Field-weakening

Translation of the "Original Dokumentation"

Name: FKT_Feldschwaechung_en

Version:

Version: 2019/45	
Change	**Letter symbol**
• Controller card KW-R27 added	STL

Previous version: 2018/44

Product version:

Product (AMK part no.)	**Firmware Version (AMK part no.)**
KW-R06 (O835) KW-R07 (O807) KW-R16 (O872) KW-R17 (O873)	AE-R05/R06 V1.10 2013/15 (204486)
KW-R24 (O901)	AE-R24 V2.03 2015/06 (205587)
KW-R24-R (O954)	AE-R24-R V2.11 2016/46 (206643)
KW-R25 (O902)	AE-R25 V2.03 2015/06 (205588)
KW-R26 (O903)	AE-R26 V2.03 2015/06 (205589)
KW-R27 (O957)	AE-R26 V2.12 2018/40 (207284)
iX / iC / iDT5 /	iX V1.03 2013/18 (204515)
iX(-R3) / iC(-R3) / iDT5(-R3) /	iX V2.08 2015/46 (206017)
ihXT /	ihX V1.00 2015/06 (205440)

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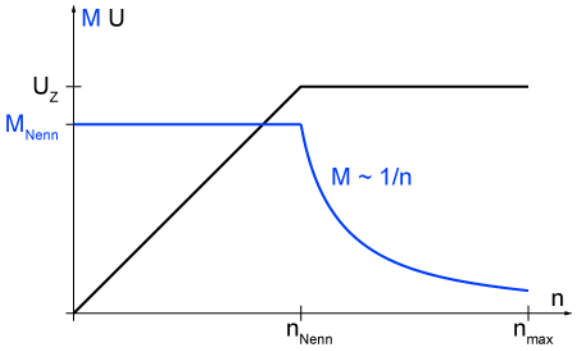
1 Field-weakening

Supported hardware:	KW-R06 / KW-R16 / KW-R07 / KW-R17 / KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT /

The permanent magnets of a rotating rotor induce a voltage to the stator which is proportional to the speed. With n = n_{nom}, the induced voltage reaches the DC bus voltage UZ which forces the torque current.

A higher speed can only be reached if the magnetic field of the permanent magnets is weakened by forcing a current to the stator windings, the magnetic field of which reduces the field of the permanent magnets.

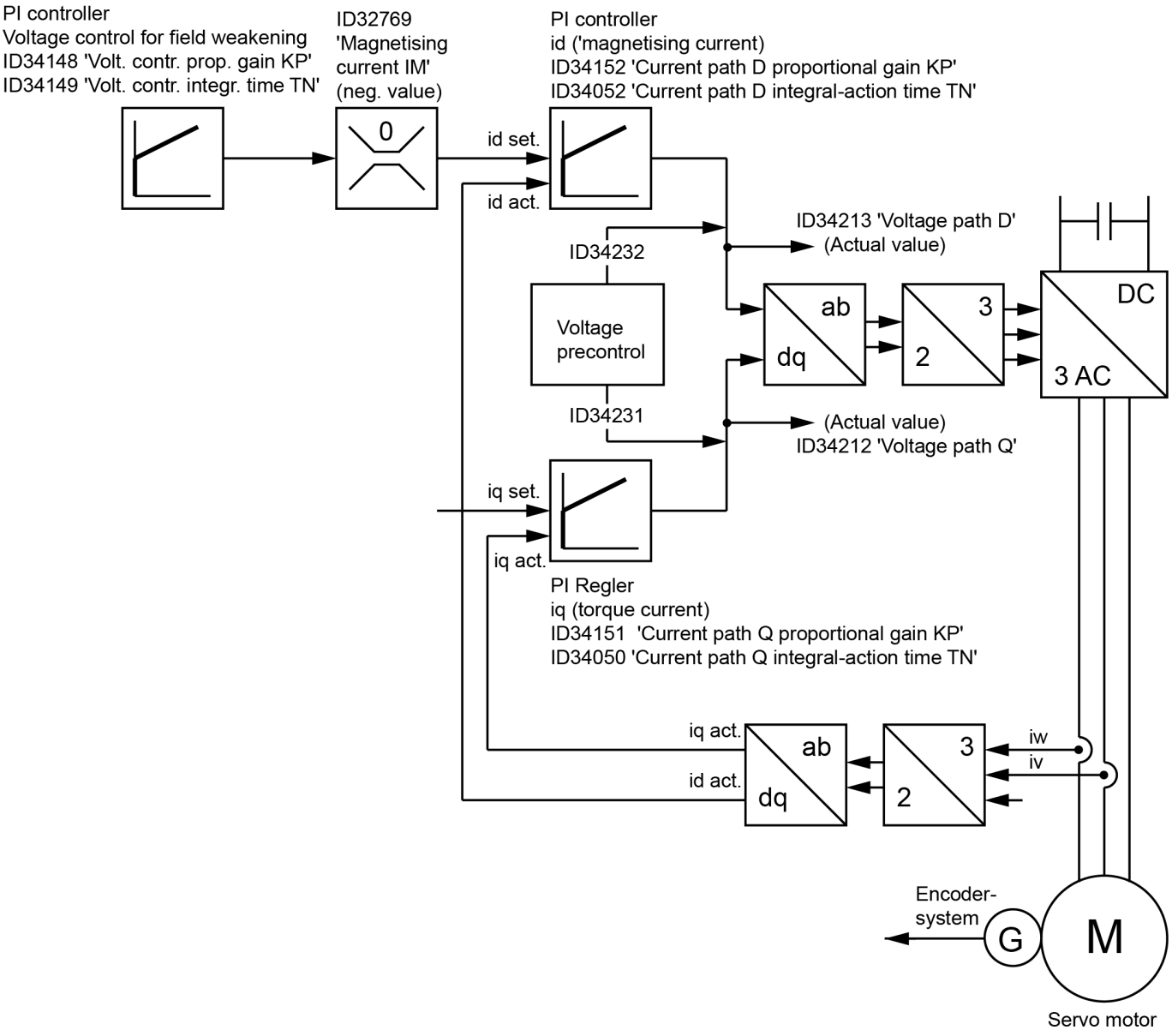
Reducing the magnetic field also means torque reduction proportional to 1/n. The additional current causes higher thermal load to the inverter and the motor.



2 Relevant parameters

Parameter	Name	Meaning See document 'Parameter description' (AMK part no. 203704)
ID32769 1)	'Magnetising current'	Maximum field-weakening current (See motor data sheet) ID32769 'Magnetising current' ≤ ID109 'Motor peak current'
ID32770 1)	'Magnetising current 1'	Minimum field-weakening current (See motor data sheet)
ID32953 1)	'Encoder type'	Encoder type and properties ID32953 = 0xXX3X - field-weakening synchronous motor See 'ID32953 'Encoder type' bit string' on page 8.
ID34148 1)	'Voltage control proportional gain KP'	Voltage control Kp
ID34149 1)	'Voltage control integrating time TN'	Voltage control TN
ID34266 1)	'Voltage reserve'	Voltage reserve for current controller ID34266 = 30 V

1) The parameter value must be set specific to the application



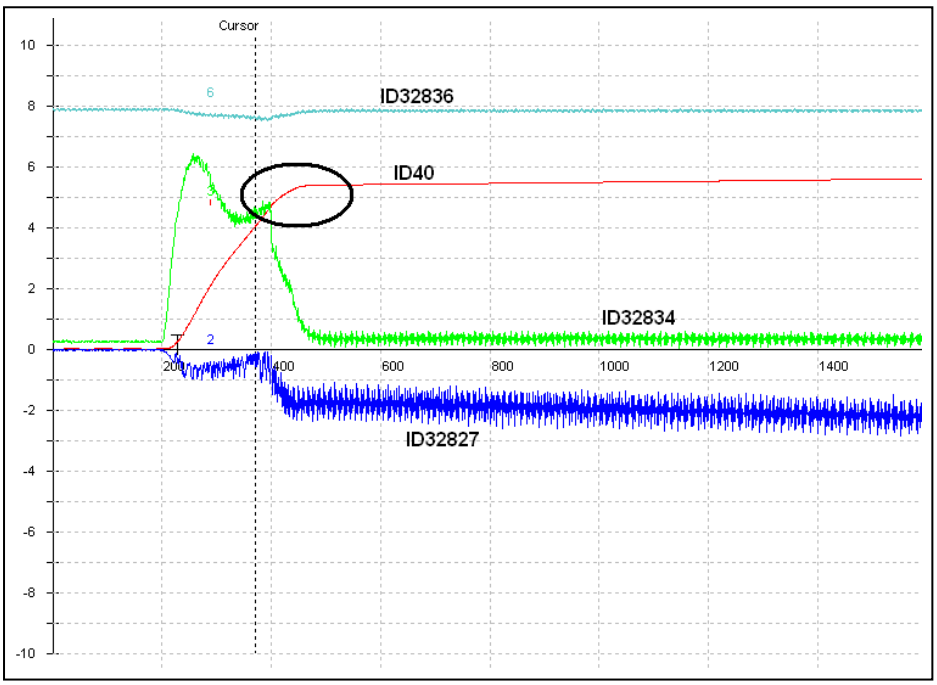
3 Startup instructions

Parameter	Name	Colour in the following oscillograms
ID40	'Velocity feedback value'	red
ID32827	'Magnetising current feedback'	blue
ID32834	'Torque current feedback'	light green
ID32836	'DC bus voltage'	light blue

Record the above mentioned parameters by means of the AIPEX PRO oscilloscope function.
(The following oscillograms are generated with a laboratory model.)

Initial situation

ID34148 'Voltage control proportional gain KP' = 0,050 A/V; ID34149 'Voltage control integrating time TN' = 100,0 ms

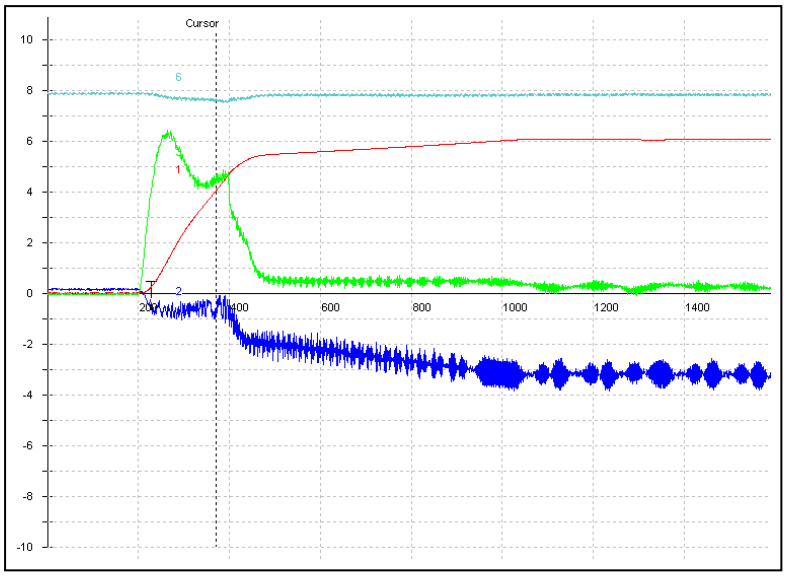


The nominal speed of the drive is 2000 rpm (cursor position). The speed shall increase up to 3000 rpm.
Parameters ID34148 'Voltage control proportional gain KP' and ID34149 'Voltage control integrating time TN' must be set so that ID40 'Velocity feedback value' increases without bending.

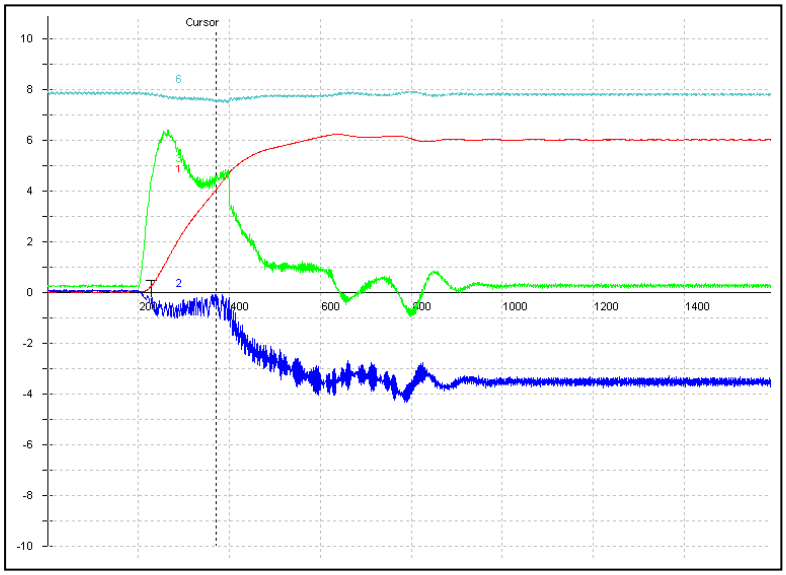
Optimisation:

Alternately, reduce ID34149 'Voltage control integrating time TN' and increase ID34148 'Voltage control proportional gain KP':

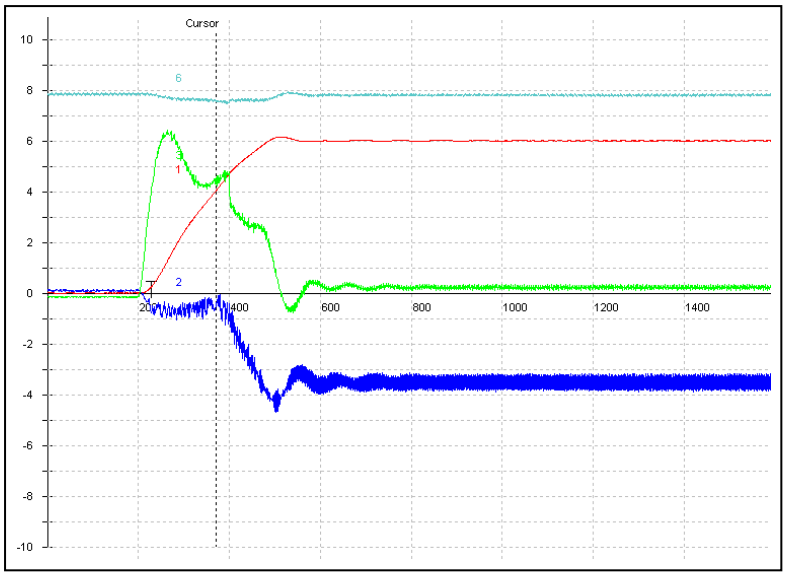
1. ID34148 'Voltage control proportional gain KP' = 0,050 A/V; ID34149 'Voltage control integrating time TN' = 25,0 ms



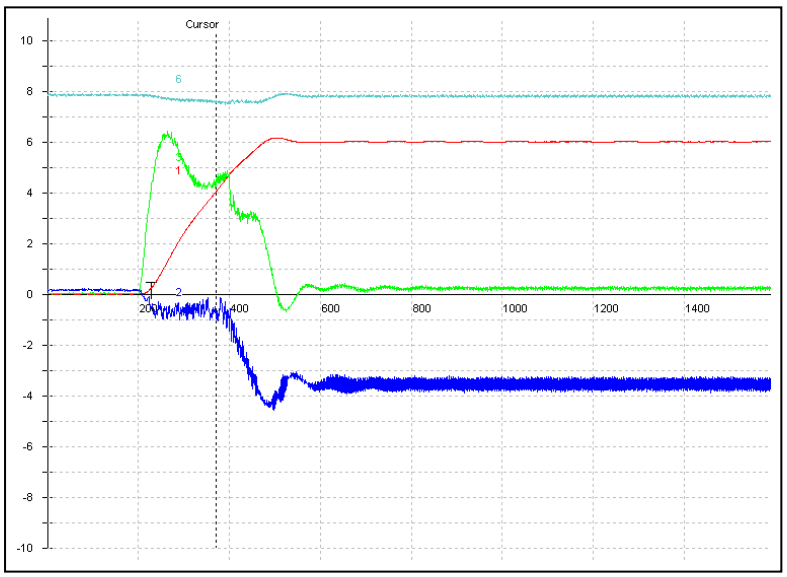
2. ID34148 'Voltage control proportional gain KP' = 0,150 A/V; ID34149 'Voltage control integrating time TN' = 25,0 ms



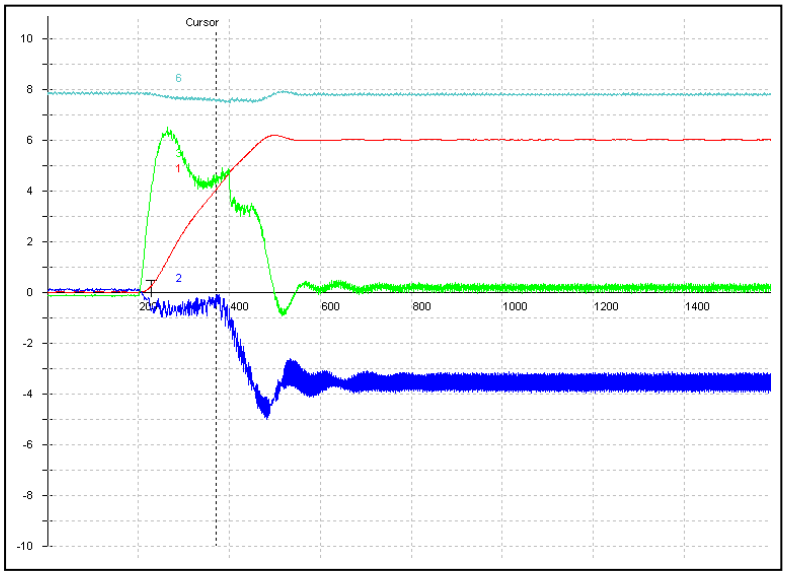
3. ID34148 'Voltage control proportional gain KP' = 0,150 A/V; ID34149 'Voltage control integrating time TN' = 10,0 ms



4. ID34148 'Voltage control proportional gain KP' = 0,175 A/V; ID34149 'Voltage control integrating time TN' = 10 ms



5. ID34148 'Voltage control proportional gain KP' = 0,175 A/V; ID34149 'Voltage control integrating time TN' = 9,0 ms



ID34149 'Voltage control integrating time TN' may not reach the same magnitude as ID34050 'Current path Q integral-action time TN' resp. ID34052 'Current path D integral-action time TN' because oscillations might occur.

Appendix

ID32953 'Encoder type' bit string

Configuration ID32953 'Encoder type'

Bit no.	Condition	Meaning
0-3 **Motor encoder** (Nibble 0)	0x0	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 /** I encoder **KW-R24-R /** Reserved
	0x1	**KW-R06 / KW-R07 /** H encoder, connected to the resolver input **iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT /** H encoder, connected to the sine encoder input **KW-R16 / KW-R17 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x2	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 /** T, V encoder [1) 2)] **KW-R24-R /** Reserved
	0x3	Reserved
	0x4	Reserved
	0x5	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 /** I encoder **KW-R24-R /** Reserved
	0x6	Reserved
	0x7	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 /** S, U encoder [2)] **KW-R24-R /** Reserved
	0x8	**KW-R06 / KW-R07 / KW-R24-R /** Resolver **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x9	**KW-R06 / KW-R07 /** Square wave pulse encoder **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved

Bit no.	Condition	Meaning
	0xA	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 /** E or F encoder Linear encoder LC183 and LC483 **KW-R24-R /** Reserved
	0xB	Reserved
	0xC	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R25 / KW-R26 / KW-R27 /** P or Q encoder **KW-R24-R /** Reserved
	0xD	**KW-R26 / KW-R27 /** Y encoder **KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 /** Reserved
4-7 **Motor model** (Nibble 1)	0x0	Asynchronous motor
	0x1	Non-field weakening synchronous motor
	0x2	U/f control
	0x3	Field weakening synchronous motor
	0x5	Sensorless operation of an asynchronous motor (Nibble 0 has to be set to the value 0)
	0x6	Asynchronous motor with voltage control (control of the magnetising current)
8-11 **Speed encoder** (Nibble 2)	0x0	like motor encoder
	0x1	**KW-R06 / KW-R07 /** H encoder, connected to the resolver input **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x2	**KW-R06 / KW-R07 /** T, V encoder [1) 2)] **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x3	Reserved
	0x4	Reserved
	0x5	**KW-R06 / KW-R07 /** I encoder **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x6	Reserved
	0x7	**KW-R06 / KW-R07 /** S, U encoder [2)] **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved

Bit no.	Condition	Meaning
	0x8	**KW-R06 / KW-R07 /** Resolver **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x9	**KW-R06 / KW-R07 /** Square wave pulse encoder **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0xA	**KW-R06 / KW-R07 /** E or F encoder (Linear encoder LC183 and LC483) **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0xB	Reserved
	0xC	**KW-R06 / KW-R07 /** P or Q encoder **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
12-15 **Position encoder** (Nibble 3)	0x0	like motor encoder
	0x1	**KW-R06 / KW-R07 /** H encoder, connected to the resolver input **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x2	**KW-R06 / KW-R07 /** T, V encoder [1) 2)] **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x3	Reserved
	0x4	Reserved
	0x5	**KW-R06 / KW-R07 /** I encoder **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x6	Reserved
	0x7	**KW-R06 / KW-R07 /** S, U encoder [2)] **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved

Bit no.	Condition	Meaning
	0x8	**KW-R06 / KW-R07 /** Resolver **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x9	**KW-R06 / KW-R07 /** Square wave pulse encoder **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0xA	**KW-R06 / KW-R07 /** E or F encoder (Linear encoder LC183 and LC483) **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0xB	Reserved
	0xC	**KW-R06 / KW-R07 /** P or Q encoder **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / ihXT / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved

1) Also applies for the linear scale "LinCoder L230" from the company Sick/Stegmann with the Hiperface interface.
2) When switching on the power supply, or when doing a homing cycle, the encoder must not turn because the digital position is read twice and plausibility checked. If the difference between both read positions is out of the internal defined range, the diagnosis message 2310 'Encoder communication' info 1 = 7 is issued.

Encoder evaluation

E-, F-encoder:

The encoder evaluation (type E / F) is a combination of analogue and digital evaluation. The absolute value is generated in the encoder after mains on and send to the inverter via EnDat 2.1 protocol. The absolute value is evaluated in the inverter only once, during operation only the SIN/COS tracks are evaluated for the motor control. The multiturn encoder (type F) not need a homing. For singleturn encoder (type E) a homing cycle must be executed to built a relation between the machine position and the encoder signal. The necessary homing mark is built in the drive controller.

In addition to the absolute value, the E and F encoders deliver the analog signals at the correct time and position to the absolute value.

During the absolute value evaluation in the inverter, in addition to the absolute value, the analog signals are evaluated in the correct time and position, thereby improving the accuracy of the absolute value.

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H-encoder:

The Hall encoder generates directly a SIN/COS signal with 1 period/revolution. Out of them the drive controller calculates the position angle of the rotor.

Per revolution the drive controller generates one homing mark to evaluate during the function homing cycle.

I-encoder:

The encoder evaluation (type I) is an analogue evaluation of the SIN/COS tracks and a homing signal.

The rotary rotor field of the permanent magnets of a synchronous motor is not aligned to the rotary stator rotary field. At synchronous motors with I-type encoder the alignment is done automatically with the function software commutation after the first switch on of the controller enable (RF) after mains on

.

The function software commutation automatically writes values in ID34174. As the function changes parameter values, the device will automatically startup the device at the next RF change. A device startup causes the temporarily changed parameter to be reset to its initial value. Temporary parameters must therefore be written cyclically or only after the software commutation function, followed by another RF change, on the application side.

P-, Q-encoder:

The encoder evaluation (type P / Q) is a complete digital evaluation. The absolute position is send via EnDat 2.1 commands cyclic synchronous from the encoder, triggered by the trigger signal (CLOCK) of the drive controller.

Any available SIN/COS signals are not evaluated!

R-encoder:

The evaluation electronic for the encoder signals scans the high frequency output signals of the encoder by an A/D converter at this time, where the exciter signal has his maximum. The scan cycle is known, because the evaluation electronic is generating also the exciter signal. The evaluation electronic scans the peak values of the encoder signal, in this way the exciter signal is eliminated. A SIN/COS signal with 1 period/revolution remains. Out of them the drive controller calculates the angle position of the rotor. To become a position relation between the machine and the encoder signals a homing cycle function must be executed. The necessary homing mark of the encoder (1/revolution) is built in the drive controller.

S-, T-, U-, V-encoder:

The encoder evaluation (type S / T / U / V) is a combination of analogue and digital evaluation. The absolute value is generated in the encoder after mains on and send to the inverter via Hiperface protocol. The absolute value is evaluated in the inverter only once, during operation only the SIN/COS tracks are evaluated for the motor control. The multiturn encoder (type T / V) not need a homing. For singleturn encoder (type S / U) a homing cycle must be executed to built a relation between the machine position and the encoder signal. The necessary homing mark of the encoder is built in the drive controller.

Y-encoder:

The Hiperface DSL protocol transmits digital data between an encoder and the drive controller by modulating the data into the supply line of the encoder. The absolute positions are send serial and cyclic synchronous from the encoder triggered by the trigger signal of the drive controller.