Function to avoid Slip-Stick effects

Translation of the "Original Dokumentation"
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Name: FKT_Anti-Slip-Stick_Obj_en

Version:

Version: 2020/04	
Change	**Letter symbol**
• Controller card KW-R24-R added • Controller card KW-R27 added • Parametrize threshold 0x2359 'Threshold variable torque limits' added	LeS / STL

Previous version: 2018/44

Product version:

Product (AMK part no.)	Firmware Version (AMK part no.)
KW-R24-R (O954)	AE-R24-R V2.13 2019/24 (207413)
KW-R25 (O902)	AE-R25 V2.12 2018/23 (206993)
KW-R26 (O903)	AE-R26 V2.12 2018/23 (206647)
KW-R27 (O957)	AE-R26 V2.12 2018/40 (207284)
iX(-R3) / iC(-R3) / iDT5(-R3) /	iX V2.12 2018/03 (207093)
ihX	ihX V2.12 2018/03 (207094)

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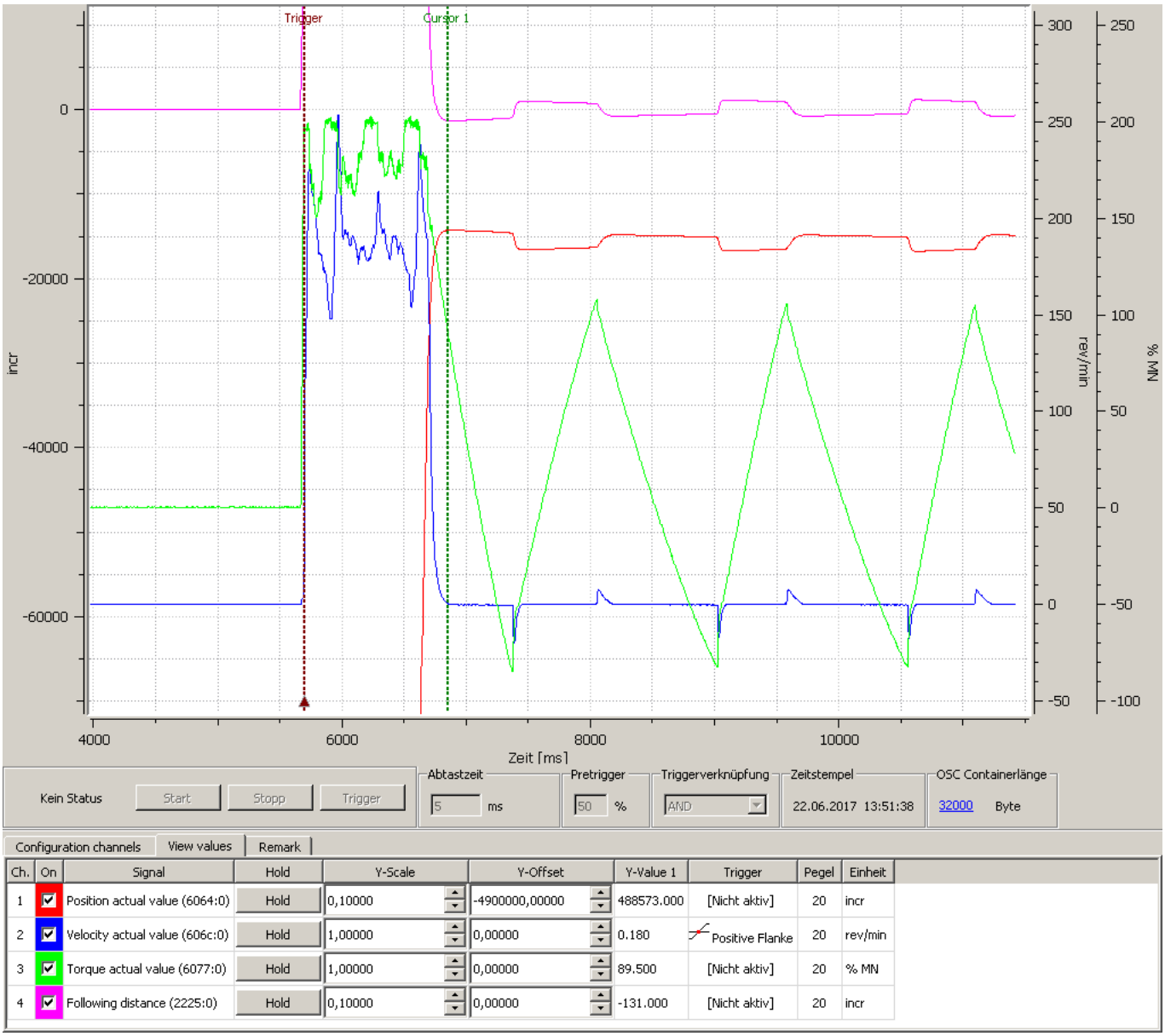
1 Slip-Stick effect

Slip-stick effects may occur during operation in applications with high static friction. In position control the axis comes to a standstill due to the high static friction with a following error or a control deviation. The deviation leads to an increasing I component of the speed controller, which in turn results in a growing moment on the shaft. The axis makes a jump around the target position, if the shaft torque overcomes the static friction and the sliding friction is lower. This behavior repeats constantly.

The overload monitoring additionally responds if the static friction is larger than the nominal torque. In unfavorable cases, this can results in an error and RF withdrawal.

Example:

The axis positions to the target, but stops with a permanent following error (Channel 4 - magenta) due to the static friction. It builds up a moment (Channel 3 - green) and when overcoming the static friction the axis jumps over the target position (speed Channel 2 - blue, position Channel 1 - red). The jerky position jumps around the target position are repeated. In this example, the static friction is asymmetrical, it is much larger in the positive direction.



Ch.	On	Signal	Hold	Y-Scale	Y-Offset	Y-Value 1	Trigger	Pegel	Einheit
1	☑	Position actual value (6064:0)	Hold	0,10000	-4900000,00000	488573.000	[Nicht aktiv]	20	incr
2	☑	Velocity actual value (606c:0)	Hold	1,00000	0,00000	0.180	Positive Flanke	20	rev/min
3	☑	Torque actual value (6077:0)	Hold	1,00000	0,00000	89.500	[Nicht aktiv]	20	% MN
4	☑	Following distance (2225:0)	Hold	0,10000	0,00000	-131.000	[Nicht aktiv]	20	incr

2 Measure to avoid the Slip-Stick effect

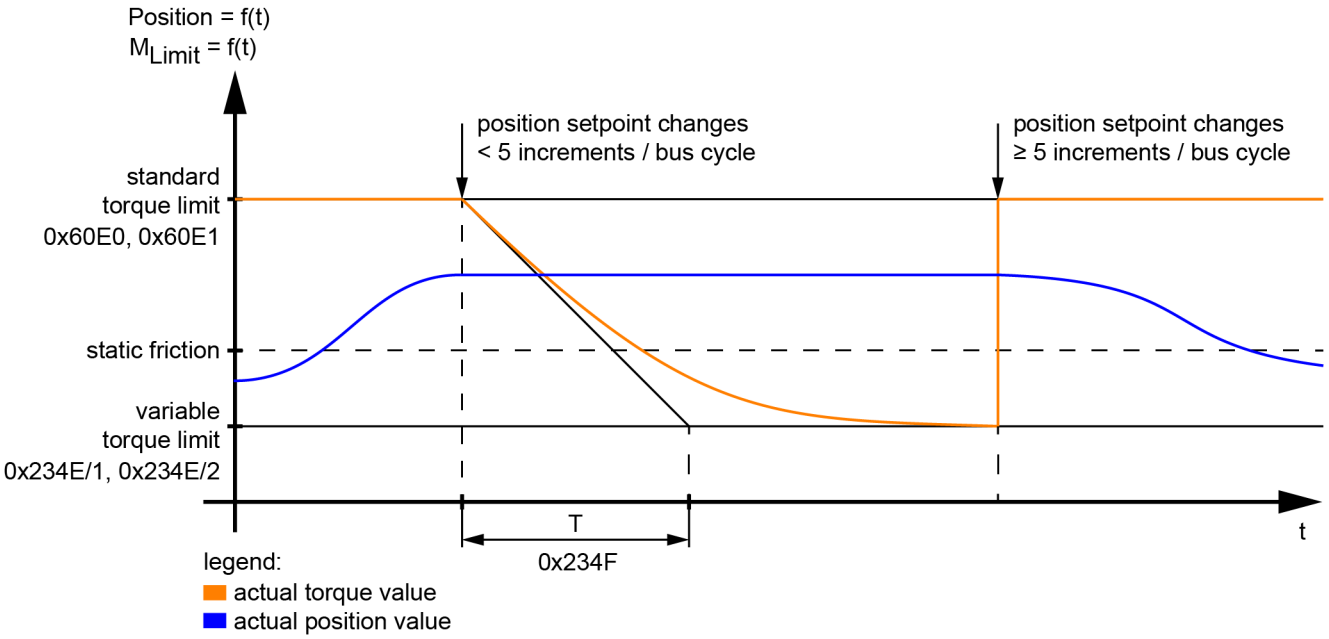
The slip-stick effect is avoided if in the position controlled standstill the torque limits are reduced to such an value that the static friction is not overcome.

The function is currently only usable in position control.

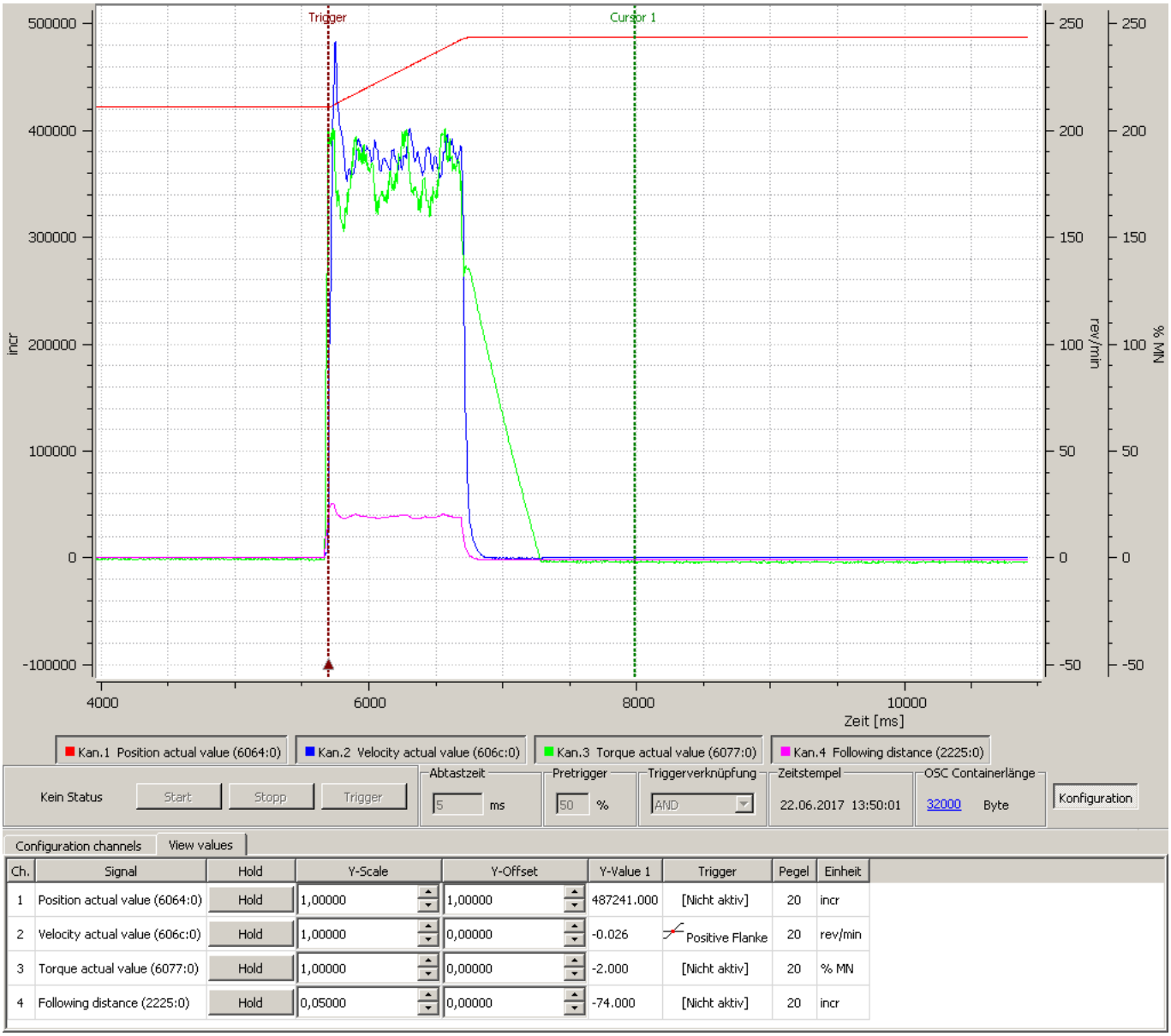
The function is activated via bit bar (0x234D 'Motion service switch' Bit 0). The torque limits (0x234E/1 'Variable positive torque limit' and 0x234E/2 'Variable negative torque limit') are treated separately due to need for the suspended axes or asymmetric frictional behavior.

Almost at a standstill (position setpoint changes <5 increments / bus cycle-time parameterizable via 0x2359 'Threshold variable torque limits') the standard torque limits with PT1 behavior are reduced to the variable torque limits. The variable torque limits and the filter time constant can be parameterized.

The variable torque limits must be selected smaller than the static friction . As a result, the slip-stick effect is avoided, however, any existing following error can not be completely degraded. The reduced torque limits are immediately increased back to the default values if setpoints are specified for a new movement.



Subsequent is a measurement with an activated reducing torque limits. The slip-stick effect no longer occurs.



2.1 Relevant objects

Objects	Meaning	
0x234D 'Motion service switch'	Bit 0	Function to avoid slip-stick effects = 0: inactive = 1: active
0x234E/1 'Variable positive torque limit'	'Variable positive torque limit' if the function to avoid slip-stick effects is active	
0x234E/2 'Variable negative torque limit'	'Variable negative torque limit' if the function to avoid slip-stick effects is active (enter with sign '-')	
0x234F 'Time constant variable torque limits'	'Time constant variable torque limits' describes the temporal transition behavior of the torque limits between normal mode and the variable values	
0x2359 'Threshold variable torque limits'	'Threshold variable torque limits' is the limit value of the position increase per bus cycle, from which the standard torque limits 0x60E0 'Positive torque limit value' / 0x60E1 'Negative torque limit value' act. For increases smaller than the threshold, the transition is made to the variables torque limits 0x234E/1 'Variable positive torque limit' / 0x234E/2 'Variable negative torque limit'	

Appendix

2.2 Objects

2.2.1 0x234D 'Motion service switch'

Object description

Index	0x234D
Name	'Motion service switch'
Object type	VAR
Data type	UNSIGNED32

Configuration 0x234D 'Motion service switch'

Bit no.	Condition	Meaning
0	0	iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 / Function to avoid slip-stick effects inactive KW-R06 / Reserved
	1	iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 / Function to avoid slip-stick effects active KW-R06 / Reserved
1	0	KW-R06 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 / Advanced position increase monitor inactive
	1	KW-R06 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 / Advanced position increase monitor aktive
2-31	0	Reserved
	1	Reserved

Entry description

Access	read/write
PDO mapping	no
Range of values	UNSIGNED32
Scaling	1
Unit	-
Default value	0000 0000 0000 0000 0000 0000 0000 0000 (LSB)
Min. value	0000 0000 0000 0000 0000 0000 0000 0000
Max. value	1111 1111 1111 1111 1111 1111 1111 1111

2.2.2 0x234E 'Variable torque limits'

Object description

Index	0x234E
Name	'Variable torque limits'
Object type	ARRAY
Data type	INTEGER16

This object is used by the following function:
'Anti Slip-Stick'

Entry description

Sub-index	0
Description	number of sub-entries
Access	read
PDO mapping	no
Range of values	1-2
Scaling	1
Unit	-
Default value	2

Sub-index	1
Description	'Variable positive torque limit'
Access	read/write
PDO Mapping	yes
Range of values	INTEGER16
Scaling	0.1
Unit	$\%M_N$
Default value	0
Min. value	-3000.0
Max. value	3000.0

Sub-index	2
Description	'Variable negative torque limit'
Access	read/write
PDO Mapping	yes
Range of values	INTEGER16
Scaling	0.1
Unit	$\%M_N$
Default value	0
Min. value	-3000.0
Max. value	3000.0

2.2.3 0x234F 'Time constant variable torque limits'

Object description

Index	0x233B
Name	'Delay software reset'
Object type	VAR
Data type	UNSIGNED16

0x234F 'Time constant variable torque limits' describes the temporal transition behavior of the torque limits between normal mode and the variable values.

This object is used by the following function:
'Anti Slip-Stick'

Entry description

Access	read/write
PDO mapping	no
Range of values	UNSIGNED16
Scaling	1
Unit	ms
Default value	0
Min. value	0
Max. value	65535

2.2.4 0x2359 'Threshold variable torque limits'

Object description

Index	0x2359
Name	'Threshold variable torque limits'
Object type	VAR
Data type	UNSIGNED32

This object'Threshold variable torque limits' is the limit value of the position increase per bus cycle, from which the standard torque limits 0x60E0 'Positive torque limit value' / 0x60E1 'Negative torque limit value' act. For increases smaller than the threshold, the transition is made to the variables torque limits 0x234E/1 'Variable positive torque limit' / 0x234E/2 'Variable negative torque limit'.

Entry description

Access	read/write
PDO mapping	no
Range of values	UNSIGNED32
Scaling	1
Unit	Increments
Default value	5
Min. value	1
Max. value	2147483647