COMBIVERT

F5 A.S.C.L.

GB Instruction manual **Asynchron Sensorless Closed Loop V1.0**

Mat.No.	Rev.
00F5HEZ-K100	1B

KEB

1. General

A.S.C.L. means asynchronous sensorless closed loop and describes the encoderless operation of three-phase current asynchronous motors at the KEB COMBIVERT. The principle is based on a mathematical model of the asynchronous motor. Thus the rotor speed can be emulated with well-known motor data.
A.S.C.L. is not an operation mode of F5-MULTI. It is an independent software version F5H-M, which is runnable on the hardware of F5 application controls.

This application has the following advantages:

- no encoder system in the motor
- no encoder interface in KEB COMBIVERT
- automatic calibration function for equivalent circuit data
- mass moment of inertia-dependent default setting of the speed controller

Software limits:

- no posi module
- no position standstill controller
- no fast setpoint setting, neither speed nor torque
- 8000/ 16000 rpm resolution blocked
- no 12 kHz switching frequency

The necessary motor data for the model can be independently identified by the KEB COMBIVERT.
Static operation at small frequencies must be avoided because the model can be unstable in this case.

2. Activation of the encoderless operation

To activate the encoderless operation the following settings are necessary:
(the modulation must not been enabled during the settings!)

Control type **(Ud.02)**
Parameter Ud.02 „control type“ must be adjusted to 4 „F5-M/ 4000 rpm“ respectively to 7 „F5-M/ 500 rpm“.

Controller configuration (cS.00)
Choose control mode = 4 „speed control“

Actual value source (cS.01)
Choose actual value source = 2 „calculated actual value“

Flux/rotor adaption mode (dS.04)
Choose dS.04 = 249 to make the following settings:
- motor model on
- maximum voltage controller on, maximum voltage 100% (no over modulation)
  (for adjustment and activation of the maximum voltage controller see also chapter 10.2)
- flux controller on, limiting of the flux controller with variable limit, fast flux build up after switching on the modulation at start
- „waiting on magnetizing“ active

⚠ Further information about flux build up and -control see also chapter 10.1 „additional information“!

Enter motor rating plate data:

- dr.00 DASM rated current
- dr.01 DASM rated speed
- dr.02 DASM rated voltage
- dr.03 DASM rated power
- dr.04 DASM cos(phi)
- dr.05 DASM rated frequency

Rated power:

The rated power must be entered in megawatt from housing size >31.

Reset field-oriented control parameter (Fr.10)

enter Fr.10 = 1 or 2 in order to precharge motor dependent parameters.

Initial setting speed controller

A small KI value is recommended for the initial adjustment of the speed controller, since the drive for the identification must be adjusted non-dynamic but smooth and uncritical.

Further adjustments:

- Dead-time comp. mode (uF.18) = 3 (auto.ident)
- Hardware current lim. mode (uF.15) = 0: off
- activate point 64 „OL2 Derating limit“ in parameter Pn.65

Motor identification (dr.48)

Inverter must be in status „LS“ (ru.00 = LS) and enter dr.48 = 8, in order to identify the equivalent circuit data of the motor automatically. The brake handling must be deactivated.

For this point the control release must be given / read chapter 3 before execution.

The following adjustments must be done after successful identification:

- optimization of the speed controller
- application-specific adaptions

Thus the basic adjustments for encoderless operation are made.

3. Identification of the motor data

3.1 General

The required equivalent circuit data for the motor model can be automatically determined by the KEB COMBIVERT.

Measurement of the motor data is generally started from status "Low Speed". Parameter dr.48 is not writeable in other operating conditions. The measured values can be invalid in case of inverter oversizing. The rated current of the motor should be at least 1/3 of the maximum short time current limit (= In.18 = hardware current).

The direction of rotation during identification of the main inductance is always "clockwise rotation“!

During measuring value 82 "calculate drive data/ Cdd" is displayed in inverter status ru.00. After completion of the measurement ru.00 = 127 „drive data completely calculated (Cddr) is displayed. If the measurement is interrupted with an error, ru.00 = 60 „error! drive data/ E.Cdd“ is displayed.
The control release must be switched off in order to leave the identification mode.

During measuring the respective motor data (dr.6, dr.7, dr.8 and dr.10) and the dead time characteristic are overwritten with the measured values. These values can be changed during running identification. The defined motor data are adjusted in the corresponding parameters after successful conclusion.

Some adjustments can be incomplete or incorrect if the identification is interrupted e.g. by switching off the control release or by error release.

If the inverter internal brake handling is used in the application, then it must be deactivated for the identification. For safety reasons output signal "brake release" is not set during measuring, since the motor can not generate a defined torque at this time.
Stator resistance, rotor resistance and leakage inductance can be measured also at engaged brake.
The drive must be decoupled from the load for identification of the main inductance and the output switching condition, which is assigned to the brake control must be set to value 1 (= always active). Thus the brake is permanently released.

Overview dr.48: Motor identification

Bit	Value	Function dr.48
0...4		**Measurement:**
	0: off	off
	1: ASM calculation from rating plate data *	Precharging of the current controller parameters and main inductance from rating plate data
	2: Leakage inductance * **3: Stator resistance *** **4: ASM rotor resistance ***	Measurement of the leakage inductance (2), respectively of the stator (3) or the rotor resistance (4)
	5: Calculation from Ls, Rr, Rs *	Calculation of the current controller parameters from equivalent circuit data
	6: ASM main inductance *	**Attention: requires motor revolution in no-load operation!** Measurement of the main inductance
	7: automatically without Lh 8: automatically all	Start of the automatic measurement of all equivalent circuit data without (value 7) and/or with (value 8) Lh
	9: Dead time detection 2 kHz * **10: Dead time detection 4 kHz *** **11: Dead time detection 8 kHz *** 12: Reserved **13: Dead time detection 16 kHz ***	Measurement of the dead time compensation characteristics for different switching frequencies
	14: Torque detection 2 kHz 15: Torque detection 4 kHz 16: Torque detection 8 kHz 17: Reserved 18: Torque detection 16 kHz	Detection of the no-load torque at different switching frequencies. This torque can be subtracted at torque display (ru.12) during operation and thus a precise display can be achieved.
	19: Current offset detection	Current offset for phase U and V is measured
	20..31: Reserved	without function
5...7		**Frequency:**
	0: 1000 Hz 32: 500 Hz 64: 250 Hz 96: 125 Hz 128: 62.5 Hz 160: 32.25 Hz 192: 15.625 Hz 224: 7.8125 Hz	Frequency, when a measurement is executed This value must be set always to 0: 1000 Hz, since the ideal measuring frequency is determined automatically at the respective measurements. Only changeable for test and diagnostics purposes.

*** at dr.48 = 8 automatically identification, at dr.48 = 7 automatically identification, apart from Lh**

3.2 Automatic mode

Since the identification in the automatic mode is very reliably and for the user the simplest method it is recommended to use it generally.
Measurement of the dead time compensation characteristics, as well as the stator- and rotor resistance and the leakage inductance is done in standstill. A small rotation of the motor caused by the test signals is possible.

It is necessary for the identification of the main inductance, that the motor accelerates to the speed for maximum torque (dr.17) and then it operates in no-load operation.
There is a special ramp "Lh identification ramp time" (dr.49) for identification.
This ramp applies for acceleration to dr.17 and deceleration at the end of the identification.
The reference value for dr.49 is 1000 rpm in mode 4000 (ud.02 = 4) and 125 rpm in mode 500 (ud.02 = 7).

A small Ki value is recommended for parameter setting of the speed controller, the drive may not vibrate during identification.

The identification can take some minutes depending on the respective motor!

3.3 Single identification

Single identifications should not be used for the first measurement of the motor adaption, since invalid measuring results can occur in case of a wrong identification sequence or omitting of individual points.
The single identification can always be used if a complete automatic measurement was executed and only single parameters shall be identified new. For example this can be a resistance measurement in warm condition or a new measurement of main inductance after changing parameter dr.19 "factor flux adaption".

3.3.1 Pre-setting of the current controller parameters and main inductance (dr.48 = 1)

The current controllers are precharged with data, which are suitable for a 50 Hz standard motor by dr.48 = 1 "ASM calculation from rating plate data" and auto identification (dr.48 = 7 or 8). These values can be not suitable for special motors (e.g. spindle motors).
Furthermore a start value for main inductance is calculated from the motor type plate data.

3.3.2 Leakage inductance measurement (dr.48 = 2)

Measurement of the leakage inductance (dr.07) occurs at standstill with amplitude-modulated current. The frequency of the measuring signal is adjustable with bits 5... 7 in parameter dr.48.
Since the inverter determines automatically the ideal measuring frequency, value 0 should be always selected for bits 5... 7.

Bit	Value	Function dS.04
5...7	0: 1000 Hz 32: 500 Hz 64: 250 Hz 96: 125 Hz 128: 62.5 Hz	**Frequency:** Frequency, when a measurement is executed Set this value always to 0 (1000Hz), since the ideal measuring frequency is determined automatically at the respective measurements. Only changeable for test and diagnostics purposes.

3.3.3 Stator resistance measurement (dr.48 = 3)

Measurement of the stator resistance is done with DC current.

3.3.4. Rotor resistance measurement (dr.48 = 4)

Measurement of the rotor resistance (dr.08) occurs at standstill with amplitude-modulated current. The frequency of the measuring signal is adjustable with bits 5... 7 in parameter dr.48. Since the inverter determines automatically the ideal measuring frequency, value 0 should be always selected for bits 5... 7.
The measuring frequency must be reduced to 7. 8125 Hz for reasons of measuring accuracy. Therefore the motor is ability to rotate.

3.3.5. Calculation of the current controller from equivalent circuit data (dr.48 = 5)

The current controller parameters are calculated from the equivalent circuit data with the adjustment of dr.48 = 5. Is not identified in auto mode, if this action should occur after measurement of leakage inductance, rotor and stator resistance and before identification of the main inductance.

3.3.6. Identification of the main inductance (dr.48 = 6)

It is necessary for the identification of the main inductance that the motor accelerates to the speed for maximum torque (dr.17). A small Ki value is recommended for parameter setting of the speed controller, the drive may not vibrate during identification.
The motor must be able to rotate in no-load operation. The drive stops automatically after identification of the main inductance.

There is a special ramp ‚Lh identification ramp time‘ (dr.49) for identification. This ramp applies for acceleration and deceleration at the end of the identification. The reference value for dr.49 is 1000 rpm in mode 4000 (ud.02 = 4) and 125 rpm in mode 500 (ud.02 = 7).

3.3.7. Dead time detection (dr.48 = 9...13)

The dead time detection only works as single identification if the stator resistance is correct preset. The measured values can be read out via In.39 and In.40.
The dead time compensation characteristic is not contained in the data protection by reading of a complete list, because it is specific for the respective inverter.

The measured dead time compensation characteristics are effective, if uF.18 = 3 is selected.

3.4 Additional trimmings

3.4.1 Torque detection (dr.48 = 14...18)

This point should only be executed if the application really requires this increased torque accuracy. The torque display can be trimmed for applications with high requirements on the accuracy of this display.

As standard the torque display does not display value 0 at encoderless no-load operation. Reason for this are partly switching frequency-dependent losses in the inverter and partly friction losses caused by the application.
If the torque display shall be cleared about this offset, the torque offset of the complete drive can be measured for the different switching frequencies by setting dr.48 = 14...18. The drive accelerates stepwise with the adjusted ramp in dr.49 to a maximum synchronous speed factor of 1.3. The adjusted speed limits in the oP parameters remain effective.

The measured no-load torque is stored as correction characteristic. During operation the display of the actual torque in ru.12 is corrected with this characteristic.

The torque offset characteristic can be read out with parameters dr.58/dr.59.
Since the trimming values are not contained in the complete list, also the data transfer to another inverter is complex.

3.4.2 Current offset detection

As standard the current offset is permanently detected by the inverter and adjusted as long as the modulation is switched off. Therefore the current offset detection via dr.48 is normally not necessary.

In rare cases more accurate current offset values are reached if the trimming is done with an energized motor. If dr.48 = 19, the inverter outputs a test signal to the motor and the trimming is carried out once.
Furthermore the automatic measurement is deactivated at no modulation, so the identified offset remains permanently activated.

It is recommended to make changes at the current offset values only in agreement with KEB.

4. Adjustment of the speed controller

4.1 Default setting of the speed controller

Kp (cS.06) and Ki (cS.09) of the speed controller can be preset by the inverter.
The mass moment of inertia of the entire system (motor + rigidly coupled load) must be entered in cS.25 „moment of inertia“.

The mass moment of inertia for a standard synchronous motor, which is dependent on the adjusted motor rating is loaded in Fr.10 „load mot. dependent para.“ = 1 or 2 in cS.25 (dr.03). Since in many applications the ratio of the load inertia is in the range of 0.5 ... 5 * motor inertia, you obtain a value for cS.25 that has the correct dimension for 50 Hz standard motors.
Better results are achieved if the total mass moment of inertia is exactly preset. If the value is unknown, then it can be determined as described in chapter 4.2.

Parameter cS.26 "optimisation" determines the control characteristic which shall be achieved by the calculated parameters.
Parameters for a dynamic, hard speed controller adjustment are calculated with cS.26 = 2. Interference factors, such as for example torsion or tolerance of the load coupling effect that this adjustment leeds to vibrations of the complete system.
Parameters for a soft and slow speed controller adjustment are calculated with cS.26 = 15. Which of the values between 2 and 15 is most suitable for the application depends on the vibration tendency of the complete system.
The precharging of the speed controller parameters can be deactivated by the adjustment of value 19 (= off) in cS.26. At active precharging, the speed controller parameters are overwritten if the value of cS.25 or cS.26 is changed.

4.2 Determination of the mass moment of inertia

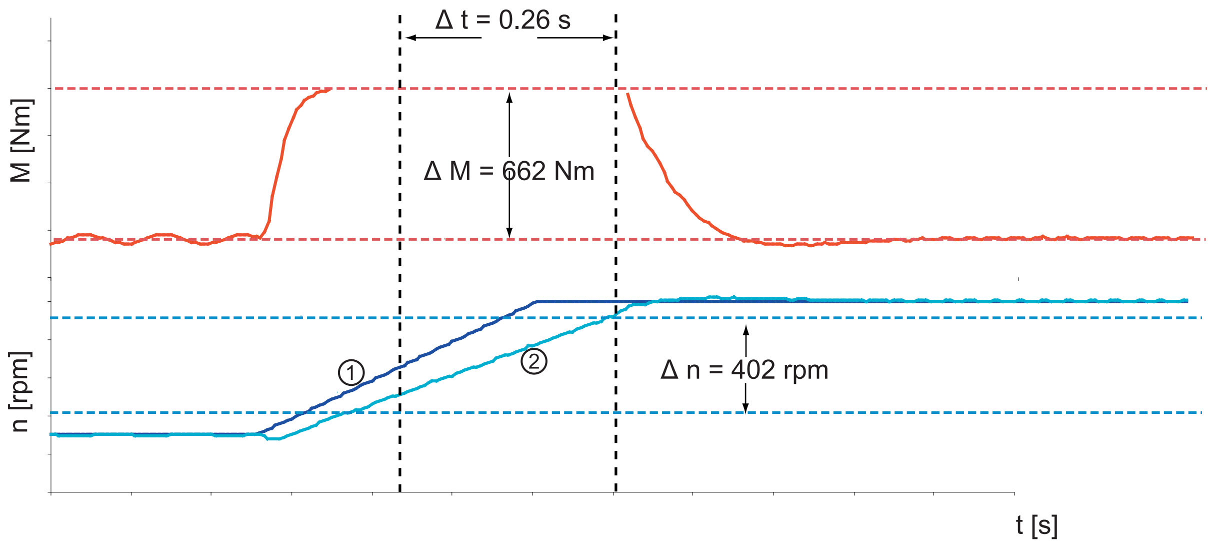
If the moment of inertia of the system is unknown, it is possible to determine it with an acceleration test.
For this the system must be accelerated with defined, constant torque. It must be guaranteed that no significant and acceleration-independent load torque occurs by the application.

The following formula is valid:

$$J_L = M * \frac{\Delta t}{\Delta n} \qquad cS.25\,[kg\,cm^2] = M\,[Nm] * \frac{\Delta t\,[s]}{\Delta n\,[rpm]} * 95493$$

Example: the following acceleration process was recorded with COMBIVIS:

Acceleration test to determine the inertia



①	setpoint speed
②	calculated actual speed

$$cS.25\ [kg\ cm^2] = 662\,Nm * \frac{0.26\,s}{402\,rpm} * 95493 = 40886\ kg\ cm^2$$

5. Operation at small speed

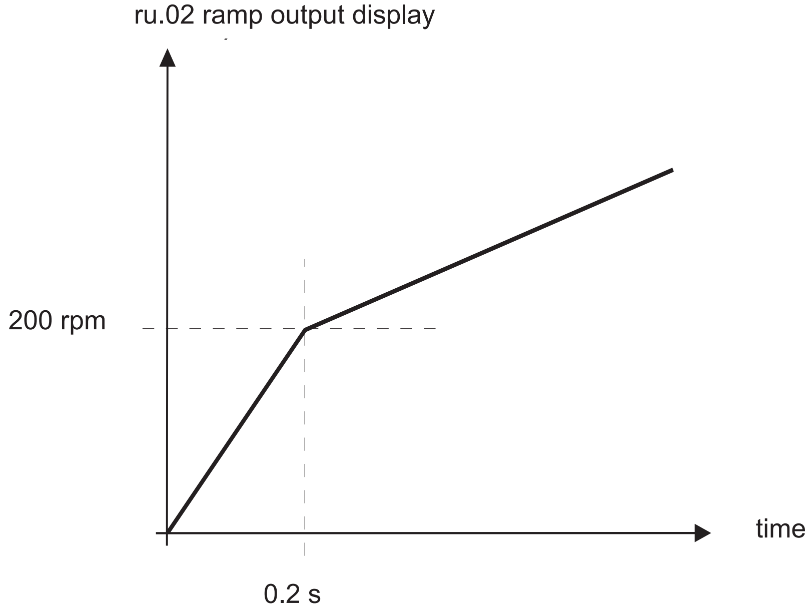
Operation at small speed is a critical range which should be passed very fast. The size of this range cannot be indicated universally valid. It is strongly dependent on the used motors.
The usable speed range for standard-asynchronous motors is approx.:

Power	gen. operation	mot. operation
2. 2 kW	1 : 20	1 : 50
85 kW	1 : 50	1 : 100

5.1 Start

In order to leave the critical range of low speed quickly when starting and stopping there is an additional ramp for this range. The ramp is defined by parameters dS.21 "ASCL start up speed" and dS.22 „ASCL startup time“.
dS.21 indicates the speed range, where the start ramp is effective.
dS.22 indicates the time for a speed change of 1000 rpm (at ud. 02 = 4) respectively 125 rpm (at ud.01 = 7).

Example:



ud.02 „control type“	= 4 (4000 rpm mode)
dS.21 „ASCL startup speed“	= 200 rpm
dS.22 „ASCL startup time“	= 1s

5.2 Stopping

5.2.1 ASCL limit U/f control (dS.19)

If the drive shall be stopped, the critical range of low frequencies must be passed through again.
Here there is an additional problem. A miscalculation of the speed can cause that the drive does not go into absolute standstill. The motor rotates continuously with a small frequency and very high current.

Under the following conditions it is switched therefore from speed-controlled into current-controlled, frequency-controlled operation:

- drive decelerates
- the stator frequency is smaller than dS.19 "ASCL v/f control limit“

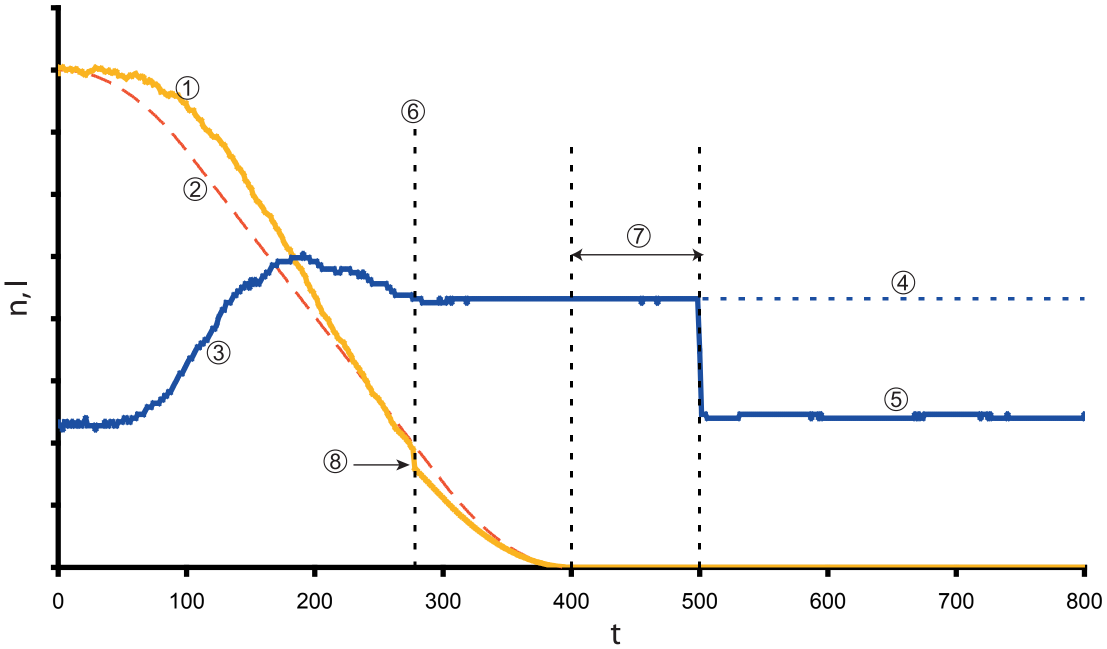
Then the drive behaves as follows:

- the output frequency is decelerated according to the adjusted deceleration ramp
- the current is kept constant from the changeover time

If the drive is stopped by switching off the rotation release, the modulation is switched off after reaching an output frequency of 0.

5.2.2 ASCL delay time v/f control (dS.20)

When stopping the drive with setpoint 0, the current is reduced to the magnetizing current value after reaching output frequency = 0.
In some cases the real speed of the motor is not yet 0 at this time. Therefore, parameter dS.20 "ASCL delay time v/f control" expands the time of the higher constant current.



①	calculated actual speed (ru.07)	④	constant current
②	setpoint speed (ru.02)	⑤	magnetising current
③	apparent current (ru.15)	⑥	change-over into open-loop operation
⑦	ASCL delay time uf-control (dS.20)	⑧	ASCL limit uf-control dec. (dS.19)

5.2.3 ASCL mode (dS.18)

If the drive shall not be stopped, but reversed, the change-over into open-loop mode is partially disturbing. This change-over can be deactivated generally with dS.18 = 4.

In order to use the open-loop mode for stopping, but without negative effects at reversing, the inverter must be programmed by way that the stopping of the motor always occurs in the same set.
Then the change-over can be activated in "stop set" (dS.18 = 0) and for the other sets disturbing influences during reversing can be avoided with dS.18 = 4.

It must always be ensured that the low frequency range will pass through fast.
This can be the reached by the adjustment of parameter dS.22 "ASCL start ramp time" and parameter dS.21 "ASCL start ramp speed". Both parameters apply for acceleration and deceleration.

5.3 Constant run

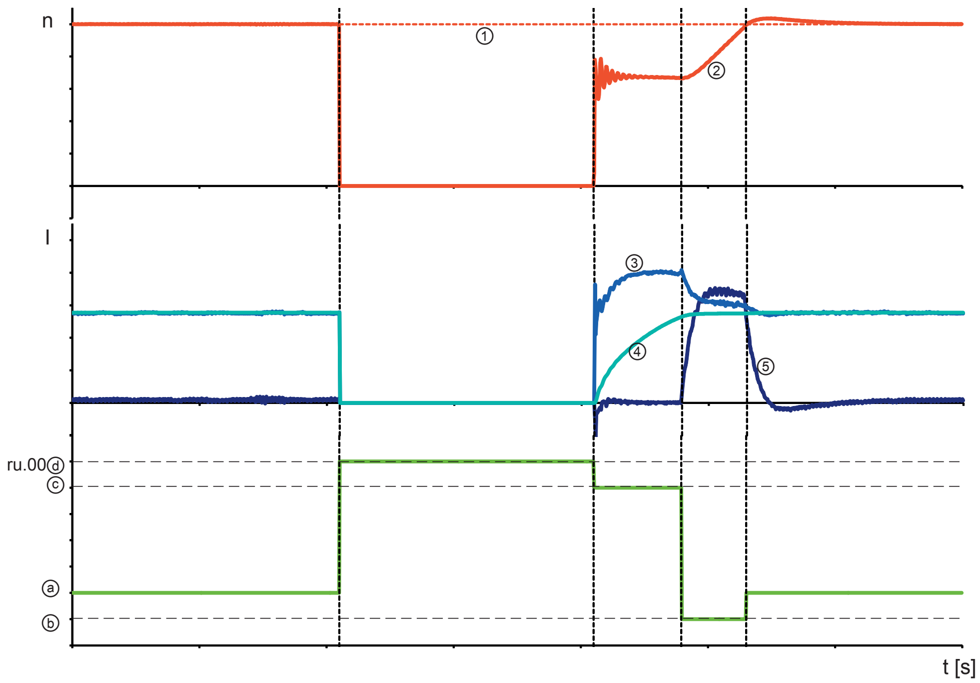
To avoid constant operation in the low frequency range, the minimum reference (oP.6 / oP.7) should be adjusted to a speed outside the critical range.
Alternatively lower values can be faded out by parameters oP.65...oP.68 (proh. reference).

6. Switching on running motor

The calculation of the actual speed can be unstable by the motor model if the motor still rotates when the modulation is switched on (e.g. "coast down" after failure).
There are two different starting methods when the motor still rotates at the startup:
Speed search (Pn.26) or DC braking (Pn.28/ Pn.33)

6.1 Speed search

With parameter Pn.26 "speed search condition" can be selected when the speed search shall be started when switching on the modulation. Since the motor normally only coasts in error case, speed search after auto-reset and after reset is sufficient in many cases.
The correct adjustment is depending on the application.

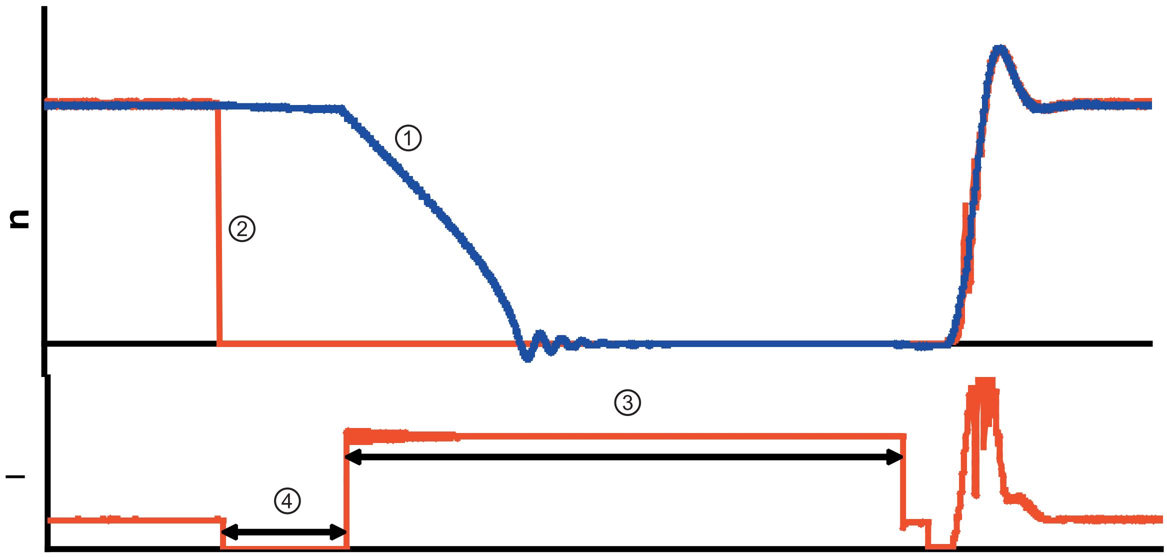


I = current [A]	n = speed [rpm]	ru.00 = status
ⓐ = acceleration	ⓑ = constant run, clockwise rotation	ⓒ = speed search
ⓓ = motor de-excitation		
① = speed control ru.02	② = actual speed ru.07 (estimated)	③ = magnetising current
④ = flux	⑤ = active current	

6.2 DC brake

The application of speed search will not be successfully for some motors.
The speed is miscalculated in this cases, the drive vibrates strongly or the drive goes into malfunction due to high current.

The motor must be stopped with DC braking in these cases, before the drive can be restarted.



①	real speed	②	calculated speed
③	DC braking	④	motor de-excitation

The torque display is not valid during DC braking. Value 0 is displayed.

6.2.1 DC braking mode (Pn.28)

The same conditions as for speed search can be selected to activate the DC brake. Value 10 (conditions) must be entered in parameter Pn.28 "DC braking mode". The conditions when the DC brake shall be executed can be selected in the check boxes.

6.2.2 DC braking max. current (Pn.33)

The DC current which decelerates the motor can be adjusted in parameter Pn.33 "DC braking max. current ASCL". A setting of 100% corresponds to rated motor current.

6.2.3 DC braking time (Pn.30)

Depending on the speed, the deceleration time until the drive comes to a standstill is different. The time must be measured by way that the drive decelerates from maximum possible speed to standstill.

7 Standardized torque display ru.90

The load of the complete drive in percent can be displayed with ru.90.

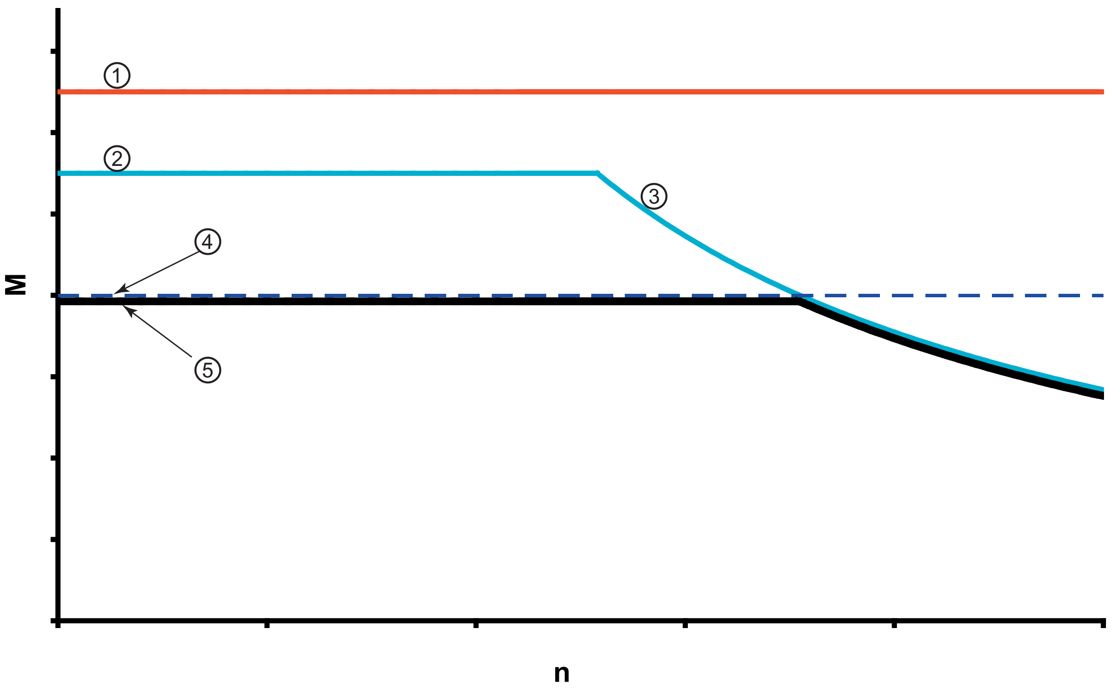
The thermal maximum permissible torque - i.e. rated torque in base speed range and in field weakening range the reduced rated torque of a 1/x function of the motor is estimated as 100% load of the motor.

The programmed torque characteristic is estimated as 100% load of the inverter. This consists of the torque limits in the cS parameters (e.g. cS.19) and the limiting characteristic in the dr-parameters (e.g. dr.15...dr.18).

The adjusted value in parameter LE.27 "reference torque" corresponds to 100% load of the application. This could be par example the torque which is permanent permissible for the mounted worm or gear box.

The lowest of the three values displays the torque, with which the complete drive may be permanently loaded at the respective speed. This torque is the reference torque for the calculation of parameter ru.90 „max. torque in %“.

ru.90 = actual torque display (ru.12) / reference torque



①	torque limit (defined by CS-Parameters)	②	rated torque
③	from rated speed: reduction of the permanent permissible torque acc. to a 1 / x function	④	reference torque (LE.27)
⑤	minimum value of the 3 curves = reference value for the calculation of ru.90		

8. Example

The start-up steps and the application of ASCL are described in the following programming example.

Start-up steps F5-ASCL for asynchronous motors

- activate F5-M parameter configuration with Ud.2 = 4 (4000 rpm) or 7 (500 rpm)
- initialize parameter with Fr.1 = -4 (default values)
- adjust controller activation cS.0 to 4 (speed control)
- adjust actual value cS.01 to 2 "calculated actual value"
- adjust source of rotation to terminal (oP.01 = 2 or 3) and generate LS status with control release
- activate the model in dS.4, limit the maximum voltage controller to 100% and switch on the flux controller (e.g. dS.4 = 249)
- enter name plate - motor data (dr.0...dr.5)
- activate adaption to the motor with Fr.10 = 1 or 2
- activate measured characteristic of the dead time compensation uf.18 = 3
- uF.15 = 0 „HSR deactivated“
- start identification with dr.48 = 8 „automatic start of all“

Example of an inverter download list with a 0.75 kW motor:

Ud.02	Control type	4: F5-M / 4000 rpm
Fr.01	Parameter set copy funct.	-4: KEB def/cust+sys/all sets
cS.00	Config. speed control	4: speed control (only F5-M/S)
cS.01	Actual value source	2: calc.+ off
oP.01	Source of rotation direction	2: FOR/REV, 0-lim.
dS.04	Flux/rotor adaption mode	249: on+off+no+on, max. 100% (ASM)+on, start and n^3/ dr.17^3+on
dr.00	DASM rated current	3.6 A
dr.01	DASM rated speed	1400 rpm
dr.02	DASM rated voltage	230 V
dr.03	DASM rated power	0.75
dr.04	DASM cos(phi)	0.72
dr.05	DASM rated frequency	50 Hz
Fr.10	Motor adaption	2: act. dc voltage (F5-M/S)
uF.18	Dead time comp. mode	3: auto. ident
uF.15	Hardware current limit	0: off

9. Used Parameters

Parameter	RO	PG	E	Min. value	Max. value	Resolution	Default	Unit
cS.00 Speed control config.	-	x	-	0	127	1	0	-
cS.01 Act. source	-	x	-	0	6	1	0	-
cS.25 Inertia	-	x	-	0.05	21474836	0.01	1	$kgcm^2$
cS.26 Optimisation	-	x	-	1.9	15	0.1	1.9 : off	-
dr.00 DASM rated current	-	-	-	0.0	1100.0	0.1	LTK	A
dr.01 DASM rated speed	-	-	-	0	64000; 8000	1; 0.125	LTK	rpm
dr.02 DASM rated voltage	-	-	-	120	830	1	LTK	V
dr.03 DASM rated power	-	-	-	0.10	400.00	0.01	LTK	-
dr.04 DASM cos (phi)	-	-	-	0.50	1.00	0,01	LTK	-
dr.05 DASM rated frequency	-	-	-	0.0	1600.0	0.1	LTK	Hz
dr.06 DASM stator resistance	-	-	-	0.000	65.535	0.001	LTK	Ohm
dr.07 DASM leakage inductance	-	-	-	0.01	500.00	0.01	LTK	mH
dr.08 DASM rotor resistance	-	-	-	0.000	65.535	0.001	LTK	Ohm
dr.09 breakdown factor	-	-	-	0.5	4.0	0.1	2.5	-
dr.10 DASM head-inductance	-	-	-	0.1	32767.7	0.1	LTK	mH
dr.48 motor identification	-	-	x	0: off	19	1	0	-
dr.49 Lh ident. acc/dec time	-	-	-	0	300	0.01	55	s
dr.58 torque offset selector	-	-	x	0	79	1	0	-
dr.59 torque offset	-	-	-	-320	320	0.01	0	Nm
dS.00 KP current	-	x	-	0	32767	1	variable	-
dS.01 KI current	-	x	-	0	32767	1	variable	-
dS.03 curr./ torq. mode	-	x	-	0	15	1	0	-
dS.04 flux/rotor adaption mode	-	x	x	0	249	1	0	-
dS.14 ASCL KP speed	-	x	-	0	32767	1	variable	-
dS.15 ASCL KI speed	-	x	-	0	32767	1	variable	-
dS.17 ASCL PT1-time	-	x	-	0	9	1	3	-
dS.18 ASCL mode	-	x	-	0	4	1	0	-
dS.19 limit uf-control dec. ASCL[1)]	-	x	-	0	n * 4000	n * 0.125	LTK	rpm
dS.20 delay time uf-control	-	x	-	0	4000	1	0	ms
dS.21 startup speed [1)]	-	x	-	0	n * 4000	n * 0.125	0	rpm
dS.22 startup time	-	x	-	0	300	0.01	5	s
In.39 deadtime selector	-	-	x	0	329	1	0	-
In.40 deadtime	-	-	-	0	255	1	0	-
LE.27 reference torque	-	-	-	0: off	32000	0.01	0: off	Nm
Pn.26 speed search condition	-	x	x	0	31	1	8	-
Pn.28 DC braking mode	-	x	x	0	9	1	7	-
Pn.33 DC braking max. curr. ASCL	-	x	x	0.0	400.0	0.1	100.0	%
Pn.65 special functions	-	x	x	0	1032	1	0	-
ru.90 max. torque in %	x	-	-	0	6553.5	0.1	0	A
uF.18 deadtime comp. mode	-	x	x	0: off	3	1	1: on	-

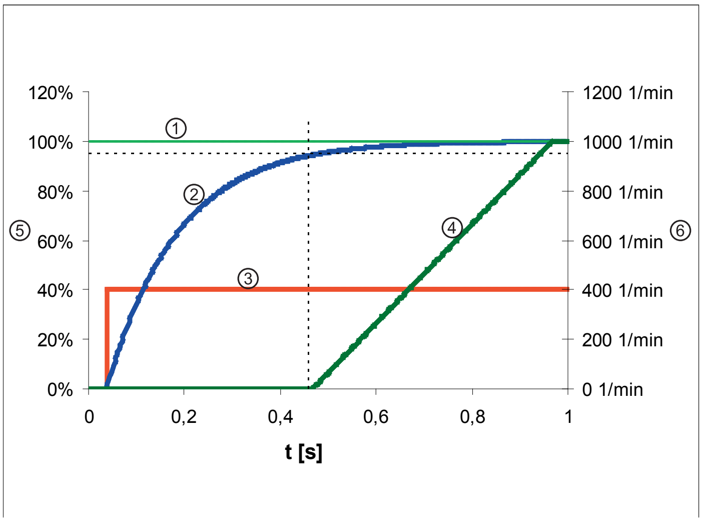
RO: Read only parameters (read only)
PG: Programmable parameters
E: Enter-Parameter
[1)] : n = 0.125 at mode 500 rpm, n = 1 at mode 4000 rpm

10 Additional Informations

10.1 Flux controller

The drive is only ready for operation after switching the modulation if the flux is build up. The drive can have an undefined behaviour if it starts before (incorrect torque display, currents too high, bad controller behaviour). Bit 7 must be always set in dS.04. Thus the setpoint setting is only released if the flux is build up to 95%.

Setpoint enabling after flux buildup (dS.04 Bit 7 = 128)



①	Setpoint (ru.01)	②	Flux (actual value) / rated flux
③	ST	④	ramp output display (ru.22)
⑤	Flux / rated flux	⑥	setpoint speed

The flux controller must be activated always for encoderless operation.
Value 96 should be selected in dS.04 under point flux control in order to have a fast flux build up:

Bit	Value	Function dS.04	ASCL
5,6		**Flux control:**	64 or 96
	64:on, n^3/dr.17^3	active, controller limit speed-dependent (at speed 0 = 0/ at speed dr.17 = dS.13)	
	96:on, start a. n^3/dr.17^3	as value 64, exception: start of the drive: for the magnetizing the limit of the flux controller is set to value dS.13 (in spite of speed 0).	

dS.13 = rated motor current * 0. 5 is set with Fr.10. In order to reduce the flux build up time and to increase the dynamics in the field weakening range it is reasonable to change this value to rated motor current.

The inverter can only provide the standstill current at speed 0. Error OL2 is released shortly if the current is higher. Thereby this can lead to problems during magnetizing at some motor/inverter combinations. Adjustment dS.04 Bit 5, 6 = 64 must be set in these cases.

10.2 Maximum voltage controller

Overmodulation should not be activated for encoderless operation.
The available voltage increases through the overmodulation of 110%, but also non sine-wave currents occur. Furthermore the model calculation is distorted, the speed and torque calculation is more inaccurate and unsmooth.

The maximum voltage controller changes the corner point for starting the field weakening operation. Thus the drive is able to adapt independently to different supply input voltages.

The following adjustments should be additionally changed in case of activation of the maximum voltage controller:

- increase field weakening speed (dr.18), which is calculated automatically by the drive with operation of Fr.10 with factor 1.15. Thus a premature field weakening is avoided. The maximum voltage controller keeps the control for the field weakening.

- activate the limiting characteristic calculation in parameter dS.03 "max. current/ torque mode"

Bit	Value	Function dS.03
		Characteristic mode:
1	0	off
	2	on: calculation of square torque characteristic activated

Very high motor currents can occur without this characteristic, if the drive reaches the field weakening range caused by overload. Also the speed calculation does not work reliable in this field weakening ran ge.

- Adapt parameter dr.16 „DASM Mmax at dr.18“ for the respective motor.
  The breakdown factor for the motor, multiplied with a safety factor must be entered in dr.16. The safety factor is necessary, because the torque characteristic must be in a sufficient distance to the physical breakdown characteristic.

Example:
Rated torque (dr.14) = 10Nm Mk/ Mn = 2.5 safety factor = 0.7
→ dr.16 = 10 * 2. 5 * 0.7 = 17.5 Nm

The calculated value of Fr.10 is the 1.5 fold rated torque.

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