V/f Operation

Translation of the "Original Dokumentation"
Rights reserved to make technical changes

Name: FKT_UF_Betrieb_en

Version:

Version: 2019/38	
Change	**Letter symbol**
• Development changed	KoJ

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)

Publisher:
AMK Arnold Müller GmbH & Co. KG
Gaußstraße 37 – 39,
D-73230 Kirchheim/Teck
Germany
Phone: +49 7021/50 05-0,
Fax: +49 7021/50 05-176
E-Mail: info@amk-group.com
Homepage: www.amk-group.com
Personally liable shareholder: AMK Verwaltungsgesellschaft mbH, Kirchheim/Teck
Registration court: Stuttgart HRB 231283; HRA 230681

1 V/f operation

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) /

In the voltage/frequency open-loop control (V/f operation), the inverter outputs the motor voltage and the frequency in relation to the U/f characteristic curve, which enable a speed controlled motor operation without encoder feedback. The V/f operation is possible only for three-phase asynchronous motors.

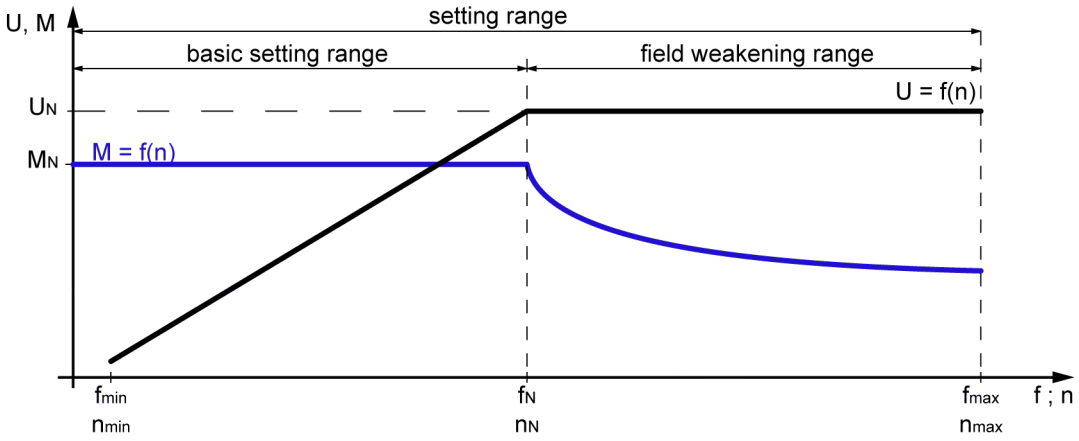
The setting range (ratio between least and greatest possible frequency) is divided into the basic setting range and the field weakening range.

The motor torque is constant in the basic setting range from the startup to the nominal frequency. At minimal speeds, there is less torque because of the ohmic resistance of the winding. The torque drop is compensated by the IxR compensation by increasing the voltage in the lower frequency range and thereby compensating the voltage drop at the ohmic resistance of the winding.

The slip compensation calculates the slip frequency and compensates the speed difference between the rotating fields of the stator and the rotor.

The speed of the connected motors varies in relation to the load. A constant load independent speed can only be reached by a slip compensation in combination with a regulation by the speed encoder.

When operating in the field weakening range, the inverter emits a constant voltage; the torque falls back.



2 Relevant parameters

Parameter	Name	Meaning See document 'Parameter description' (AMK part no. 203704)
ID111 1)	'Motor nominal current IN'	Nominal current of the motor
ID113 1)	'Maximum speed'	Maximum speed of the motor Within the field weakening range between nominal and maximum speed, the torque decreases with 1/n.
ID124 1)	'Zero velocity window'	If the actual speed value is within the standstill window $\|n_{act}\|$ < ID124, the real-time bit $n_{act} < n_{min}$ (ID331 'Message speed: actual value < minimal value') is set.
ID32768 1)	'Nominal motor voltage'	Voltage at which the motor runs at nominal speed (linked voltage between 2 motor terminals in star as well in delta connection). (Standard motors mostly 400V, AMK servo motors 350V) (See motor data sheet)
ID32772 1)	'Nominal velocity'	The voltage is increased to nominal voltage (ID32768) up to this speed. (See motor data sheet)
ID32773 1)	'Service bits'	ID32773, Bit 14 = 1: I^2t monitoring See 'ID32773 'Service bits' bit 14' on page 8.
ID32775 1)	'Pole number motor'	Pole number (p) of the motor (See motor data sheet)
ID32780 1)	'Acceleration ramp'	Time for the startup of speed zero up to ±ID113
ID32781 1)	'Deceleration ramp'	Time for the running down of ±ID113 to standstill.
ID32782 1)	'Deceleration ramp RF inactive'	Time for the running down of ±ID113 to standstill with removal of controller enable (RF) Controlled run-down
ID32800 1)	'AMK main operating mode'	Main operating mode The main operating mode becomes active after mains ON and an activated controller enable. See 'ID32800 - ID32809 'AMK operating modes' bit string ' on page 8.
ID32823 3)	'Velocity control command after ramp'	ID32823 'Velocity control command after ramp' is the actual speed value in V/f operation mode
ID32935 1)	'Voltage standstill'	Voltage that is applied at standstill (n = 0)
ID32953 1)	'Encoder type'	Motor and encoder type for different controller circuits See 'ID32953 'Encoder type' bit string' on page 12.
ID32991 1)	'U/f startup'	Speed threshold for the transfer from parabola-formed startup to a linear startup movement
ID34164 1)	'Terminal resistance'	Resistance between two motor terminals (See motor data sheet)
ID34239 1)	'V/F integrator stop'	Limitation of the speed setpoint

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

3) Parameter value is automatically generated by the controller card

3 Startup instructions

3.1 Activating V/f operation mode

ID32953 'Encoder type'

For V/f operation, 0x20h needs to be entered.
(See document 'Parameter description' (AMK part no. 203704): ID32953).

ID32800 'AMK main operating mode'

In ID32800, 0x++0043 needs to be entered.

ID32800 = 0x 00 xx 00 4 3

|	|	|	|	L Operation mode: speed control
|	|	|	L	Speed ramps ID32780, ID32781 active
|	|	L		Characteristics of position control (not relevant)
|	L			Setpoint source (application specific)
L				reserved

(See document 'Parameter description' (AMK part no. 203704): ID32800)

3.2 Further parametrization instructions

ID111 'Motor nominal current IN'

Enter the current value about 5-10% over the motor nominal current (according to type plate) to prevent the I^2t monitor motor from triggering prematurely during nominal operation.

Special case:

Standard motor 230 V (delta) / 400 V (star) in delta connection at 230 V terminal voltage:

$$I_{N\ Delta} = I_{N\ Star} \times \sqrt{3}$$

ID32772 'Nominal velocity'

The voltage is increased to nominal voltage (ID32768 'Nominal motor voltage') up to this speed.

- Valid for standard motor with synchronous net speed:
  $$n = \frac{2 \times f_{mains} \times 60}{p}$$
  Example:
  50 Hz, 4 poles: n = 1500 rpm
  50 Hz, 2 poles: n = 3000 rpm
- On AMK servo motors, enter depending on the motor output the nominal speed +(1...15 %)
  Motors less than 1 kW: about 15%
  Motors greater than 3 kW: approx. 5%

Special case:

Standard motor 230 V (delta) / 400 V (star) in delta connection with 3 x 400 V terminal voltage:
The basic speed range with constant torque is extended by the factor √3:

$$n = \frac{2 \times f_{mains} \times 60}{p} \times \sqrt{3}$$

On a 50 Hz (400 V) standard motor in delta connection, the field weakening range begins at 87 Hz. On a 4-pole motor, 87 Hz corresponds to a speed of 2600 rpm.
In star connection the field weakening range on 4-pole motors already begins at 1500 rpm. Due to the higher nominal speed, the nominal output increases by the factor √3.
On motors with self-ventilation, the available cooling is sufficient even at the greater output.
(The higher output results from the higher speed; this only increases the own losses slightly. The greater part of the losses from I^2R and the slip losses remain constant.)

ID32935 'Voltage standstill'

This parameter determines the voltage that is applied at standstill (frequency = 0). Thus the voltage drop at the winding can be compensated.
The larger the motor, the less is the voltage drop or otherwise the standstill voltage.

- On fan drives: 0 V to
  $$U = \frac{I_N \times R_{tt}}{2}$$
- For heavy starting: 0 V to
  $$U = I_N \times R_{tt}$$
- At greater breaking loose torques and for brief low speeds: 0 V to
  $$U = 2 \times I_N \times R_{tt}$$

(I_N = nominal current motor, R_{tt} = resistance motor winding between two terminals)

ID34164 'Terminal resistance'

If no IxR- and slip compensation is desired, then the value 0 has to be entered. For active IxR- and slip compensation, the resistance between two motor terminals needs to be entered in Ohm.
For motors that are listed in the AMK motor database, the resistance value that is specified there can be entered in ID34164 'Terminal resistance'.

Special case:

Standard motor 230 V (delta) / 400 V (star) in delta connection:

$$R_{tt\ Delta} = \frac{1}{3} \times R_{tt\ Star}$$

If motors are taken from the AMK motor database in this special case, then the resistance value of the database needs to be divided by 3.

ID34239 'V/F integrator stop'

If the integration ramp is set too steeply, the drive can not accelerate with the intended torque.
In this case, the speed setpoint is held when the device current exceeds the ID34239 'V/F integrator stop' percentage of the maximum current (ID110 'Converter peak current'). As a result, however, acceleration and deceleration running are extended.

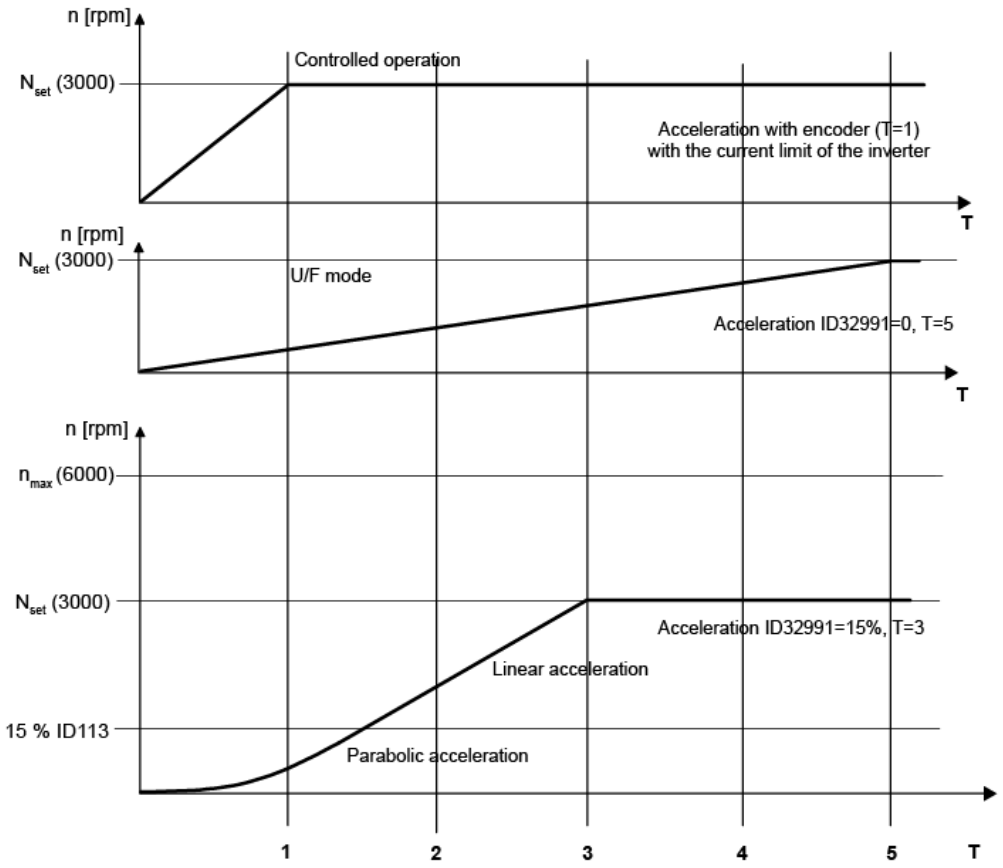
3.3 Soft start

In V/f-operation mode, starting up from standstill can frequently cause a problem, because when the axis "breaks loose" a high current can flow that may cause an overload of the inverter (shutdown "short circuit").
To securely avoid the overload in the V/f-start up (without soft start), the velocity ramp must be set flatly during start up. A flat velocity ramp leads however to undynamic behaviour of the axis.

Using ID32991, you can start up in parabola form (soft start) in the lower speed range. As of the speed specified in ID32991 'U/f startup', acceleration is linear up to the nominal speed. The value to be entered in ID32991 is the relative speed in relation to ID113 'Maximum speed'. In the speed range from standstill to the speed according to ID32991 , start up is according to a parabola, and then linear according to ID32780 'Acceleration ramp'.

If the drive is not at standstill, then acceleration is immediately with the linear ramp (ID32780). ID124 'Zero velocity window' serves as the decision criterion for the standstill.

Startup behaviour in V/f operation



Controlled operation:
T=1 is the time with which the motor accelerates as quickly as possible in the controlled operation, limited by ID82 'Positive torque limit' and ID83 'Negative torque limit' The thereby resulting minimum startup time is determined by the motor and the employed inverter.

V/f operation with linear start:
During V/f operation with linear startup time, the startup needs to be adjusted by a factor of T=5.

V/f operation with soft start:
A time of T=3 is achieved by the parabola-formed startup.

Axis run-down:
The axis run-down is not influenced by ID32991 . It corresponds to a T=2 compared to the one in the regulated drive.

Determination of ID32780 'Acceleration ramp':

The startup time in U/f operation needs to be determined by experimentation. Starting from long startup times, the minimum startup time can be approached in stages.

The effective startup time results as follows:

$$\mathbf{T_{H\ eff} = ID32780 \times (1 + 0,01 \times ID32991)}$$

4 Development

The specification of the frequency setpoint is done as in the regulated operation by the speed setpoint specification. The setpoint source is specified by the operating mode ID32800. The startup and run-down times according to ID32780 'Acceleration ramp', ID32781 'Deceleration ramp', ID32782 'Deceleration ramp RF inactive' are effective when they are activated in parameter ID32800... *Operating mode* by bit 6 = 1.

The ramp times may not be less than the physical achievable speed ramps of the system. Ramps that are too steep cause the message 2334 'System diagnostics: Output terminal overcurrent' or to the message 2321 'System diagnostics: IGBT monitoring'.

As actual value, ID32823 'Velocity control command after ramp' is displayed.

The following functions are not effective for the U/f operation:

- Torque limitation, e.g. according to ID82 'Positive torque limit'/ID83 'Negative torque limit'
- Torque display
- Power display

Appendix

ID32773 'Service bits' bit 14

Bit no.	Condition	Meaning
14	0	i^2t monitoring of motor inactive
	1	i^2t monitoring of motor If the value in ID114 'Overload limit motor'is exceeded, the warning message 2359 'Motor overload warning' is generated and warning bit code 33074 'Collective warning' and ID11 is set. As soon as ID33102 'Display overload motor' = 100 % is reached, the controller enable is withdrawn internally, the drive is braked according to ID32782 'Deceleration ramp RF inactive' until coming to a standstill, the acknowledgement QRF is set to zero and the error message 2360 'Motor overload error' is generated. See ID109 'Motor peak current'. See ID34168 'Time maximum current motor'. Formula for calculating the overload time t_x with a current I_x: $k = \left[\left(\frac{ID109}{ID111}\right)^2 - 1\right] \times ID34168$ $t_X = \frac{k}{\left(\frac{I_X}{ID111}\right)^2 - 1}$

ID32800 - ID32809 'AMK operating modes' bit string

Configuration ID32800 - ID32809 'AMK operating modes'

High word			Low word	
Bit 31				Bit 0 (LSB)
0 0 0 0	**X X X X**	**X X X X X X X X**	X X X X X X X X	X X X X X X X X
reserved	**Advanced operating mode**	**Setpoint source**	Operating mode, extensions, options	

Meaning of the bits ID32800 - ID32809

Bit no.	Condition	Meaning
0-3	0x0	No operating mode defined
	0x1	Reserved
	0x2	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Torque control
	0x3	Speed control
	0x4	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Position control **KW-R24 /** Reserved
	0x5	**KW-R06 / KW-R16 / KW-R07 / KW-R17 /** Parallel connection of the servo controller (operating mode for the slave) **iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x6	Reserved
	0x7	Reserved

Bit no.	Condition	Meaning
4	0	Torque limiting per ID82, ID83, (ID92)
	1	**KW-R06 / KW-R16 / KW-R07 / KW-R17 /** Torque limiting per analogue input A2 **iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
5	0	Reserved
	1	Reserved
6	0	Setpoint ramp inactive
	1	Setpoint ramp in the speed control operating mode (ID32780, ID32781) active
7	0	Speed fine interpolator (FIPO) inactive
	1	Speed fine interpolator (FIPO) in the speed control operating mode inactive (does not work with analogue setpoint setting!) The speed fine interpolator supplies 1 speed setpoint/250µs, synchronised to ID2 'SERCOS cycle time'.
8	0	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Position controller type P-controller **KW-R24 /** Reserviert
	1	Reserved
9 [2)]	0	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Following error compensation (SAK) inactive **KW-R24 /** Reserviert
	1	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Following error compensation in the position control operating mode for setpoints via ID47 and setpoints from the drive-internal interpolator **KW-R24 /** Reserviert
10 [1)]	0	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Position fine interpolator (FIPO) inactive **KW-R24 /** Reserviert
	1	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Position fine interpolator (FIPO) active in the position control operating mode The position fine interpolator supplies 1 position setpoint/250µs, synchronised to ID2 'SERCOS cycle time'. **KW-R24 /** Reserviert

Bit no.	Condition	Meaning
11 [2)]	0	**KW-R06 / KW-R07 /** Following error compensation (SAK) inactive **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	1	**KW-R06 / KW-R07 /** Active following error compensation in the position control operating mode for setpoints via pulse encoder input **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
12	0	Reserved
	1	Reserved
13	0	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Modulo value is formed from the active actual position value source (see bit 14). **KW-R24 /** Reserved
	1	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Modulo value is formed according to ID103. **KW-R24 /** Reserved
14	0	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Actual position value source of motor encoder ID32953 'Encoder type', ID116 'Resolution motor encoder'  The actual position value source must be set in the ID32800'AMK main operating mode' and automatically applies for the operating modes. **KW-R24 /** Reserved
	1	**KW-R06 / KW-R07 /** The actual position value source of the external encoder ID32953 'Encoder type', ID117 'Resolution external position feedback system', ID115 'Position feedback type', gear ratio ID121 'Load gear input revolution', ID122 'Load gear output revolution' is taken into consideration  The actual position value source must be set in the ID32800 'AMK main operating mode' and automatically applies for all operating modes. Bit 14 is not evaluated if a second. encoder is selected in ID34297 'Encoder type 2'. **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
15	0	Reserved
	1	Reserved

Bit no.	Condition	Meaning
16-23	0x01	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) /** Analogue input A1 (Speed control) **KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x03	**KW-R06 / KW-R07 /** Pulse encoder input **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x3C 0x41	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) /** Cyclical setpoint setting via real-time Ethernet • ID36 'Velocity command value' • ID47 'Position command value' • ID80 'Torque command value' Plus the feed forward values via real-time Ethernet • ID37 'Additive velocity command value' • ID81 'Additive torque command value' **KW-R06 / KW-R07 /** Pulse encoder input
	0x43	**KW-R24 / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Cyclical setpoint setting via real-time Ethernet • ID36 'Velocity command value' • **KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** : ID47 'Position command value' • ID80 'Torque command value' Plus the feed forward values via real-time Ethernet • ID37 'Additive velocity command value' • ID81 'Additive torque command value'
	0x44	**KW-R06 / KW-R16 / KW-R07 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Internal interpolator
	0x48	Reserved for AMK internal use: Setpoint setting through internal modules
24-27	0x00	Default operating mode
	0x01	Interpolation with internal interpolator according to SERCOS
28-31	0	Reserved
	1	Reserved

1) This parameter is used by the following function:
   'Fine interpolator position (FIPO)'
2) This parameter is used by the following function:
   'Following error compensation (SAK)'

Further values offered in AIPEX PRO under bit 16-23 are not supported any longer by new firmware versions.

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) / 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) /** 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) / 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) / 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) / 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) / 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) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0xA	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R25 / KW-R26 / KW-R27 /** E or F encoder Linear encoder LC183 and LC483 **KW-R24-R /** Reserved
	0xB	Reserved

Bit no.	Condition	Meaning
	0xC	**KW-R06 / KW-R07 / KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / 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) / 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) / 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) / 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) / 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) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x8	**KW-R06 / KW-R07 /** Resolver **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved

Bit no.	Condition	Meaning
	0x9	**KW-R06 / KW-R07 /** Square wave pulse encoder **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / 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) / 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) / 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) / 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) / 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) / 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) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved
	0x8	**KW-R06 / KW-R07 /** Resolver **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / KW-R24-R / KW-R25 / KW-R26 / KW-R27 /** Reserved

Bit no.	Condition	Meaning
	0x9	**KW-R06 / KW-R07 /** Square wave pulse encoder **KW-R16 / KW-R17 / iX / iC / iDT5 / iX(-R3) / iC(-R3) / iDT5(-R3) / 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) / 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) / 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.

.

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.