fixed installed telegrams, comparable with the Preconfigured Telegrams.

These User Telegrams can be selected in the ID 32941 SERCOS Service. If no User Telegram is selected (User Telegram = 0), then the telegram selected in ID 15 is used.

If 15 is selected in ID 32941 for "User Telegram", then ID 15 (Telegram Type Parameter) is no longer interpreted as SERCOS Preconfigured Telegram but as User Telegram, i.e. a User Telegram can be selected by means of ID 15.

3.2 Description of the parameters for the configuration of telegrams

3.2.1 ID 15 Telegram Type Parameter

The Telegram Type Parameter enables a selection between Preconfigured Telegrams and Custom Telegram. The determined telegram type is not activated in the Master and in the Slave until Communication Phase 3.

Structure of the Telegram Type Parameter:

```
15                      8                       0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 x x x
                          | | |
                          0 0 0  Preconfigured Telegram-0
                          0 0 1  Preconfigured Telegram-1
                          0 1 0  Preconfigured Telegram-2
                          0 1 1  Preconfigured Telegram-3
                          1 0 0  Preconfigured Telegram-4
                          1 0 1  Preconfigured Telegram-5
                          1 1 0  Preconfigured Telegram-6
                          1 1 1  Custom Telegram   (ID 16, ID 24)
```

The Actual Position Value (motor encoder or external encoder) cannot be selected by bit 3. Only one actual position system exists in the KU. This is selected by reference to bit 3 in the operating mode parameters ID 32 .. ID 35 or by reference to bit 30 in the AMK operating mode parameters ID 32800 ... ID 32805 (cf. KU parameter documentation).

Contents of the Preconfigured Telegrams:

Preconfigured Telegram-0:	MDT	No cyclic data
	AT	No cyclic data
Preconfigured Telegram-1:	MDT	ID 80 Torque Command Value
	AT	No cyclic data
Preconfigured Telegram-2:	MDT	ID 36 Velocity Command Value
	AT	ID 40 Actual Velocity Value
Preconfigured Telegram-3:	MDT	ID 36 Velocity Command Value
	AT	ID 51 Actual Position Value 1
Preconfigured Telegram-4:	MDT	ID 47 Position Command Value
	AT	ID 51 Actual Position Value 1
Preconfigured Telegram-5:	MDT	ID 47 Position Command Value
		ID 36 Velocity Command Value
	AT	ID 51 Actual Position Value 1
		ID 40 Actual Velocity Value
Preconfigured Telegram-6:	MDT	ID 36 Velocity Command Value
	AT	No cyclic data

Further AMKASYN-specific Preconfigured Telegrams, so-called User Telegrams (cf. Section 3.5 and Section 8.2) can be set by means of ID 32941.

3.2.2 ID 16 Custom Amplifier Telegram Configuration List

The "Configurable data record" can be configured application-specifically in the drive telegram using the data fields (cf. ID 187 List of configurable data in the AT) .

The following are configurable in ID 16:

- ID 11 Class 1 Diagnostics
- ID 12 Class 2 Diagnostics
- ID 13 Class 3 Diagnostics
- ID 14 Interface Status
- ID 51 Actual Position Value 1
- ID 53 Actual Position Value 2
- ID129 Manufacturer Class 1 Diagnostics
- ID 175 Displacement Parameter 1
- ID181 Manufacturer Class 2 Diagnostics
- ID182 Manufacturer Class 3 Diagnostics
- ID 32786 -> Contents of configuration KU message 32
- ID 32785 -> Contents of configuration KU message 16
- All IDs configurable in ID 32785 and ID 32786 (process data), cf. KU parameter description

Caution: If for a process datum from ID 16 the weighting is not the AMK default weighting, then this datum must be configured in ID 32785 “32-bit KU message" or in ID 32786 “16-bit KU message". This must be done before switching over into Phase 3. Exception: The Actual Position Value must never be configured in a KU message independently of the set position data weighting.

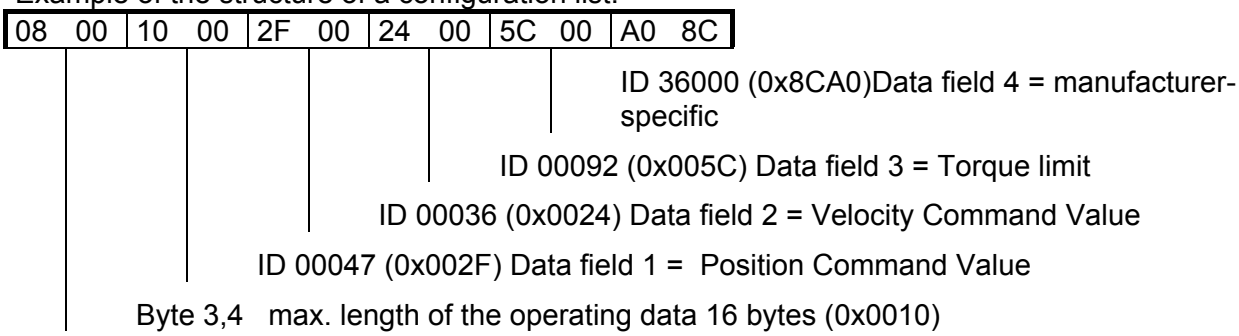
Structure of the configuration list (see ID 24).

3.2.3 ID 24 Master Data Telegram Configuration List

By means of the data fields the "Configurable Data Record" can be configured in the Master Data Telegram depending on the application.

Configurable for ID 24:
- ID 80 Torque Command Value
- ID 36 Velocity Command Value
- ID 47 Position Command Value
- All SERCOS operating parameters according to list 1 and list 2
- All temporarily changeable data (ID 270) apart from ID 32785 and ID 32786

Example of the structure of a configuration list:



Byte 1,2 Length of the programmed operating data 8 bytes (0x0008)

3.2.4 ID 10 Length of Master Data Telegram

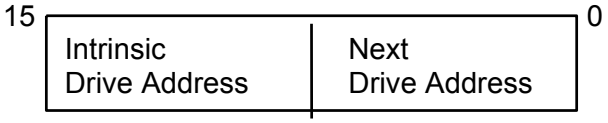
The length of the Master Data Telegram, expressed in bytes, includes data records for all drives. Every drive is informed by the Master during Communication Phase 2 of the length of the Master Data Telegram. In the Slave the length is used in the Communication Phases 3 and 4.

3.2.5 ID 9 Beginning Address in Master Data Telegram

The beginning address of a drive's data record in a Master Data Telegram, expressed as a byte position. Every drive is informed by the Master during Communication Phase 2 of the beginning address of the data record which is used by the Slave in Communication Phases 3 and 4.

3.2.6 ID 96 Slave Arrangement

During initialization, the Master needs to recognize which physical Slaves and their associated drives are present in order to optimize the automatic time slot computation. The Master can request this information from the drives during Communication Phase 2. After each entry the Master recognizes other drives which belong to the same physical Slave.
Valid drive addresses are all decimal values from 1 to 254, in accordance with hexadecimal values (01)H through (FF)H.



High_Byte: "Intrinsic Drive Address"
Low Byte: "Next Drive Address"

- Here the Slave enters in ascending order the next higher drive address which is served by it.
- If the current drive is that with the highest address at the physical Slave, then the Slave enters here the lowest address present at it.
- If the Slave operates only one drive, then the "Intrinsic Drive Address" is entered here. This is the case in the equipment series KU.

Example for KU with the address 07H:

07	07

3.3 Maximum values for configured telegrams

Maximum Length of the Configurable Data Record in the MDT (ID 186):	32
Maximum number of ID per drive in the MDT:	8
Maximum number of temp. ID per drive in the MDT:	4
Maximum Length of the Configurable Data Record in the AT (ID 185):	32
Maximum number of ID per drive in the AT:	8

3.4 Monitoring the telegram structure

A faulty telegram structure leads in the "Communication Phase 3 Transition Check" command to command acknowledgement with set error bit. In addition there is an output on the control panel (cf. Section **Fehler! Verweisquelle konnte nicht gefunden werden.** Error indications). The list "ID number list invalid operating data Phase 2“ (ID 21) is currently not supported.

3.5 User Telegrams

Setting see SERCOS Service assignment ID 32941 (Section 8.2).

User Telegram-1
MDT: ID 36 Velocity Command Value
ID 153 Spindle Angle
ID 222 Spindle Position Speed
AT: ID 51 Actual Position Value 1
ID 40 Actual Velocity Value
ID 13 Class 3 Diagnostics
ID 182 Manufacturer Class 3 Diagnostics

User Telegram-2
MDT: ID 36 Velocity Command Value
AT: ID 40 Actual Velocity Value
ID 84 Actual Torque Value

User Telegram-3
MDT: ID 47 Position Command Value
ID 36 Velocity Command Value
ID 92 Torque Limit bipolar
AT: ID 51 Actual Position Value 1
ID 40 Actual Velocity Value
ID 84 Actual Torque Value

User Telegram-4
MDT: ID 36 Velocity Command Value
ID 153 Spindle Angle
ID 222 Spindle Position Speed
ID 32893 Command Value Multiplier
ID 268 Synchronizing Angle
AT: ID 51 Actual Position Value 1
ID 40 Actual Velocity Value
ID 13 Class 3 Diagnostics
ID 182 Manufacturer Class 3 Diagnostics

User Telegram-5
MDT: ID 36 Velocity Command Value
AT: [ID 32786] Configuration AW Message Contents 32
[ID 32785] Configuration AW Message Contents 16

User Telegram-6
MDT: ID 36 Velocity Command Value
ID 180 Spindle Distance
ID 222 Spindle Position Speed
ID 32893 Command Value Multiplier
ID 268 Synchronizing Angle
AT: ID 51 Actual Position Value 1
ID 40 Actual Velocity Value
ID 13 Class 3 Diagnostics
ID 182 Manufacturer Class 3 Diagnostics

3.6 Weighting

The KU supports different weightings for position data, speed data, acceleration data and torque/force data (see KU parameter documentation).

3.6.1 Position data in modulo format

With the aid of ID 76 position data weighting type, the data format (absolute format / modulo format) and the data reference can be set.
If the modulo format is set, then the difference between two consecutive command values may not be greater than one quarter of the modulo end value (since there is no extrapolation in failed command value telegrams). The value which is used as modulo end value depends upon the current AMK operating mode ID 32800 - ID 32803 bit 13:

- Current AMK operating mode bit 13 = 0: the encoder resolution ID 116 forms the modulo end value
- Current AMK operating mode bit 13 = 1: the modulo value parameter ID 103 forms the modulo end value

The modulo value ID 103 must be able to be converted into increments without residue in the setting (see KU parameter documentation).

4 Commands and functional sequences

4.1 Overview of commands, description

Various parameters are used in the command sequences. All parameters listed for the relevant command can be changed online, i.e. without withdrawal of the controller enable (cf. Section 6.1 and list ID 270 KU parameter documentation). Here it must be observed that when these parameters are set, the ID 269 Memory Mode is set to one (cf. Section 6.1).
It applies for all other parameters which have no influence on a command that the parameter values either must already be entered correctly in the KU database or must be withdrawn briefly after the change of the controller enable.
All commands permissible through SEROCS interface® are listed in the list ID 25.
The commands cannot be interrupted in the KU SEROCS interface® Slave, i.e. the "Command set, interrupted and not executed" status (command acknowledgement = 5) is not permissible. Therefore a "Interrupt command" order (command input = 1) is acknowledged with the error message "Datum not correct".
However, it is possible with the aid of bit 13 (Drive Stop) in the control word to stop the KU-internal interpolator (IPO) in the course of command processing (cf. Section 5.1).

4.1.1 ID 99 Reset Class 1 Diagnostics

If this command is received by the drive, then if no further error exists, the Class 1 Diagnostics, the Interface Status, and the Manufacturer Class 1 Diagnostics are deleted. The command also causes error deletion in the KU. The maximum waiting time for executing the command is 3s. The torque is switched on again with the next 0→1 edge of bit 15 in the control word (cf. Section 5.1).

4.1.2 ID 127 Communication Phase 3 Transition Check

With this command the master communicates to the slave that it has transmitted all necessary communication parameters for Communication Phase 3. With this command the slave examines whether from its viewpoint error-free operation is possible in Communication Phase 3. The command is ended without error if the slave is ready to follow the input of Communication Phase 3 in the MST and to comply with the programmed time slot values and the telegram structure. Otherwise the command is ended with error. In the case of an error, the faulty parameters can be identified by reference to the list of invalid operating data phase 2 ID 21.

4.1.3 ID 128 Communication Phase 4 Transition Check

With this command the master communicates to the slave that it has transmitted all necessary communication parameters for the Communication Phase 4. With this command the slave examines whether from its viewpoint error-free operation is possible in Communication Phase 4. The command is ended without error if the slave is ready to following the input of Communication Phase 4 in the MST. Otherwise the command is ended with error.

4.1.4 ID 148 Drive Controlled Homing Cycle Command

The following conditions apply:
- The position measuring system is connected to the drive, the Actual Position Value is acquired by the drive
- The reference switch (cam) is connected directly to the drive or to the control unit

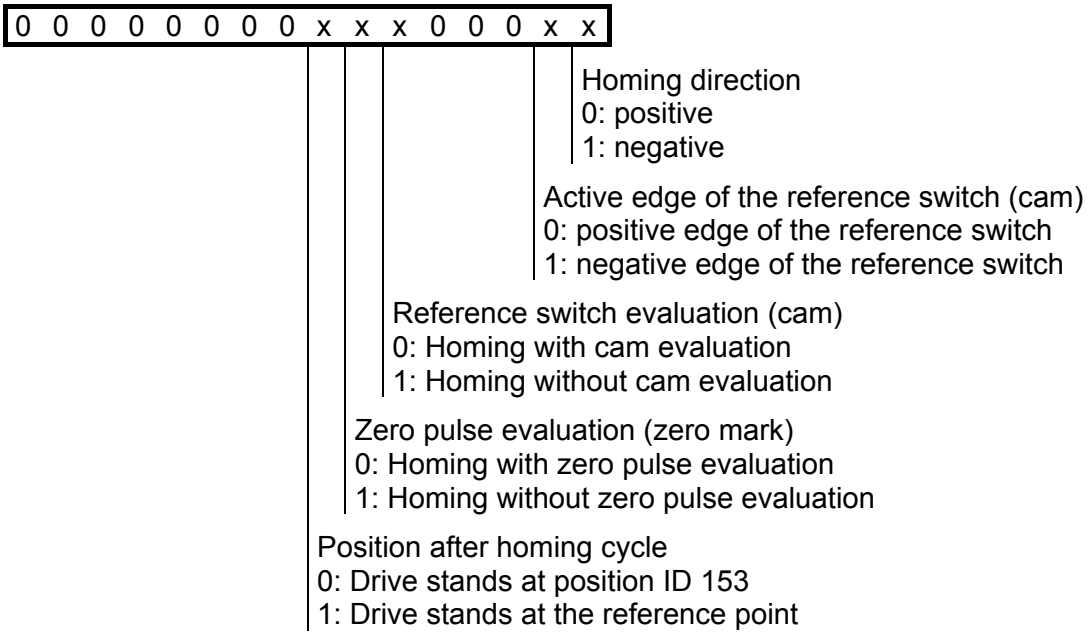
When the NC sets and enables the "Drive Controlled Homing" Procedure Command, the drive automatically starts a drive-internal position control and accelerates to the Homing Velocity (ID 41) taking the Homing Acceleration (ID 42) into account. The drive resets the Status Actual Position Value bit (ID 403). Further parameterization for the Homing Cycle is programmed in the Homing Parameter (ID 147) and in the AMK Homing Parameter (ID 32926). All changes of the cyclic command values are ignored as long as the procedure command is activated. After passing over the reference marker pulse, the drive stops taking the Homing Acceleration into account. The command is performed correctly when the drive has stopped and the Actual Position Value is relative to the reference point of the machine. The drive announces this by setting the Status Actual Position Value bit (ID 403) and "Reference Point Known" (ID 32912). The NC reads the Position Command Value (ID 47) of the drive via the service channel and switches the command value system to this Position Command Value. Afterwards the procedure command is cancelled by the NC and the drive follows the command values of the NC. If the NC deletes the command, then the drive switches over to the operating mode set in the control word.

The following parameters can be changed:

– Homing Velocity	ID 41	
– Homing Acceleration	ID 42	(only if ID 32941 bit 5 = 1)
– Acceleration positive/negative	ID 136 / ID 137	(only if ID 32941 bit 5 = 0)
– Actual Position Value reference size 1	ID 52	
– Reference Size Offset 1	ID 150	
– Homing Cycle Parameter	ID 147	
– AMK Homing Cycle Parameter	ID 32926	
– Cam release speed	ID 32940	
–		

Since only one position system exists in the KU, the parameters ID 52 reference size 1 and ID 150 Reference Size Offset 1 apply for homing with internal and external position measuring system.

Structure of the Homing Cycle Parameter ID 147



The following applies for the Homing Cycle Parameter ID 147:
- Bit 5, 6 and 7 are evaluated only if ID 32941 bit 5 = 1
- Since the functions of bit 5 and 6 are also present in the AMK Homing Cycle Parameter ID 32926, these are evaluated only if ID 147 bit 15 = 0
-
-

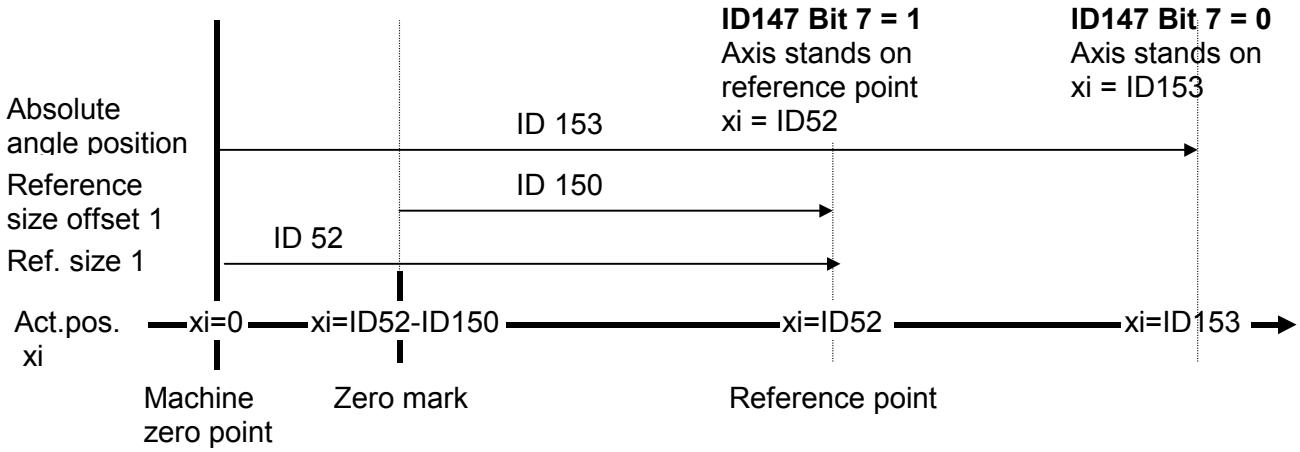


Figure: Effect of the parameters in the "Drive Controlled Homing Cycle" command
-

4.1.5 ID 32912 Reference Point Known

With the setting ID 32912 = 0 a non-referenced status of the drive is caused.
With the setting ID 32912 = 1 a referenced status of the drive is caused.

4.1.6 ID 172 Displacement to the Referenced System Procedure Command

The drive has calibrated its Actual Position Value system with the aid of a Homing Cycle with "external" command values (cf. Section 4.3.1). The Status Actual Position Value bit (ID 403) is set. The drive switches the cyclic command value setting off internally with activation of the command. During the active command the NC switches its command values over to the referenced Position Command Value system (e.g. Position Command Value = Actual Position Value or read Position Command Value from drive and set accordingly). An assignment of the Position Command Value/Actual Position Value status to real-time bits is not necessary for this procedure.
Afterwards the command is deleted by the NC and the drive follows the command values of the NC. If the NC deletes the command, then the drive switches over to the operating mode set in the control word.
The command has no changeable parameters.

4.1.7 ID 152 Position Spindle Command

When a drive is below the Spindle Position Speed (ID 222), this command automatically switches it to internal position control and positions to the stated Spindle Angle (ID 153). If the drive is not yet homed, a Homing Cycle is performed. While this command is active, all changes to cyclic command values are ignored. During the activated command the drive retains its position control and accepts new inputs for Spindle Position Speed (ID 222) and Spindle Angle (ID 153). If the NC deletes the command, then the drive switches over to the operating mode set in the control word.
With open command the Spindle Angle ID 153 and the Spindle Position Speed ID 222 can be set anew at any time.
The following parameters can be changed:

- Spindle Angle ID 153
- Spindle Position Speed ID 222
- AMK Spindle positioning param. ID 32925
-

4.1.8 ID 223 Drive Controlled Synchronizing Operation Command

When the Master activates the "Drive Controlled Synchronizing Operation" command, the synchronizing spindle is synchronized on the lead spindle as programmed in the synchronizing operation parameter (ID 225). The synchronizing spindle ignores any cyclic default command values from the Master. The synchronizing operation is cancelled by disabling the command.
The command is executed correctly when synchronized operation has been reached. The command is transferred only to the synchronizing spindle. Changes of the cyclic command values are ignored during the active command.

For the synchronizing operation commands, a position control with trailing error compensation and the command value source of pulse generator input (terminal X34) must be set in ID 32805 (AMK Secondary Operating Mode 5). I.e. the Secondary Operating Mode 5 must be initialized with 00030804H for instance.

If the synchronizing operation is triggered by means of command ID 223, then the synchronizing operation is always performed with angle alignment. On triggering the synchronizing operation by the operating mode switch-over (see Section 4.2), the angle alignment is performed only in a certain operating mode. The AMK Synchronizing Operation Parameter is always taken into account. The settings in ID 225 Synchronizing Operation Parameter are not evaluated.
Before start of the synchronizing operation the required parameters must be set. A change of the parameters for synchronizing operation is possibly only if the required synchronism is reached. However, it is possible to set these parameters during command processing.

If the Slave has reached the command value speed, the message bit "Speed Synchronous" is set in the "Manufacturer Class 3 Diagnostics". If the Slave has reached the command value angle, the message bit "Angle Synchronous" is set in the "Manufacturer Class 3 Diagnostics".
On withdrawal of the Controller Enable RF both message bits are deleted.
The following parameters can be changed:

- Synchronizing Angle ID 268
- Command Value Multiplier ID 32893
- Synchronizing Operation Parameter ID 225
- AMK Synchronizing Operation Parameter ID 32927
- Homing Velocity ID 41
- Synchronous position offset ID 230
-

4.1.9 ID 197 Set Coordinates System Command

When the command is activated the drive ignores the cyclic Position Command Value and takes over the set "Coordinate Starting Value" (ID 198) as internal Position Command Value. Before the NC deletes the command, it must have set its command value coordinate system to that of the drive. After deletion of the command the drive takes over the Position Command Value. ID 198 must be set before starting the command.
The following parameters can be changed:

- Coordinate Starting Value ID 198

4.1.10 ID 199 Displace Coordinates System Command

The command adds the programmed "Coordinate Displacement Value" (ID 275) to the internal Actual Position Value. Before the NC deletes the command it must have set its actual value coordinate system to that of the drive.
The following parameters can be changed:

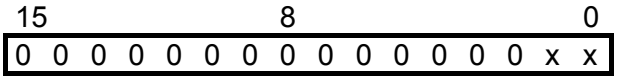
- Coordinate Displacement Value ID 275

4.1.11 ID 216 Switch Parameter Set Command

Parameter sets can be switched over with this command. The drive switches over to the parameter set which is programmed in the Preselect Parameter Set Command (ID 217). Special features of the behavior of SERCOS operating parameters are described in the SERCOS description.
The following parameters can be changed:
- Preselect Parameter Set Command ID 217

4.1.12 ID 217 Preselect Parameter Set Command

The parameter set of the drive is selected by means of the parameter set preselection. The Switch Parameter Set Command (ID 216) is used to switch parameter sets. The four selectable parameter sets are agreed in ID 32813 (see KU parameter documentation).



0 0 Main parameter set
0 1 1st alternative parameter set
1 0 2nd alternative parameter set
1 1 3rd alternative parameter set

4.1.13 ID 32963 Read Position Command Value Command

With selection of the command the momentarily valid Position Command Value coordinate system of the drive is determined. The current value of the Position Command Value coordinate system is located in ID 47 after ending the command.

4.1.14 ID 170 Measuring Probe Cycle Command

The measuring probe must be connected to X33 BE4. The "Measuring Probe Cycle" command serves for activating the "Measuring with measuring probe" function. Both a single measurement and a multiple measurement is possible with the aid of this command. Setting and enabling the command activates the measuring function in the drive. The KU signals this by setting the data status to "set, enabled, not yet executed". There is no acknowledgement of command executed, i.e. the command change bit is set only in the case of an error. The measurement is enabled by the signal "Measuring probe 1 enable" ID 405.

With arrival of the selected edge at the measuring probe, the drive stores the Actual Position Value in the corresponding parameter ID 130 or ID 131 and sets the associated bit in the measured value status ID 179. The status bits in the measured value status can be addressed via ID 409 and ID 410 and can be assigned to the real-time status bits. The control system can recognize the end of the measuring process either by
- cyclically reading the ID 179 measured value status or by
- evaluating status bits. For this purpose the corresponding bit from ID179 must be assigned to a SERCOS real-time status bit.

After the selected edge has arrived, the measurement is disabled. This disable is deleted again by resetting the "Measuring probe 1 enable". This is acknowledged by a deleted measured value status ID 179 or ID 409 and ID 410. The measurement is enabled again by subsequently setting the "Measuring probe 1 enable".

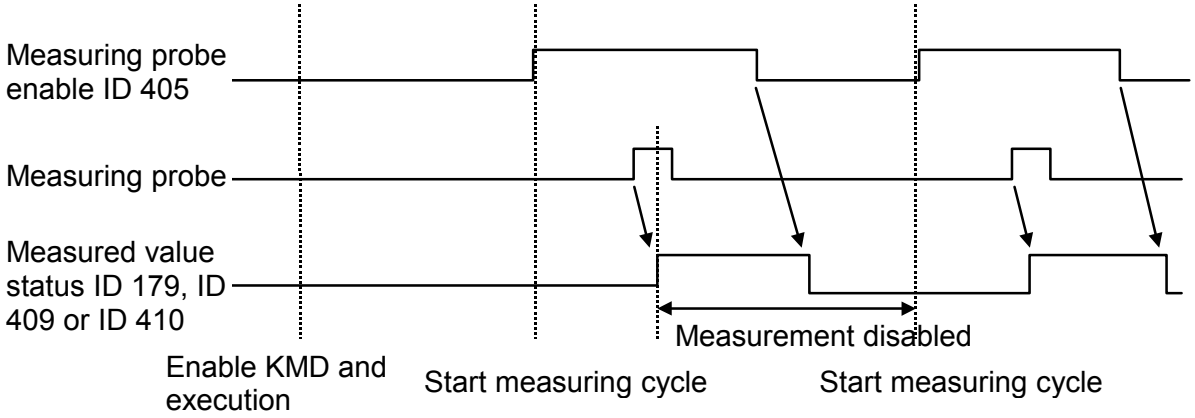


Figure: Bit string for the "Measuring probe cycle" command

The following parameters can be changed:
- Measuring probe enable ID 405
- Measuring probe control parameter ID 169

15							8								0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x

0	0	not permissible
0	1	Pos. edge probe
1	0	Neg. edge probe
1	1	not permissible, i.e. no measurement possible on pos. and simultaneously neg. edge

Caution:
Measuring probe cycles and homing a drive are mutually exclusive. Therefore, if the homing or spindle positioning or synchronizing operation with homing command is started, a currently active measuring probe cycle is interrupted.

4.1.15 Relative Positioning Command

Relative Positioning is possible only with command processing by means of operating modes (see Section 4.2).
The following parameters can be changed:
- Relative Positioning Final Value ID 180
- Positioning Speed ID 222

4.2 Command processing by means of operating modes

To accelerate inputting movement commands, some commands can be switched on and off like operating modes.

Switching on operating mode commanding
So that inputting operating modes is interpreted as command, a **One** must be set in the lowest nibble in ID 32941 SERCOS Service. The following assignment of operating modes to the commands then results:

Operating mode 1	Spindle Positioning
Operating mode 2	Synchronizing Operation without Angle Adjustment
Operating mode 3	Synchronizing Operation with Angle Adjustment
Operating mode 4	Relative Positioning[1)]

1) not executable by means of SERCOS command

If operating mode 0 is input, then the operating mode set in the AMK Main Operating Mode ID 32800 results.

Acknowledgement of the operating mode commands
The actual operating mode (AT status word) becomes the same as the control operating mode (MDT control word) if the command is 'READY' for the first time. If an error occurs previously, then the actual operating mode remains at the old status.
The command status can also be read in the relevant command status. The command change bit is not set.

4.3 Functional sequences

4.3.1 Homing synchronous axes

For synchronous axes there is the requirement that they are moved synchronously during all conditions. To guarantee this synchronism even in homing, it is possible to perform the Homing Cycle in the KU with a command value input from "external". The control can move the synchronous axes synchronously during homing only by inputting identical command values to the synchronous axes.

Parameter settings
The following parameters must be taken into account in the Homing Cycle:

- ID 147 Homing Cycle Parameter - Set bit 15 to activate the AMK Homing Cycle Parameter
- ID 32926 AMK Homing Cycle Parameter - Bit 8 must be set
- ID 150 Reference offset - On detection of the reference mark the Actual Position Value ID 51 is set to the negative value of ID 150 (Actual Position Value = ID 52 - ID 150)
- ID 305 / ID 307 real-time status bit allocation = ID 400: The reference point switch ID 400 can be read with the aid of a real-time status bit, for instance.

Procedure

- Reading reference point switch status with the aid of the real-time status bit or by reading ID 400.
- Set command ID 148 "Drive Controlled Homing" for the synchronizing axes (input of 1). In this way the reference point switch is provided in the real-time status bit 1.
- Evaluation of the reference point switches and possibly inputting command values to move from the reference point switch.
- Inputting command values for the Homing Cycle.
- Waiting until the drives are referenced, e.g. with the aid of the command change bit in the status word or of the Status Actual Position Value ID 403
- Delete command ID 148 "Drive Controlled Homing" for the synchronizing axes (inputting 0).
- Starting command ID 172 "Displacement to the Referenced System" for the synchronizing axes and switching the Position Command Value to the referenced system (e.g. Position Command Value = Actual Position Value or read Position Command Value from drive and set accordingly). An allocation of the status Position Command Value/Actual Position Value to real-time bits is not necessary for this procedure.
- Delete command ID 172 "Displacement to the Referenced System" for the synchronizing axes.
- Evaluation of the Actual Position Value and correction of the synchronizing axes to one another.

5 Control and status bits

5.1 Control and status bits for power and torque control

The power supply can be controlled only in KU25/KU40 by means of the signal UE “DC BUS enable“. The torque generation is controlled in all KU devices by means of the signal RF “Inverter On“. The signals SBM "System Ready", QRF "Inverter on handshake“ and QUE "DC BUS enable handshake" are available as status signals. Should the signals UE and RF be activated by means of the SERCOS interface®, the ID 32795 (UE source) and the ID 32796 (RF source) must be set to 5 in each case.
The SERCOS interface® control/status bits are imaged as follows on the AMK signals:

SERCOS control bits 13 .. 15
The effect of the control bits for switching on power is influenced by the compatibility bit ID 32941 bit 5.

Drive Stop bit 13 (is not supported at first)
This bit is evaluated only if the control bits 14 and 15 are “1“. The KU-internal interpolator (IPO) can be controlled in the course of command processing with the aid of this control bit. A prerequisite for the effect of this control bit is that the compatibility bit ID 32941 bit 5 = 1. The following then applies:

0 -> 1 no activity
1 -> 0 no activity

Drive Enable bit 14

0 -> 1 The internal cycle enable and power section UE are activated
1 -> 0 Torque enable RF, internal cycle enable EF and power section UE are deleted, i.e. the axis coasts (only if ID 32941 bit 5 = 1, otherwise the axis brakes)

Drive On bit 15

0 -> 1 Torque enable RF of the drive ON, prerequisite: Bit 14 = ON
1 -> 0 Torque enable RF of the drive OFF

The signal UE can be set or reset by writing the ID 32889. The acknowledgement QUE can be evaluated either by reading the ID 32889 or with the aid of the SERCOS status bit 15. The signals EF, QEF and QES are safety-relevant hardware signals. They are not accessible through the SERCOS interface®.

Caution: Activating the torque enable RF (0→1 edge control bit drive on) is not possible if there is an open command for this drive.

SERCOS status bits 14 and 15

AMK signals			Status bits		Meaning
QUE	QRF	SBM	Bit 15	Bit 14	
0	0	0	0	0	Not ready for switching power in, drive in error status (see Class 1 Diagnostics)
0	0	1	0	1	Drive ready for switching power in
1	0	1	1	0	Power on, drive torque-free
1	1	1	1	1	In operation, drive with torque

5.2 Diagnostic classes and errors

SERCOS status bits 11, 12, 13
These status bits indicate a change in the relevant diagnostics classes. If errors have occurred in the KU and warnings are specified by SERCOS, then the corresponding bits are set in the diagnostic classes 1 and 2 and simultaneously the coarse classifying bits of the Manufacturer Class Diagnostics.
The AMK-specific bits are always set if errors and warnings occur in the KU module. The existing errors and warnings are classified coarsely by the bits in the IDs 129 and 181.

The bits 15 in Class 1 Diagnostics and Class 2 Diagnostics refer to errors and warnings which can be read from the error stack with the control panel. The error stack contains all arising errors and warnings, therefore also those specified by SERCOS interface® in the Class 1 and 2 Diagnostics. The error stack can be read out by means of ID 32962. The error number of the first error can be read via the diagnostic number ID 390.

The Class 1 Diagnostics errors are reset in accordance with SERCOS interface® with the "Reset Class 1 Diagnostics" command (ID 99).

5.2.1 ID 11 Class 1 Diagnostics

This function of this ID is the drive interlock in the case of an error. An error in the Class 1 Diagnostics becoming active leads to "1" setting of the change bit for Class 1 Diagnostics in the drive status and to withdrawal of the Inverter On.

Bit	LSB
0	Overload Shutdown
1[1)]	Inverter overtemperature shutdown
2	Motor overtemperature shutdown
3	Cooling error shutdown
4	Control voltage error
5	Feedback error
6[1)]	Error in the electronic commutation system
7	Overcurrent error
8[1)]	Overvoltage error
9[1)]	Undervoltage error
A[1)]	Power supply phase error
B	Excessive following error
C	Communication error (ID 14)
D[2)]	Software limit is exceeded (ID 49,50)
E	reserved
F	Manufacturer-specific error (ID 129)

1) Error evaluation in the KU not present
2) This message is available only in the Manufacturer Class 3 Diagnostics Bit 0 (negative position limit exceeded) and Bit 7 (positive position limit exceeded)

5.2.2 ID 12 Class 2 Diagnostics

This function of this ID is a shutdown warning. A warning in the Class 2 Diagnostics becoming active or disappearing leads to "1" setting of the change bit for Class 2 Diagnostics in the drive status (see also ID 97 Mask Class 2 Diagnostics).

Bit	LSB
0	Overload warning
1	Inverter overtemperature warning
2	Motor overtemperature warning
3[2)]	Cooling error warning
4	reserved
.	
.	
D[1)]	Position limit is exceeded (ID 49,50)
E	reserved
F	Manufacturer-specific warning (ID 181)

1) Warning in the KU not present
2) Warning in the KU not present, it is available detailed instead of this in the Manufacturer Class 2 Diagnostics Bit 8 .. 11

5.2.3 ID 13 Class 3 Diagnostics

With the aid of this, ID messages on operating states are output. A message in the Class 3 Diagnostics becoming active or disappearing leads to "1" setting of the change bit for Class 3 Diagnostics in the drive status (see also ID 98 Mask Class 3 Diagnostics)

Bit	LSB
0	$n_{actual} = n_{command}$
1	$n_{actual} = < n_{min}$
2	$\| n_{act} \| < \| n_x \|$
3	$\| Md \| >= \| Md_x \|$
4	$\| Md \| >= \| Md_{limit} \|$
5	$\| n_{command} \| > \| n_{limit} \|$
6	In Position
7	$\| P \| >= \| P_x \|$
8[1)]	Service Request
.	
.	
F	SERC: Manufacturer-specific operating status

1) Message currently not supported by the KU

5.2.4 ID 14 Interface Status

If an error is set in the Interface Status, then this leads to setting the communication error in the Class 1 Diagnostics. The communication error is not set by the Communication Phase (Bit2-0). If there is no communication error, then the current communication phase can be queried by means of the Interface Status. If there is a communication error, then the error and the Communication Phase are stored.

Bit	LSB
0	|
1	|- Communication Phase
2	|
3	MST failure
4	MDT failure
5	Invalid phase
6	Phase incrementing error
7	Phase decrementing error
8	Phase switching without ready message
9[1)]	Switching to not initialized operating mode
A[1)]	Drive with same drive address in the ring
.	
.	
F	

1) Error evaluation currently not realized

5.2.5 ID 28 MST Error Counter

The MST Error Counter counts all invalid MSTs in the Communication Phases 3 and 4. In the case where more than two consecutive MSTs are invalid, the invalid MSTs over two are not counted. The MST error counter counts to a maximum of 65535. This means that if a value of 65535 is set in the counter, there may have been a noisy transmission over a long period of time.

5.2.6 ID 29 MDT Error Counter

The MDT Error Counter counts all invalid MDTs in the Communication Phases 3 and 4. In the case where more than two consecutive MDTs are invalid, the invalid MDTs over two are not counted. The MDT error counter counts to a maximum of 65535. This means that if a value of 65535 is set in the counter, there may have been a noisy transmission over a long period of time.

5.2.7 ID 97 Mask Class 2 Diagnostics

By means of this mask, warnings in Class 2 Diagnostics, such as overload warning (ID 00310) or motor overtemperature warning (ID 00312), can be masked with respect to their effect on the change bit in Drive Status. The masked warnings do not act on the change bit of Class 2 Diagnostics. The mask does not act on the operating data of Class 2 Diagnostics. (ID 12).

0 - masked warning
1 - unmasked warning

5.2.8 ID 98 Mask Class 3 Diagnostics

By means of this mask, messages in Class 3 Diagnostics, such as message $n_{act} = n_{command}$ (ID 00330) or message Md >= Mdx (ID 00333) can be masked with respect to their effect on the change bit in drive status. The masked messages do not act on the change bit of Class 3 Diagnostics. The mask does not act on the operating data of Class 3 Diagnostics. (ID 13)

0 - masked message
1 - unmasked message

5.2.9 ID 129 Manufacturer Class 1 Diagnostics

Additional AMKASYN-specific error messages. If an error is set or reset in the Manufacturer Class 1 Diagnostics, then a manufacturer-specific error bit in Class 1 Diagnostics is set as well. Further information about existing errors can be determined by reading the list of error codes ID 32962.

Bit	LSB
0	System error
1	
2	KU basic module control error
3	
4	KU basic module miscellaneous error
5	Configuration error
6	
7	
8	KU SERCOS option error (see Section **Fehler! Verweisquelle konnte nicht gefunden werden.**)
.	
.	
F	

5.2.10 ID 181 Manufacturer Class 2 Diagnostics

AMKASYN-specific warnings. If a warning is set or reset in Manufacturer Class 2 Diagnostics, the manufacturer-specific warning bit in Class 2 Diagnostics is set as well.

Bit	LSB
0	
1	KU module warning (control)
2	
3	KU module warning (miscellaneous)
4	
5	
6	
7	
8	Cooling air overtemperature
9	External component overtemperature
A	Power supply unit overtemperature
B	Supply/regenerative braking overtemperature
C	Mains overvoltage
D	Mains undervoltage
E	
F	

5.2.11 ID 182 Manufacturer Class 3 Diagnostics

Additional AMKASYN-specific messages of the operating statuses. If an operating status is set or reset in Manufacturer Class 3 Diagnostics, the manufacturer-specific operating status bit in Class 3 Diagnostics is set as well.

Bit	LSB
0	Negative software limit exceeded
1	Drive angle synchronous
2	Drive speed synchronous
3	
4	
5	Residual distance (cf. ID 32922) was deleted
6	Overcurrent message: I^2t monitor > 50 % of overcurrent limit
7	Positive software limit exceeded
8	Reference Point Known
.	
.	
F	

5.2.12 ID 134 Master Control Word

The Master Control Word ID 134 can be read through the service channel or the KU control panel.

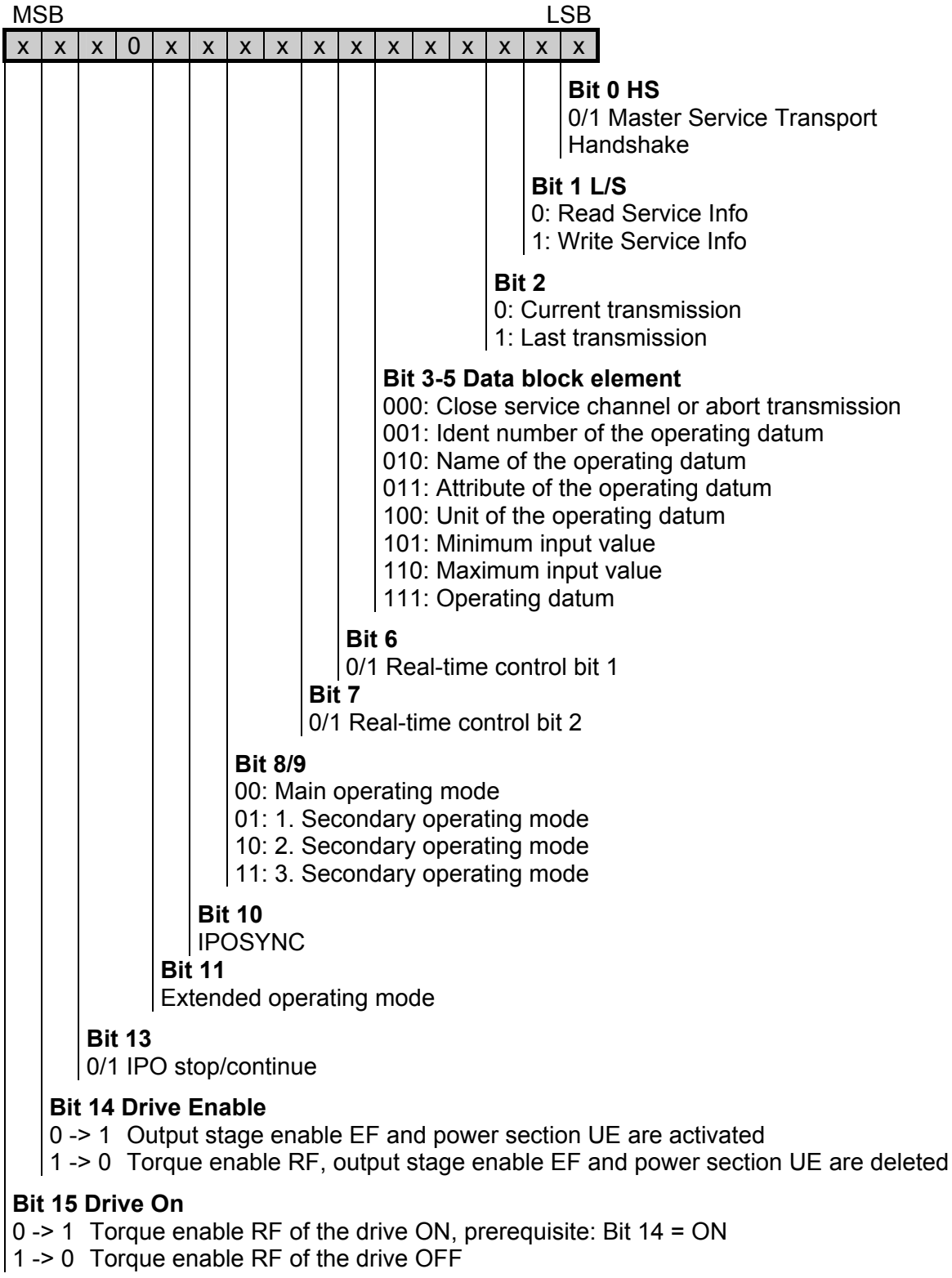


Figure: Control word structure

5.2.13 ID 135 Drive status word

The drive status word ID 135 can be read through the service channel or the KU control panel. Only the bits described below are displayed. The bits for controlling the service channel are not displayed.

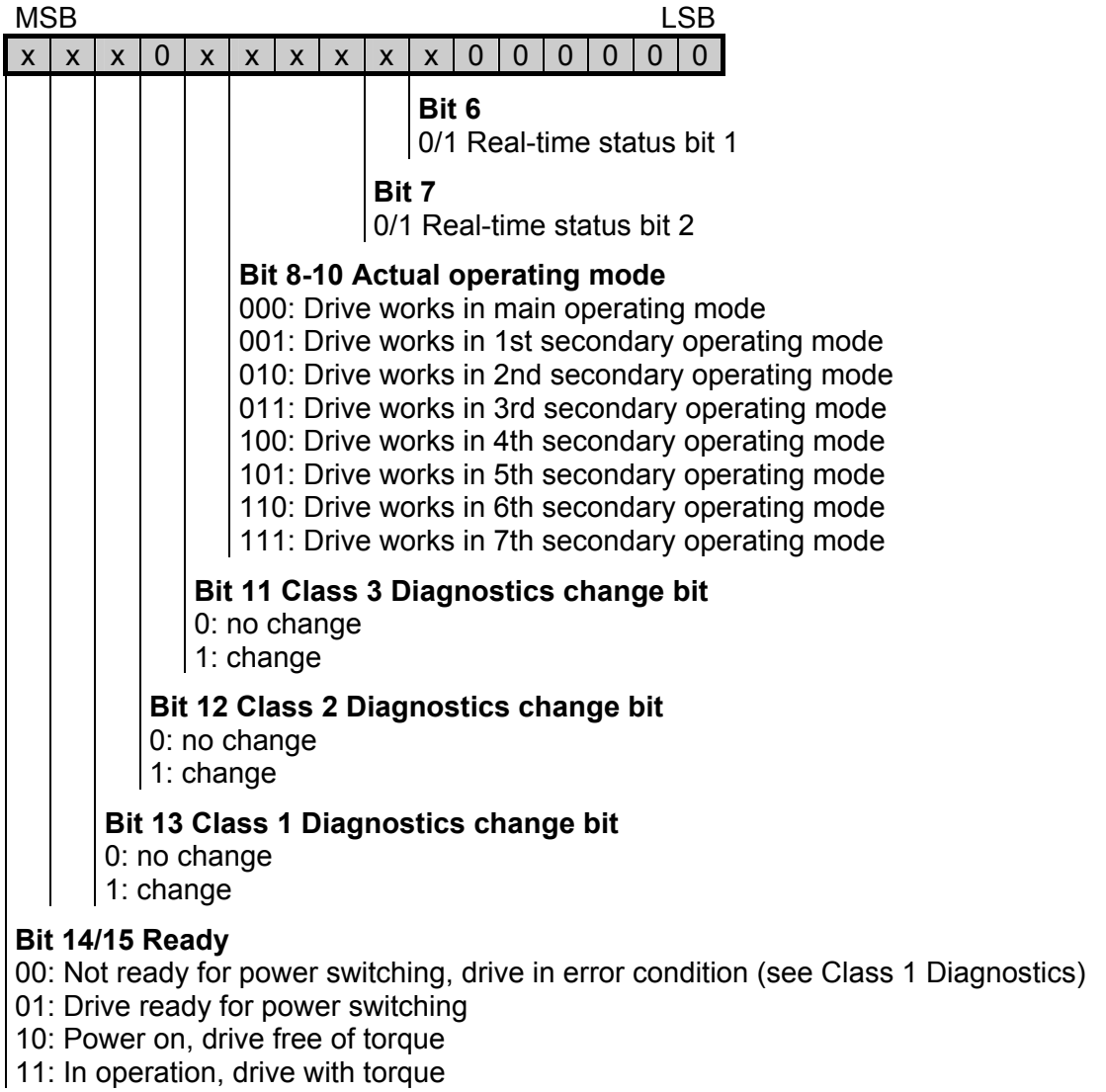


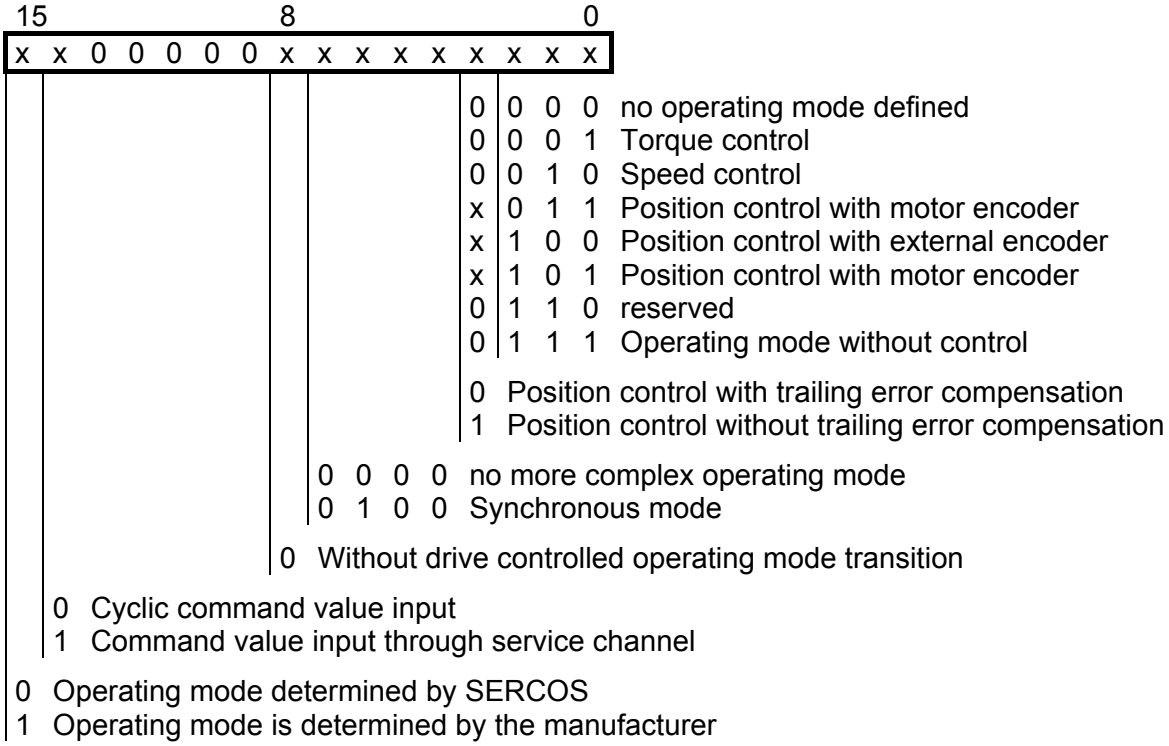
Figure: Status word structure

5.3 Operating modes, operating mode switch-over

The operating mode can be switched over with the aid of the control bits 8, 9 and 11. The operating modes themselves can be defined by the ID 32 .. ID 35 as well as the ID 284 and ID 285. Switching over into the secondary operating modes 6 and 7 can indeed occur, but the definition of these operating modes (ID 286 and ID 287) cannot be changed, since these are used for drive-internal functions. The actual operating mode is displayed in the status word in bit 8, 9 and 10.

On access to a SERCOS interface® operating mode parameter, there is a conversion to the corresponding AMK operating mode parameter (ID 32800 .. ID 32805). More extensive settings can also be made in these AMK operating mode parameters (cf. KU parameter documentation).

Structure of the SERCOS operating mode parameters
The SERCOS interface operating mode parameters ID 32 ... ID 35, ID 284 and ID 285 are structured as follows:



Converting the SERCOS operating mode into the AMK operating mode
The SERCOS operating modes are converted into AMK operating modes only on operation of the SERCOS interface® interface!!!

Conversion of basic operating modes Bit 0 - 2

Bit 0 - 3 SERCOS operating mode ID 32-35		Bit 0 - 3 AMK operating mode ID 32800 ff	
000	no operating mode defined	000	no operating mode defined
001	Torque control	010	Torque control
010	Speed control	011	Speed control
011	Position control with motor encoder	100	Position control with motor encoder (bit 13 = 0)
100	Position control with external encoder	100	Position control with external encoder (bit 13 = 1)
101	Position control with motor encoder	100	Position control with motor encoder (bit 13 = 0)
110	reserved		
111	Operating mode without control		

Conversion of SAK Bit 3
SERCOS operating mode bit 3 ⇔ AMK operating mode bit 11

Conversion of more complex operating modes bit 4 - 7

0001 Interpolation in the drive	⇒ no illustration, not realized
0010 Block-controlled operation	⇒ no illustration, not realized
0100 Synchronous mode	⇒ command value source pulse generator input
1000 Electronic gear	⇒ no illustration, not realized

Conversion of operating mode transition bit 8

No drive controlled operating mode transition on operating mode change.
A drive controlled operating mode transition is realized only with the aid of commands.

Conversion command value input bit 14

Cyclical command value input ⇒ AMK command value source 3C

5.4 Real-time bits

Binary information can be exchanged quickly between control and drive with the aid of real-time control bits and real-time status bits.
Allocations for the real-time control bits are defined via the ID 301 and ID 303. The following allocations are possible:

- ID 400 Reference point switch
- ID 404 Actual position value status
- ID 405 Measuring probe enable

Allocations for the real-time status bits are defined via the ID 305 and ID 307 (see KU parameter documentation, allocation of bit information to binary outputs section).

The signal control and signal status word are currently not supported.
The Class 2 and 3 Diagnostics (ID 12,13) and the Manufacturer Class 2 and 3 Diagnostics (ID 181,182), which contain many important status bits, can be used in the configured telegram as cyclic datum.

6 Data transmission through the demand data channel

There is a further access to the parameters of the drive control by using the SERCOS interface® Slave.

6.1 Structure of the database

The parameters of the drive control are located in the database of the KU module. They are available there in a form similar to the SERCOS data block on non-volatile memory (EEPROM).
Changes to these stored data become effective only after system initialization. For this purpose the controller enable RF must be switched off and back on. The online changeable parameters (temporary parameters) and the system variables form an exception.

Temporary parameters:
Many parameters can be changed and thus immediately effective with the aid of an online (temporary) parameter change in the working memory. In the temp. parameter list ID 270 all temporarily changeable parameters are listed (cf. KU parameter description).
The differentiation between an online parameter change and the change in the EEPROM is performed with regard to SERCOS interface® by reference to the ID 269 Memory Mode. An initial value can be filed in the EEPROM for ID 269. The following apply:

- ID 269 = 1: In the parameter access to temporarily changeable parameters, a change becomes effective immediately, or on reading the currently effective value is read. Access to parameters which cannot be changed temporarily is not influenced, i.e. the data in the non-volatile memory are accessed.
- ID 269 = 0: In the parameter access to all parameters, access is always to the data in the non-volatile memory.

System variables:
These are data which are generated by the system and serve primarily for display and diagnostic purposes. These process parameters can only be read. They are always current.

The SERCOS operating parameters:
The SERCOS interface® Slave software administers additional parameters which must be quickly accessible for executing the tasks of the SERCOS interface® Slave. These parameters are SERCOS operating parameters below. The SERCOS operating parameters are located in the RAM and are initialized at Power On. They are realized like the temporary parameters, whereby the datum is not changed in system booting. These SERCOS operating parameters can be read. At the Power On of the SERCOS interface Slave, the SERCOS operating parameters of the Ident numbers marked in Section 8.1.2 with D are initialized with the values of the operating data from the database of the KU module. In the case of the Ident numbers marked with I in Section 8.1.2, the SERCOS operating parameters are initialized internally at zero.

7 System diagnostics, test and start-up functions

7.1 System diagnostics

KU Control panel
Apart from the error evaluations customary in SERCOS interface®, errors are also indicated by means of the control panel. Like all other errors, SERCOS interface® errors are also administered by the error administration of the KU. All SERCOS interface® errors are displayed by the control panel display

Error No. OPT 1 Error text

The following table shows a summary of the SERCOS specific error messages.

Error No.	Class	Error text	Cause
2561	FATAL ERROR	SERCOS MST failure	The MST reception is monitored in the Communication Phase 3 and 4. An error was found here.
2562	FATAL ERROR	SERCOS MDT failure	The MDT reception is monitored in the Communication Phase 3 and 4. An error was found here.
2563	FATAL ERROR	SERCOS Inadmiss.Com.Phase	Invalid Communication Phase
2564	FATAL ERROR	SERCOS Phase incrementing	Error in phase incrementing (sequence)
2565	FATAL ERROR	SERCOS Phase decrementing	Error in phase decrementing (not on Phase 0)
2566	FATAL ERROR	SERCOS Phase switching	Phase switching without ready message
2569	FATAL ERROR	SERCOS Memory error	Memory error (allocating)
2570	FATAL ERROR	SERCOS Memory error	Memory error (de-allocating)
2572	FATAL ERROR	SERCOS AT/MDT config.	AT/MDT configuration error (for command ID 127)
2573	FATAL ERROR	SERCOS Memory space error	Memory space error (system error)
2574	FATAL ERROR	SERCOS RAM test error	Error in the SERCOS-Asic memory test
2575	FATAL ERROR	SERCOS Error ext. power supply	In KU-SC2 modules: ext. 48V voltage supply was applied too late or not at all
2576	FATAL ERROR	SERCOS Initialization error	Error in the internal memory initialization
2577	CONFIG. ERROR	SERCOS Config. error SERCOS parameters	Error in allocating the real-time control or real-time status bits
2588	WARNING	SERCOS Test function active	Message that a test function (continuous light or zero bit stream) is active

If one of the above named error messages stands on the control panel, a more accurate evaluation can take place. For this purpose the diagnostic key and then the F2 key must be pressed. The following picture appears:

K:	M:	Z:
F:	I:	

The explanation of the errors listed below applies only for errors in which the module number is 141 (M: 141).

Communication errors according to SERCOS interface® (see ID 14)

Error F:	Error description	Info value I: for this error
1	MST failure	Communication Phase
2	MDT failure	Communication Phase
3	Invalid Communication Phase	Communication Phase
4	Error in phase incrementing (sequence)	Communication Phase
5	Error in phase decrementing (not on Phase 0)	Communication Phase
6	Phase switching without ready message	Switching to Phase 3: see error 12 Switching to Phase 4: 80 (synchronization error)

Other errors

Error F:	Error description	Info value I: for this error
9	Memory error (allocating)	not used
10	Memory error (de-allocating)	not used
12	AT/MDT configuration error (for command ID 127)	10 MDT too large 11 Starting address (ID 9) outside MDT or (ID 9+data record length) > ID 10 12 too many MDT-IDs (cycl.) 13 too many MDT-Ids 14 too many AT-Ids 14 AT too large 16 ID in the AT actual list 17 AT contains not configurable ID 18 Configuration in ID 24 does not fit in MDT range (too many bytes in the config. data record) 19 ID in the MDT actual list 20 MDT contains not configurable ID 21 too many temporary Ids 22 Initializing temporary ID error
13	Memory place error (system error)	not used = 0
14	Error in the memory test SERCOS-Asic	not used = 0
15	External power supply error	not used = 0
16	Error in the internal memory initialization	not used = 0
17	Error in allocating the real-time control or real-time status bits	not used = 0
18	Message that a test function (continuous light or zero bit stream) is active	not used = 0

ID 95 / ID 32962 Diagnostics
These lists serve the control system for displaying drive-internal diagnostic messages in the ASCII format. Since all error messages can be read from the KU with the aid of these lists, the list is structured as field of error messages with the following structure:

4 characters error number
2 characters error source (00 system functions, 01 control)
26 characters error text (terminated with \0)

Example: 2311,01,Error motor encoder\0
| | |
| | 26 characters error text
| 2 characters error source
4 characters error number

ID 390 Diagnostic number
The error number of the first occurring error or warning as 2 byte parameter can be read with the diagnostic number ID 390.

7.2 Display of the Communication Phase

If the KU is activated in the SERCOS interface® ring, then the current communication phase can be read via the ID 33114 and displayed on binary output bits.
A prerequisite for the display on binary output bits is that the individual bits are assigned to the communication phase output bits (cf. KU parameter documentation, allocation of bit information to binary outputs section). The following applies:
Communication phase bit 0: Code 33120
Communication phase bit 1: Code 33121
Communication phase bit 2: Code 33122

Example: Display of communication phase bit 1 and 2 on BA3 and BA4.
Prerequisite for this is:
- ID 32867 = 33121 Communication phase (process status) bit 1 on BA3
- ID 32868 = 33122 Communication phase (process status) bit 2 on BA4

The display is then structured as follows:

BA4	BA3	Meaning
0	0	Phase 0 or 1
0	1	Phase 2 or 3
1	0	Phase 4

7.3 Light intensity

The transmission light intensity is set in ID 32941 SERCOS service bit 11-15 (see Enclosures: SERCOS-Service ID 32941 assignment). The transmission light intensity must be adapted to the FOC cable length. As transmitter types the type 81.01 and the type 81.11 with small maximum light powers are used on the KU-SC1/2. The values stated in the table apply only for correctly manufactured and run FOC cables.

Distance	Light intensity
5m	1
10m	2
15m	3
20m	3
25m	4
30m	5
≥35m	6

Table: Minimum light intensities to be set

7.4 Setting the baud rate

Baud rates of 2 and 4 Mbit/s can be set for the KU SERCOS interface® Slave. The setting is made in ID 32941 SERCOS service bit 4 (see Appendix: Assignment of SERCOS service ID 32941). The following applies:

- ID 32941 bit 4 = 0 Baud rate 2 Mbit/s
- ID 32941 bit 4 = 1 Baud rate 4 Mbit/s

7.5 Test modes

Zero bit stream
The zero bit stream test mode can be selected with the aid of bit 8 in the SERCOS service word ID 32941. In this test mode the KU transmits consecutive zeroes, which result in constant level change in the grid of the baud rate on the basis of the NRZI coding. Operation of the SERCOS interface® interface is not possible in this mode.

Continuous light
The continuous light test mode can be selected with the aid of bit 10 in the SERCOS service word ID 32941. In this test mode the KU transmits an optical high level without level change at the optical output. Operation of the SERCOS interface® interface is not possible in this mode.

7.6 Front panel

The diagram shows the front panels of the optional modules KU-SC1 and KU-SC2. The module KU-SC2 as distinct from the module KU-SC1 has the possibility of feeding an external voltage with which the module is supplied even if the KU is switched off. In this way the ring remains closed.

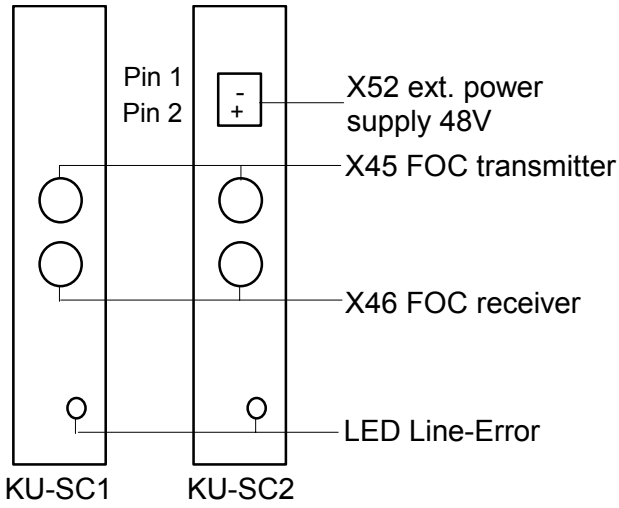


Fig.: Front panel of the modules KU-SC1 and KU-SC2

The "Line Error" LED lights up either if
- no reception signal is present or
- the signal distortion is too large (see SERCOS interface® specification).

8 Appendix

8.1 Parameter overview

The following tables provide an overview of the most important parameters for the operation of SERCOS interface®.
The SERCOS operating parameters are identified with the attribute "S": They possess further different attributes which describe for instance parameter initialization.

Attributes for the SERCOS operating parameter
S Identification of a SERCOS operating parameter
D Initialization of the SERCOS operating parameter from the database of the KU module
I Internal initialization of the SERCOS operating parameter to zero
N Datum is not transferred to database of the KU module on writing and thus cannot be displayed on the KU control panel

8.1.1 Parameter overview (ordered according to use)

SERCOS transmission control

a) Time slot calculation

ID	Designation	Attribute			Section
2	SERCOS Cycle Time (Tscyc)	S	D		2.3.1
3	Minimum AT Transmit Starting Time (T1min)				2.3.2
4	Transmit/Receive Transition Time (TATMT)				2.3.3
5	Minimum Feedback Acquisition Time (T5)				2.3.4
6	AT Transmission Starting Time (T1)	S	D		2.3.9
7	Feedback Acquisition Starting Time (T4)	S	D		2.3.10
8	Command Valid Time (T3)	S	D		2.3.11
87	Transmit to Transmit Recovery Time				2.3.5
88	Receive to Receive Recovery Time				2.3.6
89	MDT Transmit Starting Time (T2)	S	D	N	2.3.8
90	Command Value Transmit Time				2.3.7

b) Telegram configuration

ID	Designation	Attribute			Section
9	Beginning Address in Master Data Telegram	S	D		3.2.5
10	Length of Master Data Telegram	S	D		3.2.4
15	Telegram Type Parameter	S	D		3.2.1
16	Custom Amplifier Telegram Configuration List	S	D		3.2.2
24	Master Data Telegram Configuration List	S	D		3.2.3
36	Velocity Command Value	S	D		3.2.1 / 3.2.3
40	Actual Velocity Value				3.2.1 / 3.2.2
47	Position Command Value				3.2.1 / 3.2.3
51	Actual Position Value				3.2.1 / 3.2.2
80	Torque Command Value	S	D		3.2.1 / 3.2.3
84	Actual Torque Value				3.2.1 / 3.2.2
96	Slave Arrangement SLKN				3.2.6
103	Modulo Value				3.6.1
185	Length of the Configurable Data Record in the AT				3.3
186	Length of the Configurable Data Record in the MDT				3.3
187	List of the Configurable Data in the AT				3.2.2
188	List of the Configurable Data in the MDT				3.2.3
32785	Configuration AW Message 16				3.2.2
32786	Configuration AW Message 32				3.2.2

c) Phase commands

ID	Designation	Attribute			Section
127	Phase 3 Transition Check	S	I	N	4.1.2
128	Phase 4 Transition Check	S	I	N	4.1.3

Class Diagnostics / Errors

ID	Designation	Attribute			Section
11	Class 1 Diagnostics				5.2.1
12	Class 2 Diagnostics				5.2.2
13	Class 3 Diagnostics				5.2.3
14	Interface Status				5.2.4
15	Telegram Type Parameter	S	D		3.2.1
16	Custom Amplifier Telegram Configuration List	S	D		3.2.2
21	List of invalid operating data Phase 2				4.1.2
24	Master Data Telegram Configuration List	S	D		3.2.3
28	MST Error Counter				5.2.5
29	MDT Error Counter				5.2.6
99	Reset Class 1 Diagnostics	S	I	N	4.1.1
129	Manufacturer Class 1 Diagnostics				5.2.9
134	Master Control Word				5.2.12
135	Drive status word				5.2.13
181	Manufacturer Class 2 Diagnostics				5.2.10
182	Manufacturer Class 3 Diagnostics				5.2.11
95	Diagnostics				7.1
390	Diagnostic number				7.1
32926	Diagnostics				7.1

Cyclic data

ID	Designation	Attribute			Section
36	Velocity Command Value	S	D		3.2.1 / 3.2.3
40	Actual Velocity Value				3.2.1 / 3.2.2
47	Position Command Value				3.2.1 / 3.2.3
51	Actual Position Value				3.2.1 / 3.2.2
80	Torque Command Value	S	D		3.2.1 / 3.2.3
84	Actual Torque Value				3.2.1 / 3.2.2
103	Modulo Value				3.6
32785	Configuration AW Message 16				3.2.2
32786	Configuration AW Message 32				3.2.2

Commands

a) Spindle Positioning

ID	Designation	Attribute			Section
152	Position Spindle Command	S	I	N	4.1.6
153	Spindle Angle				4.1.6
222	Spindle Position Speed				4.1.6

b) Homing Cycle

ID	Designation	Attribute			Section
47	Position Command Value				3.2.1 / 3.2.3
148	Drive Controlled Homing Cycle Command	S	I	N	4.1.4
403	Status Actual Position Value				4.1.4
32912	Reference Point Known				4.1.5/ 4.1.4

c) Synchronizing operation

ID	Designation	Attribute			Section
222	Spindle Position Speed				4.1.6
223	Drive Controlled Synchronizing Operation Command	S	I	N	4.1.8
268	Synchronizing Angle				4.1.8
32893	Command Value Multiplier				4.1.8
32927	AMK Synchronizing Operation Parameter				4.1.8

d) Parameter set switching

ID	Designation	Attribute			Section
216	Switch Parameter Set Command	S	I	N	4.1.11
217	Preselect Parameter Set Command				4.1.12

e) Set Coordinates System command value

ID	Designation	Attribute			Section
197	Set Coordinates System Command	S	I	N	4.1.9
198	Coordinate Starting Value				4.1.9

f) Displace Coordinates System actual value

ID	Designation	Attribute			Section
199	Displace Coordinates System Command	S	I	N	4.1.10
275	Coordinate Displacement Value				4.1.10

g) Read Position Command Value

ID	Designation	Attribute			Section
32963	Read Position Command Value Command	S	I	N	4.1.13

h) Measuring probe cycle

ID	Designation	Attribute			Section
169	Measuring probe control parameters				4.1.14
170	Measuring probe cycle command	S	I	N	4.1.14
179	Measured value status				4.1.14
130	Measured value 1st probe positive edge				4.1.14
131	Measured value 1st probe negative edge				4.1.14
405	Measuring probe 1 enable				4.1.14
409	Measured value 1st probe positive edge latched				4.1.14
410	Measured value 1st probe negative edge latched				4.1.14

Other

ID	Designation	Attribute			Section
25	List of all commands				4.1
30	Manufacturer version				2
103	Modulo value				3.6
140	Control unit type				2
142	Application type				2
143	SERCOS interface®				2
269	ID Memory Mode	S	D	N	6.1
270	List of temporary parameters				6.1
32889	Inverter On				5.1
33114	Process status (communication phase)				7.2

8.1.2 Parameter overview (ordered according to ID numbers)

ID	Designation	Attribute			Section
2	SERCOS Cycle Time (Tscyc)	S	D		2.3.1
3	Minimum AT Transmit Starting Time (T1min)				2.3.2
4	Transmit/Receive Transition Time (TATMT)				2.3.3
5	Minimum Feedback Acquisition Time (T5)				2.3.4
6	AT Transmission Starting Time (T1)	S	D		2.3.9
7	Feedback Acquisition Starting Time (T4)	S	D		2.3.10
8	Command Valid Time (T3)	S	D		2.3.11
9	Beginning Address in Master Data Telegram	S	D		3.2.5
10	Length of Master Data Telegram	S	D		3.2.4
11	Class 1 Diagnostics				5.2.1
12	Class 2 Diagnostics				5.2.2
13	Class 3 Diagnostics				5.2.3
14	Interface Status				5.2.4
15	Telegram Type Parameter	S	D	N	3.2.1
16	Custom Amplifier Telegram Configuration List	S	I	N	3.2.2
18	List of operating data Phase 2				2.1
19	List of operating data Phase 3				2.2
21	List of invalid operating data Phase 2				4.1.2
24	Master Data Telegram Configuration List	S	I	N	3.2.3
25	List of all commands				4.1
28	MST Error Counter				5.2.5
29	MDT Error Counter				5.2.6
30	Manufacturer's version				2.3.6
32	Main Operating Mode				5.3
33	Secondary Operating Mode 1				5.3
34	Secondary Operating Mode 2				5.3
35	Secondary Operating Mode 3				5.3
36	Velocity Command Value	S	I	N	3.2.1 / 3.2.3
40	Actual Velocity Value				3.2.1 / 3.2.2
47	Position Command Value				3.2.1 / 3.2.3
51	Actual Position Value				3.2.1 / 3.2.2
80	Torque Command Value	S	I	N	3.2.1 / 3.2.3
84	Actual Torque Value				3.2.1 / 3.2.2
87	Transmit to Transmit Recovery Time				2.3.5
88	Receive to Receive Recovery Time				2.3.6
89	MDT Transmit Starting Time (T2)	S	D	N	2.3.8
90	Command Value Transmit Time				2.3.7
95	Diagnostic Text				7.1
96	Slave Arrangement SLKN				3.2.6
99	Reset Class 1 Diagnostics	S	I	N	4.1.1
103	Modulo Value				3.6
127	Phase 3 Transition Check	S	I	N	4.1.2
128	Phase 4 Transition Check	S	I	N	4.1.3
129	Manufacturer Class 1 Diagnostics		I		5.2.9
130	Measured value 1st probe pos. edge				4.1.14
131	Measured value 1st probe neg. edge				4.1.14
140	Control unit type				2
142	Application type				2
143	SERCOS interface®				2
148	Drive Controlled Homing Cycle Command	S	I	N	4.1.4
152	Position Spindle Command	S	I	N	4.1.6

ID	Designation	Attribute			Section
153	Spindle Angle	S	D	N	4.1.6
169	Measuring probe control parameters				4.1.14
170	Measuring probe cycle command	S	I	N	4.1.14
179	Measured value status				4.1.14
180	Relative Spindle Distance				4.1.13
181	Manufacturer Class 2 Diagnostics				5.2.10
182	Manufacturer Class 3 Diagnostics				5.2.11
185	Length of the Configurable Data Record in the AT				3.3
186	Length of the Configurable Data Record in the MDT				3.3
187	List of configurable data in the AT				3.2.2
188	List of configurable data in the MDT				3.2.3
197	Set Coordinates System Command	S	I	N	4.1.9
198	Coordinate Starting Value	S	I	N	4.1.9
199	Displace Coordinates System Command	S	I	N	4.1.10
216	Switch Parameter Set Command	S	I	N	4.1.11
217	Preselect Parameter Set Command				4.1.12
222	Spindle Position Speed				4.1.6
223	Drive Controlled Synchronizing Operation Command	S	I	N	4.1.8
268	Synchronizing Angle				4.1.8
269	ID Memory Mode	S	I	N	6.1
270	List of temporary parameters				6.1
275	Coordinate Displacement Value				4.1.10
301	Real-time control bit 1 allocation				5.4
301	Real-time control bit 2 allocation				5.4
301	Real-time control bit 1 allocation				5.4
301	Real-time control bit 1 allocation				5.4
390	Diagnostic number				7.1
403	Status Actual Position Value				4.1.4
405	Measuring Probe 1 Enable				4.1.14
409	Measured Value 1st Probe positive edge latched				4.1.14
410	Measured Vale 1st Probe negative edge latched				4.1.14
32785	Configuration AW Message 16				3.2.2
32786	Configuration AW Message 32				3.2.2
32889	Inverter On				5.1
32893	Command Value Multiplier				4.1.8
32912	Reference Point Known				4.1.5/ 4.1.4
32927	AMK Synchronizing Operation Parameter				4.1.8
32963	Read Position Command Value Command	S	I	N	4.1.13
33114	Process status (communication phase)				7.2

8.2 Assignment of SERCOS-Service ID 32941

Different KU-specific settings are made here for the KU SERCOS interface® Slave.

MSB LSB

31 27	23	19	15	11	7	3	0

Bit 0-3 spec. function
Bit 0: Op. mode command
Bit 1: spec. error ind.
Bit 3: Modulo position
Command Value/Actual
Position Value

Bit 7-11 Start-up function
0 none
1 zero bit stream
2 T/R test

Bit 11-15 LED current transmitter
0 min. LED current
:
7 max. LED current

Bit 15-19 User Telegrams
0 Telegram type according to SERCOS
1 User Telegram 1
2 User Telegram 2
3 User Telegram 3
4 User Telegram 4
5 User Telegram 5
6 User Telegram 6

Bit 28-31 Time synchronization
Bit 29: Feedback Acquisition and Command Value setting at time T4
Bit 30: Independent calculation of a value for T3 and T4 by the KU

8.3 Application notes

8.3.1 System start for KU-SC2 (KU-SC with external 48V power supply)

1. Basic state (supply off, SERCOS in Communication Phase 0 or ring separated on the master side)
2. 48V supply voltage on (1s transient time for Slave connection). Ring is thus closed.
3. KU power supply on
4. Wait for KU ready (SBM or SBT message). The continuity of the Sercos ring for MSTs of the Communication Phase 0 is no sign of the readiness of the KU for the SERCOS phase booting.
5. Master closes SERCOS ring and communicates with the switched in drives (phase booting)
6. If the KU does not respond in Communication Phase 1, then the KU was switched on too late, for instance (ring no longer in Phase 0). It must then be switched back into Communication Phase 0 and a new phase booting must take place.

9 Impressum

Title **AMKASYN system KU Documentation SERCOS interface® Slave**

Objective **Documentation SERCOS interface® Slave**

Part-Number **26838**

History

Date
2000/02

Service Tel.: **+49/(0)7021 / 5005-191, Fax –193**

Business Hours:
Mo-Fr 7.30 - 16.30, On weekends and holidays calls are forwarded to an emergency response number by the automated answering system.

To assure a fast and accurate response to solve customer problems we ask for your cooperation in providing us with the following information:

- Nameplate data
- Software version
- System configuration and application
- Description of problem and presumed cause of failure
- Diagnostic message (error code)

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