TM460

Initial Commissioning of Motors

PERFECTION IN AUTOMATION
A MEMBER OF THE ABB GROUP

Prerequisites and requirements

Training modules	TM210 – Working with Automation Studio TM400 – Introduction to Motion Control TM410 – Working with integrated motion control
Software	Automation Studio 4.3 ACP10/ARNC0 Technology Package 3.16.2
Hardware	None

Table of contents

1 Introduction

The quality of motion control plays a decisive role in determining the quality, precision and dynamic capabilities of the overall process. To maximize this quality, you must first know or calculate the characteristics of the motor as precisely as possible.

Figure 1: B&R drive system

This training module describes the requirements a motor must fulfill in order to be operated on a B&R servo drive. It also explains how to calculate the motor's parameters, insert them in Automation Studio and prepare the motor for operation, step by step.

> This documentation applies to the synchronous, induction and linear motors from the ACOPOS system.
>
> The descriptions do not apply to the ACOPOSinverter system.

1.1 Learning objectives

This training module uses selected examples illustrating typical application tasks to help participants learn how various functions are structured and configured.

- You will learn the requirements for operating a motor with a B&R servo drive.
- You will learn about the characteristics that determine compatibility.
- You will learn how the parameters required to commission an synchronous or induction motor can be calculated.
- You will learn how to calculate the parameters for a motor, encoder, temperature sensor and holding brake and enter them in the ACOPOS parameter table.
- You will learn about the table used to calculate replacement parameters for linear motors.
- You will learn how to calculate the commutation offset for synchronous motors.
- You will learn the steps involved in commissioning and the order in which they must be performed.

2 Selection criteria

A number of components are needed to operate a motor on a servo drive:

- Encoder:
  The encoder returns the current position of the shaft to the servo drive. There are some applications that work without an encoder interface.
- Temperature sensor:
  The temperature sensor is used to monitor the winding temperature of the connected motor. This monitoring can be used to protect the motor winding and other components from potential overheating.
- Holding brake:
  The holding brake prevents the motor shaft from moving when the controller is switched off and has come to a standstill.

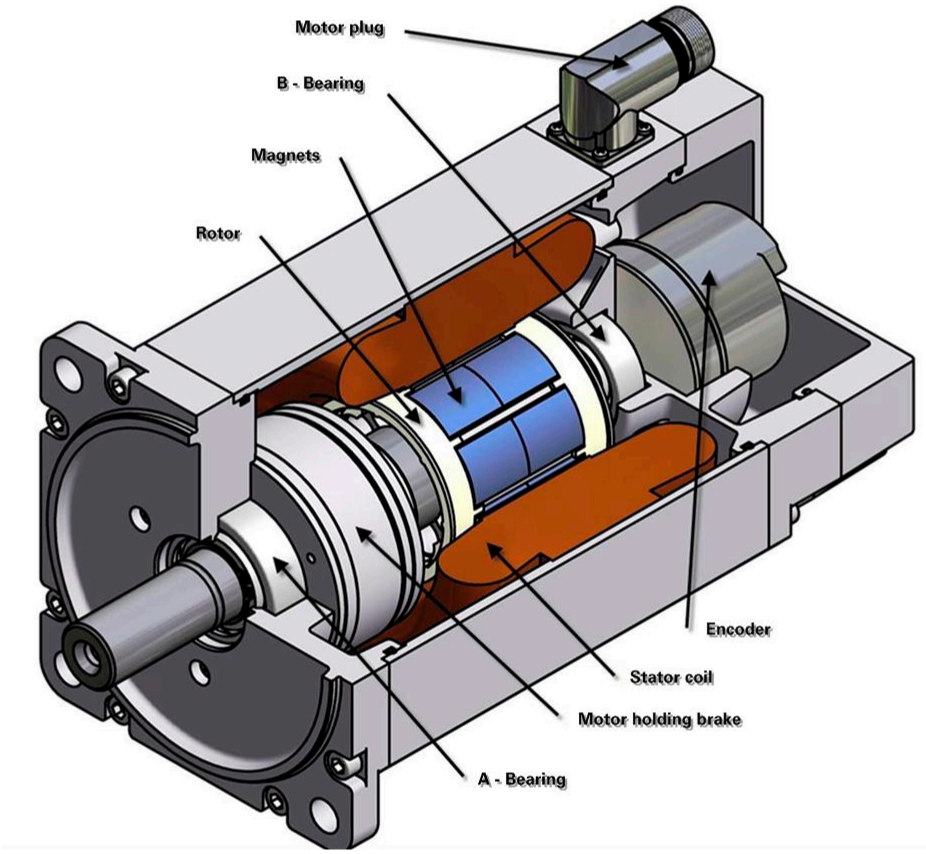

Figure 2: Servo motor structure

Selection criteria

2.1 Component compatibility

A general criteria when selecting a motor is to make sure it is compatible with the type of ACOPOS servo drive being used.

A key value here is the electrical stress of the connected motor. For more information about dimensioning, see Automation Help or the user's manual.

In the ACOPOS and ACOPOSmulti systems, the electrical stress[1,2,3] of the connected motor falls under limit curve A as defined in IEC TS 60034-25.

Hardware \ Motion control \ ACOPOS \ Technical data \ ACOPOS servo drives \ ACOPOS ... \ Technical data

Hardware \ Motion control \ ACOPOSmulti \ Technical data \ Inverter modules 8BVI \ ... \ Technical data

Hardware \ Motion control \ ACOPOS ... \ Dimensioning

2.1.1 Motor

The following table contains an overview of potential motor designs and indicates which design can be used with a B&R servo drive:

		Movement type	
		Rotary	Linear
Motor type	Synchronous	✓	✓
	Asyn-chronous	✓	☐

Table 1: Motor type vs. movement type

The most important criterion for the motor is the dielectric strength of the insulation. If the dielectric strength of the insulation and the permissible dielectric strength of the motor are lower than the maximum value for the servo drive, then the motor could be severely or irreparably damaged.

1 IEC TS60034-25 defines limit curves that can be used to match motors (or their isolation systems) and inverters. These curves define the relationship between the maximum occurring phase-phase voltage on the motor terminals and the corresponding rise time. To evaluate an inverter using a limit curve, all of the evaluated PWM edges must be below the limit curve.

2 ACOPOSmulti inverter modules correspond to limit curve A as defined in IEC TS 60034-25.

3 The winding insulation of the connected motors must be suited for loads of the limit value curve A in accordance with IEC TS 60034-25

2.1.2 Encoder

Among others, the following encoder interfaces can be used in the ACOPOS system:

- EnDat™
- Resolver
- Incremental encoder
- Hiperface™
- SSI
- SinCos
- BiSS

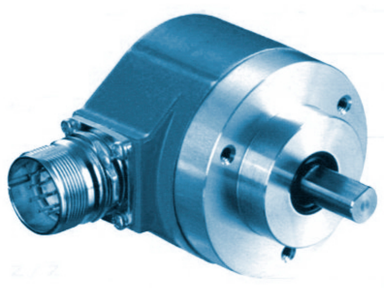

Figure 3: An encoder

An overview of encoder systems for the ACOPOS product family can be found on the B&R website:

www.br-automation.com → Products → Motion control → Overview of encoder systems

EnDat and resolver encoders are used in B&R motors. When using any interface, make sure that the encoder interfaces match the data of the ACOPOS plug-in cards. In particular, check the counting frequency and the supply voltage.

Induction motors can also be operated without an encoder in UF mode.

Permanent magnet synchronous motors can be controlled when operating without an encoder (ACP10_MC library V2.300).

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Encoder interface

Motion control \ ACP10/ARNC0 \ Reference manual \ ACP10 \ NC objects \ NC object "ncAXIS" \ Controller \ Controller mode "ncUF"

2.1.3 Temperature sensor

Although not an absolute requirement, the selected motor should have a temperature sensor. The ACOPOS system supports various types with different functionality. Sensors of the type KTY83-110 are preferred.

Type	Description
Linear thermistor	The value of a linear thermistor changes at an approximately linear rate across its measurement range. Either NTC or PTC thermistors can be used. The current motor temperature can be read. The advantage of this is that the motor can be protected actively.
PTC switches	A PTC switch produces a jump in resistance when it reaches the nominal response temperature. It is therefore only possible to determine whether or not the motor is too hot.

Table 2: Overview of types and their distinguishing features

Type	Description
Thermal switches	A thermal switch is an encased bimetallic switch equipped with hysteresis, usually in the form of an N.C. switch.

Table 2: Overview of types and their distinguishing features

If no temperature sensor is used, then monitoring is based only on the calculated temperature model, which is always active in parallel.

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Temperature sensor

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Temperature model

2.1.4 Holding brake

A holding brake must have a rated voltage of 24 V in order to be controlled directly by the ACOPOS. The maximum current consumption must be lower than the maximum current provided by the ACOPOS.

In cases where a holding brake with different characteristics must be used, it can be connected via an additional circuit.

Figure 4: Cutaway view of a holding brake

Hardware \ Motion control \ ACOPOS \ Technical data \ ACOPOS servo drives \ ACOPOS ... \ Technical data

Hardware \ Motion control \ ACOPOSmulti \ Technical data \ Inverter modules 8BVI \ ... \ Technical data

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Holding brake

3 Installation

3.1 Receiving a delivery

Check the motor for any damage when you remove it from the transport packaging. Protruding parts such as the motor or encoder connectors are at particular risk of damage.

In very rare cases, transport safeguards may have been used on the motor to prevent the rotor from turning. If so, then they must be removed.

If possible, the motor should not yet be connected to the machine mechanics. This is a precaution to prevent potential damage that could occur from unexpected movement during motor setup.

3.2 Wiring

The motor can now be connected to the ACOPOS using the motor cable and encoder cable.

Cables pre-assembled for use with ACOPOS are available for B&R motors. For 3rd-party motors, consult the ACOPOS user's manual for information on the pinout of each cable.

Be sure to accurately observe all of the safety notices in the ACOPOS manual when wiring in order to prevent personal and material damage. Failure to observe the safety notices can result in death or injury!

The shielding for the motor and encoder cables absolutely must be connected in order to prevent possible interference which could negatively affect control performance.

Hardware \ Motion control \ ACOPOS ... \ Technical data \ Cables \ Motor cables \ Wiring

Hardware \ Motion control \ ACOPOS ... \ Technical data \ Cables \ Motor cables \ Cable diagram

4 Parameter identification and configuration

All motor characteristics must be specified in order for the servo drive to operate the motor and protect it from damage.

> On B&R motors with an EnDat encoder, the motor data is saved directly in the encoder's memory. The ACOPOS system draws them from here automatically.

This section looks at how to configure the motor in Automation Studio.

Only 3rd-party motors are covered, since the data required for B&R motors is already available in Automation Studio.

Adding a new motor to the Automation Studio project

When an axis is added, a dialog box opens for selecting the motor. Here you can select an existing motor, import motor data or set up a new synchronous or induction motor.

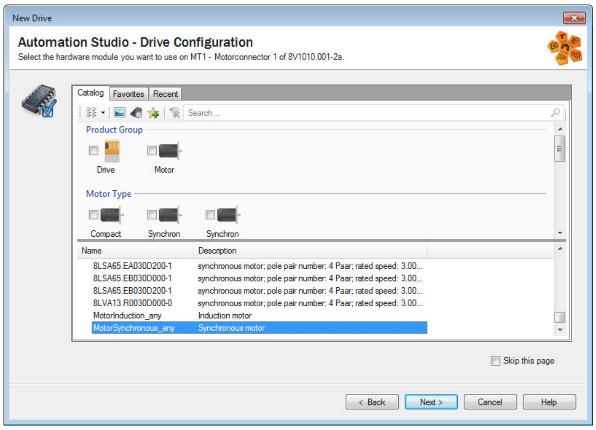

Figure 5: Drive configuration - Add new motor

The motor data is loaded onto the servo drive using a configuration file. This file is managed in the Physical View after adding the new motor.

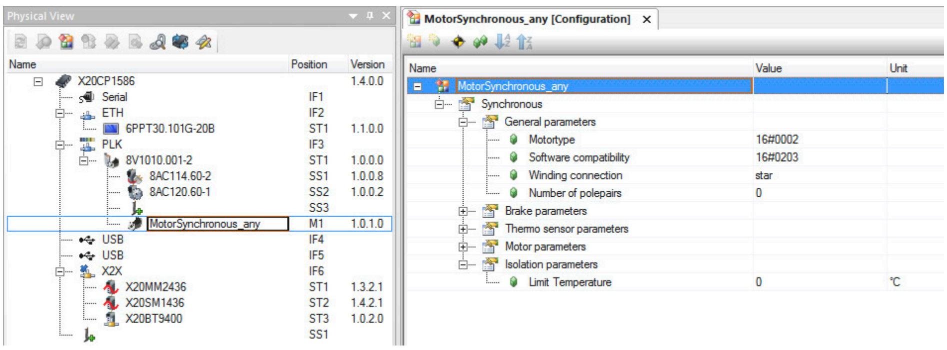

Figure 6: Managing motor data in the Physical View

Alternatively, a motor can be selected from the Hardware Catalog and added to an existing ACOPOS parameter table. These parameter tables can also be used for multiple axes.

Clicking on "Finish" inserts a blank motor template into the parameter table. This contains all of the parameters required for operation.

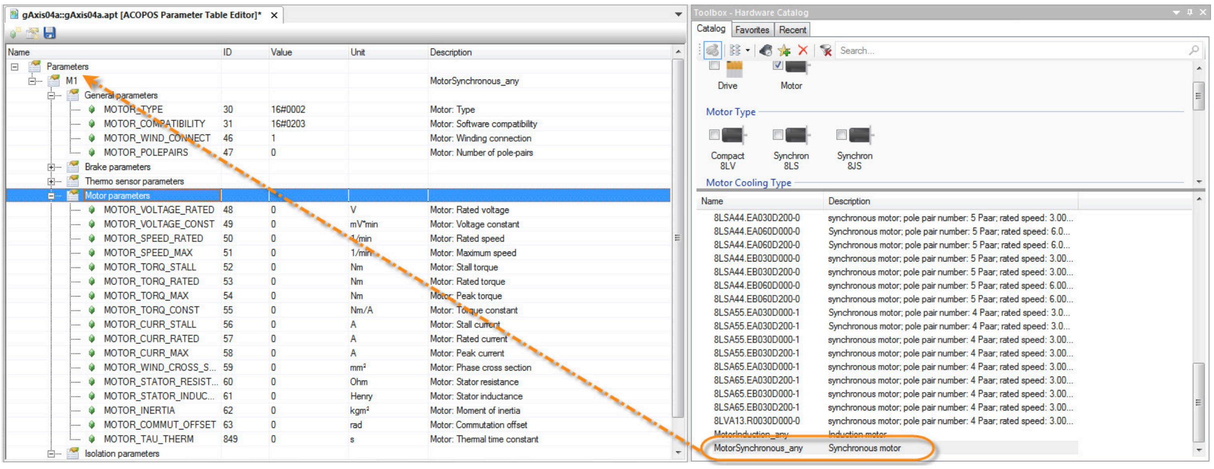

Figure 7: ACOPOS parameter table for a synchronous motor

The drive data can now be entered in the parameter table.

> **!** Pay attention to the units used when entering the values. The units used are listed in the "Units" column. A description of the parameters can be found in the Automation Help.

> **?** Motion control \ ACP10/ARNC0 \ Reference manual \ ACP10 \ ACOPOS parameter IDs \ Overview
>
> Motion control \ ACP10/ARNC0 \ Project creation \ Motion control \ Creating an ACOPOS axis \ Wizard navigation
>
> Motion control \ ACP10/ARNC0 \ Project development \ Motion control \ Configuration modules \ ACOPOS parameter table
>
> Motion control \ ACP10/ARNC0 \ Project development \ Motion control \ Configuration modules\ NC mapping table

4.1 Synchronous motor

When adding a synchronous motor, you will need all of the motor data.

If any of the required information is not provided in the data sheet, you will need to request it from the manufacturer.

For some parameters, the values can also be measured, estimated or calculated. Formulas for estimating the values can be found in the Automation Help.

The ACOPOS applies a replacement value for some parameters. This makes it possible to operate the motor, but there is no guarantee that these values are suitable a particular motor.

> **?** Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Synchronous motor

Exercise: New synchronous motor

Create a new parameter table and configure the synchronous motor with the model number 110B31-0640-D03JD-AA:

		Series 110B31-0640-D03JD-AA	Series 110B32-0700-D03JD-AA	Series 110B33-0640-D03JD-AA
Rated Values				
Peak torque (c.d.f. 15%)*	[Nm]	10	17	26
Stall torque (c.d.f. 100%)*	[Nm]	4.5	8	12
Rated torque (c.d.f. 100%)*	[Nm]	3	5	9
Rated speed	[min^{-1}]	3000	3000	1500
Peak current (per phase) (c.d.f. 15%)*	[A$_{RMS}$]	14.0	14.0	14.0
Stall current (per phase) (c.d.f. 100%)*	[A$_{RMS}$]	6,4	7	6.4
Rated current (per phase) (c.d.f. 100%)*	[A$_{RMS}$]	4.4	4.5	4.9
Max. DC link voltage	[V$_{DC}$]	370	370	370
* Mounting Flange 200 x 240 x 20 mm^3				
Technical Data Motor				
Motor constant (at 25 °C)	[Nm/W$^{1/2}$]	0.52	0.79	1.12
Torque constant	[Nm/A]	0.70	1.14	1.88
Voltage constant	[V/1000min^{-1}]	36.6	59.4	97.5
Winding resistance (at 25 °C)	[Ω]	0.90	1.05	1.40
Winding inductivity	[mH]	3.00	4.00	6.00
Maximum current per phase	[A$_{RMS}$]	14.0	14.0	14.0
Number of pole pairs		3	3	3
Motor inertia	[kgm^{2}x10^{-3}]	0.57	1.10	1.70
Insulation class			JATISO, DV-155J VIII	
Ambient temperature	[°C]		-20...+40	
Protection class			IP54	
Max. axial load	[N]		250	
Max. radial load	[N]		600	
Max. axial load during assembly	[N]		2000	
Mass	[kg]	6.3	9.5	12.4
Motor length (L)	[mm]	175	225	275

Figure 8: Data sheet for synchronous motor 110B31-0640-D03JD-AA

When using this data sheet for actual operation, the rated voltage must be requested from the manufacturer.

The wire cross section must be specified for the temperature model to function properly.

This is not specified in this data sheet and must be requested from the manufacturer.

If a parameter is set to 0, the ACOPOS assumes a default value. The default value only offers minimal protection, however.

See "Solution: Synchronous motor configuration".

4.2 Induction motor

There are several ways to determine the parameters for configuring the induction motor.

The following methods are possible:

- 4.2.1 "Take parameters from the motor data sheet:"
- 4.2.2 "Calculate parameters from data on power rating plate"
- 4.2.3 "Automatic parameter identification"

4.2.1 Take parameters from the motor data sheet:

A simple way to configure the parameters is to use the data from the data sheet. Some values not listed on the data sheet can be estimated or calculated. Consult the Automation Studio Help documentation for information on how to determine these values.

> It is a good idea to check or recalculate manufacturer specifications.

> Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Induction motor

4.2.2 Calculate parameters from data on power rating plate

When using an induction motor, all of the required motor characteristics can be calculated using the data from the power rating plate. The Automation Help provides a calculation table to help you with this.

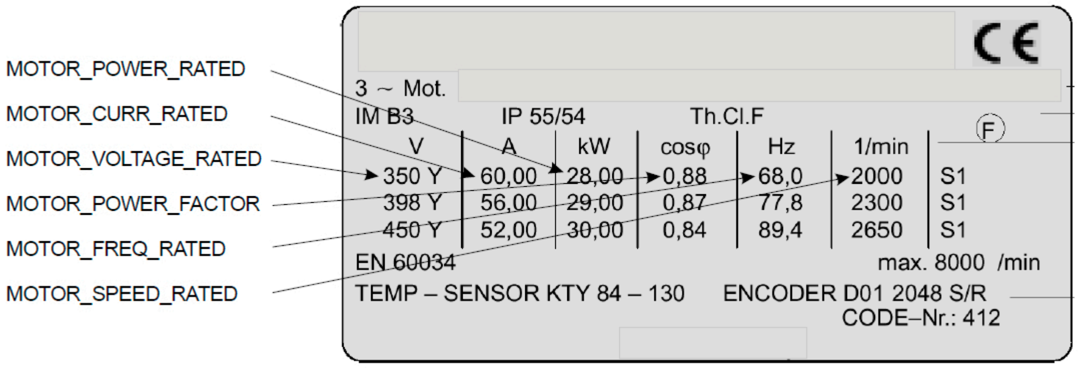

Figure 9: Parameters on the power rating plate

Input Please insert the data for the used connection		
Parameter	**Value**	**U**
MOTOR_VOLTAGE_RATED	460	V_{rms}
MOTOR_FREQUENCY_NOMINAL	60	Hz
MOTOR_CURR_RATED	20	A_{rms}
MOTOR_SPEED_RATED	1765	rpm
MOTOR_POWER_FACTOR	0,924	1

Output ACOPOS motor data (star equivalent circuit)		
Bezeichnung	**Wert**	**U**
MOTOR_STATOR_RESISTANCE	0,260	Ω
MOTOR_ROTOR_RESISTANCE	0,260	Ω
MOTOR_MUTUAL_INDUCTANCE	0,1236	H
MOTOR_STATOR_INDUCTANCE	0,00212	H
MOTOR_ROTOR_INDUCTANCE	0,00212	H
MOTOR_POLEPAIRS	2	1
MOTOR_CURR_STALL	20	A_{rms}
MOTOR_CURR_RATED	20	A_{rms}
MOTOR_CURR_MAX	166,48	A_{rms}
MOTOR_MAGENTIZING_CURR	5,56	A_{rms}
MOTOR_TORQ_STALL	77,97	Nm
MOTOR_TORQ_RATED	77,97	Nm
MOTOR_TORQ_MAX	675,29	Nm

Figure 10: Calculation table for missing parameters (from Automation Studio Help documentation)

Parameter name	Manufacturer data for a motor in star connection	Motor parameter for 2 parallel connected motors in delta connection	Unit
MOTOR_VOLTAGE_RATED	400	230,9	V_{rms}
MOTOR_STATOR_RESISTANCE	1,840401864	0,307	Ω
MOTOR_STATOR_INDUCTANCE	0,00499831	0,00083	H
MOTOR_MUTUAL_INDUCTANCE	0,11557379	0,019	H
MOTOR_ROTOR_RESISTANCE	1,840401864	0,307	Ω
MOTOR_ROTOR_INDUCTANCE	0,00499831	0,00083	H
MOTOR_TORQ_STALL	15	30,00	Nm
MOTOR_TORQ_RATED	15	30,00	Nm
MOTOR_TORQ_MAX	40,5	81,00	Nm
MOTOR_CURR_STALL	8,2	28,41	A_{rms}
MOTOR_CURR_RATED	8,2	28,41	A_{rms}
MOTOR_CURR_MAX	48,38	167,59	A_{rms}
MOTOR_MAGNETIZING_CURR	3,451476835	11,96	A_{rms}
MOTOR_WIND_CROSS_SECT	1,3000	4,5033	mm²
MOTOR_SPEED_MAX	1500	2598	rpm

Figure 11: Calculation table for star and parallel circuits (from Automation Help)

These values must be entered according to type of motor circuit (Y/Δ)

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Induction motor \ Parameter estimation from power rating plate data

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Induction motor \ Parameter conversion for motor connections

4.2.3 Automatic parameter identification

Automatic parameter identification is the easiest way to get the exact motor characteristics.

To do this, different test signals are automatically applied to the motor output by the servo drive and their reactions are monitored. The identification quality is determined by matching a model with the measured values.

Procedure:

- Enter parameters from power rating plate
- Start test procedure
- Evaluate quality of parameters

Enter parameters from power rating plate

The first step is to enter all the required parameters from the power rating plate:

Parameter	Description
PIDENT_MOTOR_TYPE	1…Induction motor
PIDENT_CURR_RATED	Nominal current
PIDENT_VOLTAGE_RATED	Nominal voltage
PIDENT_SPEED_RATED	Nominal speed
PIDENT_COS_PHI	Active power factor
PIDENT_FREQ_RATED	Nominal frequency

Table 3: Parameters required for configuration

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Drive identification \ Motor \ Motor data \ Parameter IDs

Motion control \ ACP10/ARNC0 \ Reference manual \ ACP10 \ NC objects \ NC object "ncAXIS" \ Setup \ Setup for induction motors \ Data structure

Start test procedure

The test procedure can be started from the NC Test or using the parameter CMD_PIDENT (ParID 997).

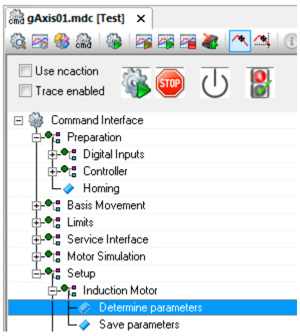

Figure 12: Starting parameter identification using the command interface in the NC Test

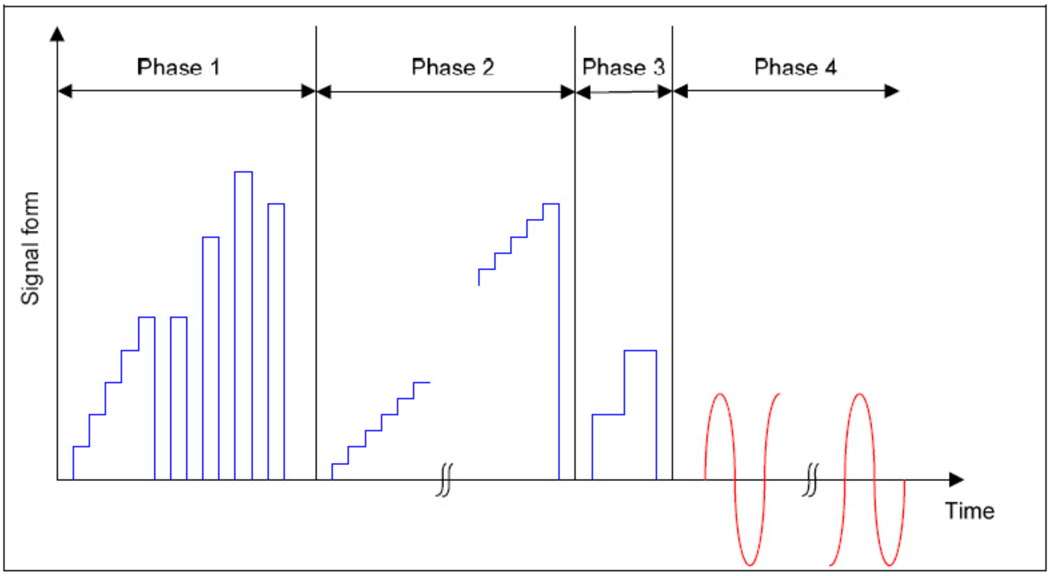

Figure 13: Signal form for parameter identification

Motion control \ ACP10/ARNC0 \ NC Diagnose \ NC Test \ Configuration

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Drive identification \ Motor \ Motor data \ Identifying motor parameters using test signals

Evaluate quality of parameters

The parameters PIDENT_STATE (ParID 996) = 0 and PIDENT_FIT (ParID 998) ≠ 0.0 indicate that the identification is complete. PIDENT_FIT indicates whether or not the procedure was successful:

PIDENT_FIT	Evaluation
80.1% … 100%	Good
60.1% … 80%	Tolerable
≤ 60%	Unsatisfactory
0.0%	Invalid

Table 4: Evaluating the quality of the identified parameters

The evaluation can also be read in the NC Test:

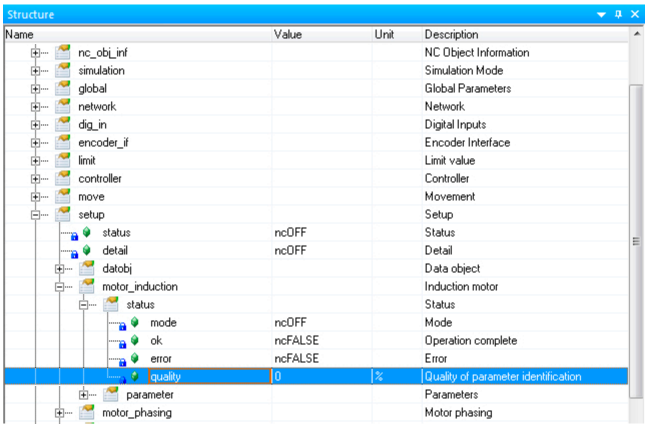

Figure 14: Reading the quality of the identified parameters in the NC Test

After identification is complete, all parameters can be read and saved in a parameter table. Repeating the procedure 2-3 times can improve the quality of the identification.

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Drive identification \ Motor \ Motor data \ Identifying motor parameters using test signals \ Procedure

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Drive identification \ Motor \ Motor data \ Identifying motor parameters using test signals \ Notes

Exercise: Parameter identification using the power rating plate

Use the power rating plate to create a parameter table for the induction motor AEG AMF V 1325 ZA 2: Use the delta circuit parameters:

Figure 15: Power rating plate for induction motor AEG AMF V 1325 ZA 2

See "Solution: Induction motor configuration".

4.3 Synchronous linear motor

The ACOPOS system can be used to operate synchronous linear motors. This requires an additional configuration step, however. All ACOPOS parameters are designed for rotary axes, so linear motor data must first be converted.

This can be done using the conversion table included in Automation Help:

Name	Value	Unit
MOTOR_POLEPAIR_WIDTH	0,0281	m
MOTOR_LINEAR_SPEED_NOMINAL	5	m/s
MOTOR_LINEAR_SPEED_MAX	5	m/s
MOTOR_FORCE_STALL	10,5	N
MOTOR_FORCE_RATED	10,5	N
MOTOR_FORCE_MAX	21	N
MOTOR_LINEAR_VOLTAGE_CONSTANT	4,00	$V_{rms}/(m/s)$
MOTOR_FORCE_CONST	60	N/A_{rms}
MOTOR_MASS	4,7	kg
ENCODER: Type	SinCos	
ENCODER: Line length	1000	um/Line
MOTOR_BRAKE_FORCE_RATED	860	N
Input fields: Enter values		
Output fields		

$\mapsto$

Name	Value	Unit
τ Reference length = τ_P*z_P [m]	0,281	m
MOTOR_POLEPAIRS	10	-
MOTOR_SPEED_RATED	1068	min^{-1}
MOTOR_SPEED_MAX	1068	min^{-1}
MOTOR_TORQ_STALL	0,47	Nm
MOTOR_TORQ_RATED	0,47	Nm
MOTOR_TORQ_MAX	0,94	Nm
MOTOR_VOLTAGE_CONST	18,73	mVmin
MOTOR_TORQ_CONST	2,683	Nm/A_{rms}
MOTOR_INERTIA	0,0094005	kgm^2
SCALE_ENCOD_INCR	4603904	Inc/p_P
MOTOR_BRAKE_TORQ_RATED	38,46	Nm

Figure 16: Table for converting linear to rotary axes

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Synchronous linear motor

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Synchronous linear motor \ Parameter conversion from linear motor to synchronous motor

Exercise: Create a parameter table for a linear motor

Create a parameter table for the linear motor BLMX-502-B.

Motor Model	Units	BLMX-382		BLMX-502	
Performance Specifications					
Continuous @ 1.36 bar Force 20 psi	N	1,030.0		1,186.0	
	lb	231.0		266.0	
Continuous Force, no air	N	669.0		816.0	
	lb	150.0		184.0	
Peak Force	N	4,120		4,744	
	lb	924		1064	
Electrical Specifications					
Winding Designation		-A	-B	-A	-B
BEMF, line-line	V/m/s	74.02	145.67	109.05	54.33
	V/in/s	1.88	3.70	2.77	1.38
Continuous @ 1.36 bar Current 20 psi	Amp_{pk}	16.12	8.06	12.59	25.03
	Amp_{rms}	11.40	5.70	8.90	17.70
Continuous Current, no air	Amp_{pk}	10.47	5.23	8.63	17.11
	Amp_{rms}	7.40	3.70	6.10	12.10
Force Constant, Sine Drive	N/Amp_{pk}	63.64	127.28	94.75	47.38
	lb/Amp_{pk}	14.35	28.71	21.35	10.61
	N/Amp_{rms}	90.00	180.00	134.00	67.00
	lb/Amp_{rms}	20.30	40.60	30.20	15.00
Motor Constant	N/√W	3.60		41.20	
	lb/√W	7.57		9.30	
Thermal @ (1.36 bar, 20 psi) Resistance (no cooling)	°C/W	0.11		0.11	
		0.25		0.24	
Resistance, 25°C, line-line	ohms	3.4	13.6	5.1	1.3
Resistance, 125°C, line-line	ohms	4.8	19.0	7.1	1.8
Inductance, line-line	mH	3.0	12.0	4.0	1.0
Max Terminal Voltage	VDC	320		320	
Mechanical Specifications					
Air Flow	m^3/s	$5.4x10^{-3}$		$6.4x10^{-3}$	
	SCFM	11.4		13.7	
Coil Weight	kg	3.4		4.45	
	lb	7.5		9.8	
Coil Length	mm	382.0		502.0	
	in	15.0		19.8	
Heat Sink Area [Thickness 25.4mm (1in)]	mm	254x406		254x510	
	in	10x16		10x20	
Magnet Track Weight	kg/m	37.26		37.26	
	lb/ft	25.10		25.10	
Magnetic Pole Pitch	mm	30.00		30.00	
	in	1.18		1.18	

Figure 17: Data sheet for linear motor BLMX-502-B

The values for "MOTOR_LINEAR_SPEED_NOMINAL" and "MOTOR_LINEAR_SPEED_MAX" are not listed:

These can be assumed to be 5 m/s.

See "Solution: Synchronous linear motor configuration".

4.4 Encoder interface

Once all motor data has been entered in the parameter table, it is time to configure the next component; the encoder. This is done by inserting an encoder interface in the Physical View or by inserting a parameter group that corresponds to the model number of the ACOPOS encoder interface card.

The parameters for the encoder interface are typically entered in the parameter table via the Drive Wizard. You can change the type of encoder interface later on by re-inserting it in the Physical View.

Insert an encoder interface

Add an encoder interface from the Hardware Catalog under the drive in the Physical View.

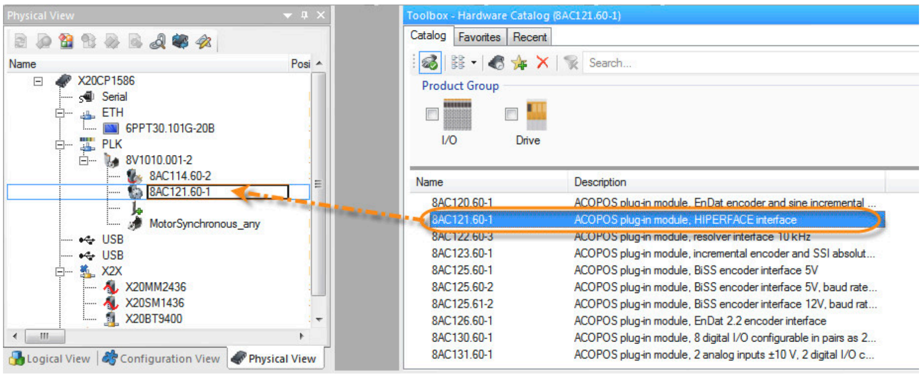

Figure 18: Add the encoder interface from the Hardware Catalog

Alternatively, an encoder interface card can be added from the Hardware Catalog to an existing ACOPOS parameter table. You need to enter the number of the slot where the encoder interface card will be inserted.

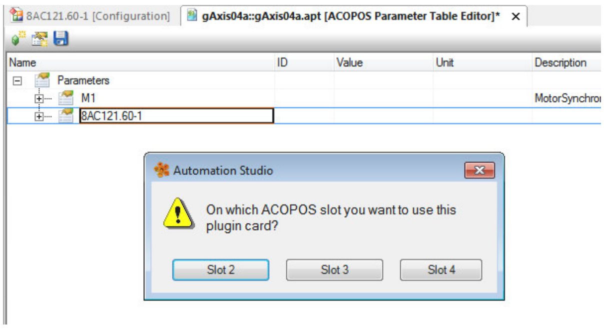

Figure 19: Choose the slot where you wish to add the encoder interface card in the ACOPOS parameter table.

When you are finished with this dialog box, a parameter group is inserted in the table containing all of the parameters required for operating the encoder.

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Encoder interface

Motion control \ ACP10/ARNC0 \ Reference manual \ ACP10 \ ACOPOS parameter IDs \ Encoder 1, 2, 3

Exercise: Encoder configuration

Configure the respective plug-in card and encoder for each motor:

1) Synchronous motor: EnDat encoder
2) Induction motor: Incremental encoder with 512 inc/rev
3) Linear motor: Sin/Cos encoder

Parameter	Value / description
Material measure	Graduated metal rule with AURODUR grid divi-sion
Division period	20 µm
Therm. Coefficient of linear expansion	Depends on the mounting surface
Accuracy class	±5 µm
Measurement length ML in mm	140
Reference marks	One at the middle of the measurement length
Limit switch	L1/L2 with 2 different magnets Output signal: TTL (without cable driver)
Max. movement speed	240 m/min
Vibration 55 to 2000 Hz	Vibration 55 to 2000 Hz ≤200 m/s² (EN 60068-2-6)
Shock 11 ms	≤500 m/s² (EN 60068-2-27)
Operating temperature	0 to 50°C
Mass	Sampling head: 20 g (without attachment cable) Scale: approx. 115 g + 250 g/m measurement length Attachment cable: 70 g/m
Power supply	5 V ±5% / <200 mA (without load)
Incremental signals	TTL
Signal period	integr. 5x interpolation: 4 µm integr. 10x interpolation: 2 µm
Electrical connection	Cable 3 m with Sub-D connector (15-pin); Interface electronics integrated in the plug
Max. cable length	20 m

Table 5: Overview of encoder data

The reference length must be used as the basis for calculating the linear motor encoder's resolution. The resolution can also be found in the conversion table (Linear → Rotary).

See "Solution: Encoder configuration".

4.5 Temperature sensor

The parameters required for the temperature sensor are already contained in the motor configuration and can now be filled in.

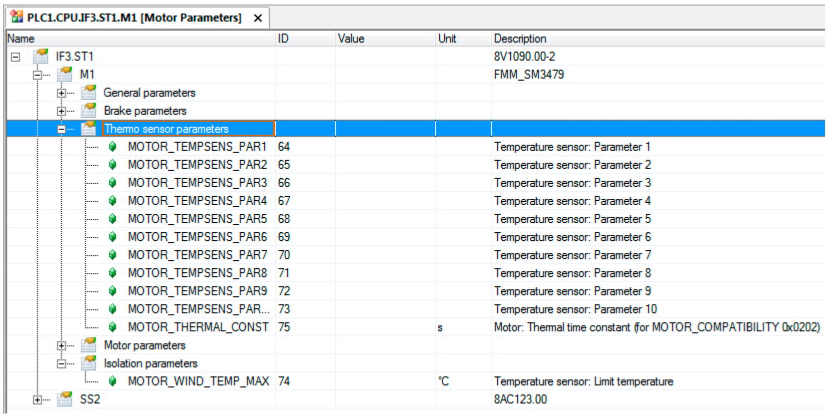

Figure 20: Parameters for the temperature sensor

Depending on the particular temperature sensor, certain parameters may or may not be needed. Parameters that are not required should be set to "0.0".

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Temperature sensor

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Temperature model

Motion control \ ACP10/ARNC0 \ Reference manual \ ACP10 \ ACOPOS parameter IDs \ Temperature sensor

The parameters for the PTC switch and thermal switch can be entered with the help of the data sheet.

For the linear thermistor you will also need a conversion table. The conversion table can be found in the Automation Help:

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T_I[°C]	-30	-10	10	30	50	70	90	110	130	150	170														
R_I [Ohm]	391	460	538	626	722	826	940	1062	1194	1334	1482														

MOTOR_TEMPSENS_PAR1	391	MOTOR_TEMPSENS_PAR6	75,71
MOTOR_TEMPSENS_PAR2	1482	MOTOR_TEMPSENS_PAR7	102,20
MOTOR_TEMPSENS_PAR3	-30,00	MOTOR_TEMPSENS_PAR8	126,41
MOTOR_TEMPSENS_PAR4	12,01	MOTOR_TEMPSENS_PAR9	148,88
MOTOR_TEMPSENS_PAR5	45,98	MOTOR_TEMPSENS_PAR10	170,00

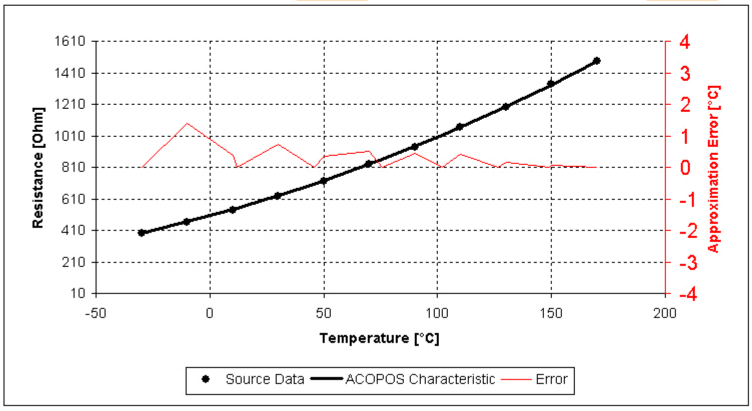

Figure 21: Parameter calculation for a thermistor

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Temperature sensor \ Function \ Characteristic curve \ Lookup table (Thermistor) \ Example: KTY84-130

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Temperature sensor \ Function \ Characteristic curve \ Lookup table (Thermistor) \ Example: KTY84-130 \ Procedure

Exercise: Configuration of a temperature module

Configure the following temperature sensors:

1) Synchronous motor with a KTY81-120 sensor

   For assistance, consult the calculation table provided in the Automation Help

AMBIENT TEMPERATURE		TEMP. COEFF.	KTY81-110				KTY81-120			
(°C)	(°F)	(%/K)	RESISTANCE (Ω)			TEMP. ERROR (K)	RESISTANCE (Ω)			TEMP. ERROR (K)
			MIN.	TYP.	MAX.		MIN.	TYP.	MAX.	
−55	−67	0.99	475	490	505	±3.02	470	490	510	±4.02
−50	−58	0.98	500	515	530	±2.92	495	515	535	±3.94
−40	−40	0.96	552	567	582	±2.74	547	567	588	±3.78
−30	−22	0.93	609	624	638	±2.55	603	624	645	±3.62
−20	−4	0.91	669	684	698	±2.35	662	684	705	±3.45
−10	14	0.88	733	747	761	±2.14	726	747	769	±3.27
0	32	0.85	802	815	828	±1.91	793	815	836	±3.08
10	50	0.83	874	886	898	±1.67	865	886	907	±2.88
20	68	0.80	950	961	972	±1.41	941	961	982	±2.66
25	77	0.79	990	1000	1010	±1.27	980	1000	1020	±2.54
30	86	0.78	1029	1040	1051	±1.39	1018	1040	1061	±2.68
40	104	0.75	1108	1122	1136	±1.64	1097	1122	1147	±2.97
50	122	0.73	1192	1209	1225	±1.91	1180	1209	1237	±3.28
60	140	0.71	1278	1299	1319	±2.19	1265	1299	1332	±3.61
70	158	0.69	1369	1392	1416	±2.49	1355	1392	1430	±3.94
80	176	0.67	1462	1490	1518	±2.8	1447	1490	1532	±4.3
90	194	0.65	1559	1591	1623	±3.12	1543	1591	1639	±4.66
100	212	0.63	1659	1696	1733	±3.46	1642	1696	1750	±5.05
110	230	0.61	1762	1805	1847	±3.83	1744	1805	1865	±5.48
120	248	0.58	1867	1915	1963	±4.33	1848	1915	1982	±6.07
125	257	0.55	1919	1970	2020	±4.66	1899	1970	2040	±6.47
130	266	0.52	1970	2023	2077	±5.07	1950	2023	2097	±6.98
140	284	0.45	2065	2124	2184	±6.28	2043	2124	2205	±8.51
150	302	0.35	2145	2211	2277	±8.55	2123	2211	2299	±11.43

Figure 22: Data sheet - KTY81-120

2) Induction motor without temperature sensor

3) Linear motor with thermal switch (NC)

   The sensor is triggered at 120°C.

   See "Solution: Temperature sensor configuration".

4.6 Holding brake

As for the temperature sensors, the parameters for the holding brake are also included in the motor parameters.

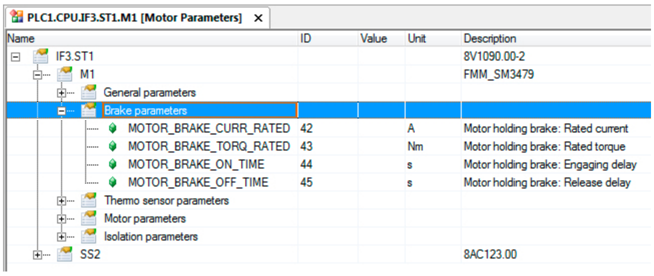

Figure 23: Parameters for the holding brake

If a holding brake is used, the respective ParIDs can be written with values. The current and voltage on the servo holding brake connection are monitored. It is therefore necessary to set all values to 0 if there is no holding brake in order to prevent unnecessary error messages.

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Motor \ Holding brake

Motion control \ ACP10/ARNC0 \ Reference manual \ ACP10 \ ACOPOS parameter IDs \ Motor holding brake

Exercise: Configuring a holding brake

Configure the holding brake 06.P1 for the synchronous motor.

	01.P1	02.P1	03.P1	05.P1	06.P1	07.P1	08.P1	09.P1	10.P1
M_{2N} 20° C [Nm]	0,4	1	2	4,5	9	18	36	72	145
$M_{stat.}$ 100° C [Nm]	0,35	0,8	1,8	4	8	15	32	65	130
$M_{dyn.}$ 20° C [Nm]	0,3	0,8	1,7	3,8	7,5	15	28	55	110
[kgm²]	0,001	0,001	0,001	0,001	0,0015	0,004	0,012	0,036	0,10
[min⁻¹]	3000	3000	3000	3000	2000	2000	2000	2000	2000
$W_{R0,1}$ [kJ]	200	300	410	580	890	1290	2900	6200	13000
__.P1 [kgm²]	0,001	0,001	0,001	0,001	0,0015	0,004	0,012	0,036	0,10
[min⁻¹]	3000	3000	3000	3000	2000	2000	2000	2000	2000
n_{max} [min⁻¹]	10000	10000	10000	10000	10000	10000	10000	8000	8000
Ankerteil Armature *J*									
...10 [10^{-4}kgm²]	0,01	0,014	0,045	0,122	0,37	1,15	4,00	11,5	39,0
...20/30 [10^{-4}kgm²]	0,013	0,021	0,068	0,18	0,54	1,66	5,56	16,0	53,0
Gewicht Weight P1.110. [kg]	0,075	0,11	0,15	0,30	0,46	0,9	1,6	2,85	5,35
Schaltzeiten Switching times									
t_2* [ms]	10	12	25	35	40	50	90	140	190
t_{11}=* [ms]	2	2	2	2	2	3	3	7	12
t_1=* [ms]	6	6	6	7	7	10	22	25	65

* siehe B7, Seite 10

Legende

M_{2N}	Nennmoment nach Einlauf (Schlupfdrehzahl 20 min⁻¹)	[Nm]
$M_{stat.}^{100°C}$	Nennmoment bei 100° C (Schlupfdrehzahl 20 min⁻¹)	[Nm]
$M_{dyn.}^{20°C}$	Schaltmoment bei angegebenen Bedingungen	[Nm]
M_{erf}	erforderliches Drehmoment	[Nm]
M_L	Lastmoment	[Nm]
M_A	dynamisches Bremsmoment	[Nm]
J	Massenträgheitsmoment	[kgm²]
P	Antriebsleistung	[kW]
n	Drehzahl	[min⁻¹]
K	Sicherheitsfaktor (K≥2)	[-]
X_{min}	Nennluftspalt	[mm]
X_{max}	maximaler Luftspalt, bei dem der Anker anzieht	[mm]
W_R	Reibarbeit	[J]
$W_{R0,1}$	Reibarbeit bis 0,1mm Abrieb	[kJ]

* see B7, page 10

Legend

M_{2N}	rated torque after running in process (slip speed 20 rpm)	[Nm]
$M_{stat.}^{100°C}$	rated torque at 100° C (slip speed 20 rpm)	[Nm]
$M_{dyn.}^{20°C}$	switching torque at specified conditions	[Nm]
M_{erf}	required torque	[Nm]
M_L	load torque	[Nm]
M_A	dynamic braking torque	[Nm]
J	moment of inertia	[kgm²]
P	driving power	[kW]
n	speed	[rpm]
K	safety factor (K≥2)	[-]
X_{min}	nominal air gap	[mm]
X_{max}	max. air gap at which the armature attracts	[mm]
W_R	friction work	[J]
$W_{R0,1}$	friction work until 0,1mm wear	[kJ]

Figure 24: Data sheet - Holding brake 06.P1 (t1…Turn-on delay)

The data sheet does not list a nominal current for the holding brake. For this example we can assume the value 1.2 A.

See "Solution: Holding brake configuration".

5 Commissioning

Once all the motor components have been configured, we can begin preparing the components for operation. Ideally, the motor shaft can move freely. This simplifies the process.

5.1 Holding brake

The holding brake should first be operated manually (from the NC Test) to ensure functionality.

The ParID CMD_BRAKE (ParID 86) can be used to execute the following commands:

- ncSWITCH_ON ... Engage brake
- ncSWITCH_OFF ... Disengage brake

After the switch-off command has been written, you should hear a "clicking" sound and should be able to move the shaft by hand.

When working with a hanging load, the motor should be at the lowest stopping point, because otherwise the axis could drop when the brake is disengaged and cause mechanical damage.

Possible sources of error:

- Holding brake circuit interrupted
- Circuit polarity reversed

5.2 Temperature sensor

The startup process for temperature sensors depends on the type of sensor being used:

Sensor type	Testing sequence
Linear thermistor	• Monitor the temperature in the NC Test at room temperature (without pre-heating or load). • The case of overtemperature due to internal or external rise in temperature must be tested. • Must be tested for open circuit. • Must be tested for broken connection.
PTC switch	• The case of overtemperature due to internal or external rise in temperature must be tested. • Must be tested for open circuit. • Must be tested for short circuit.
Thermal switches	• The case of overtemperature at nominal response temperature due to internal or external rise in temperature must be tested. • Overtemperature can easily be tested using switches.

5.3 Encoder

Unlike temperature sensors, there is no difference between encoder interfaces when starting up the encoder.

The encoder (or shaft) must first be rotated manually while checking the LEDs on the plug-in card. The LEDs should light up according to the direction of rotation.

The next step is to manually rotate the shaft to a certain degree (preferably 360°) and to monitor how the actual position behaves (direction, resolution).

If open circuit detection is supported by the encoder, this can be tested by removing the connector from the plug-in card.

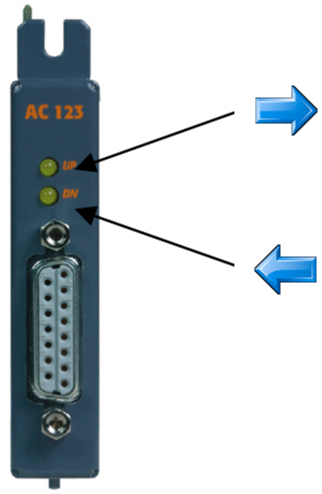

Figure 25: AC123 plug-in card - LEDs indicate direction of rotation

The following conditions may cause the encoder to react in a manner other than expected:

- Incorrect wiring
- Shielding not connected
- Faulty plug-in module or encoder
- Incorrect configuration

5.4 Motor phasing

The motor can now be started up. The following sequence is different for synchronous and induction motors. One more important step is needed for synchronous motors without which motor control would not be possible; phasing.

Phasing is used in synchronous motors to determine on which encoder position the field direction rotates. The difference between this position and the current rotor position produces what is known as the "commutation offset ρ_0".

Additionally, phasing can be used to check the wiring as well as the motor and encoder's direction of rotation. The number of pole pairs is also calculated.

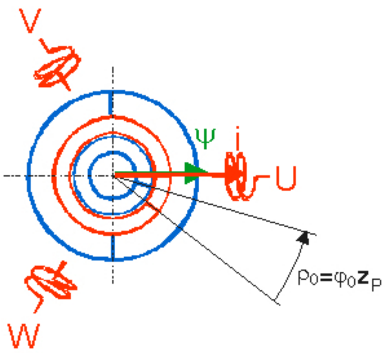

Figure 26: Commutation offset

With an induction motor, phasing is performed in stepper mode in order to check the wiring, the direction of rotation and the number of pole pairs. Unlike synchronous motors, phasing is not required for operating the motor.

There are a number of factors that determine which phasing should be used.

Make sure that the mode selected is appropriate for the motor and mechanics. Failure to do so can cause serious damage.

This decision tree and the corresponding table can help you make the right choice:

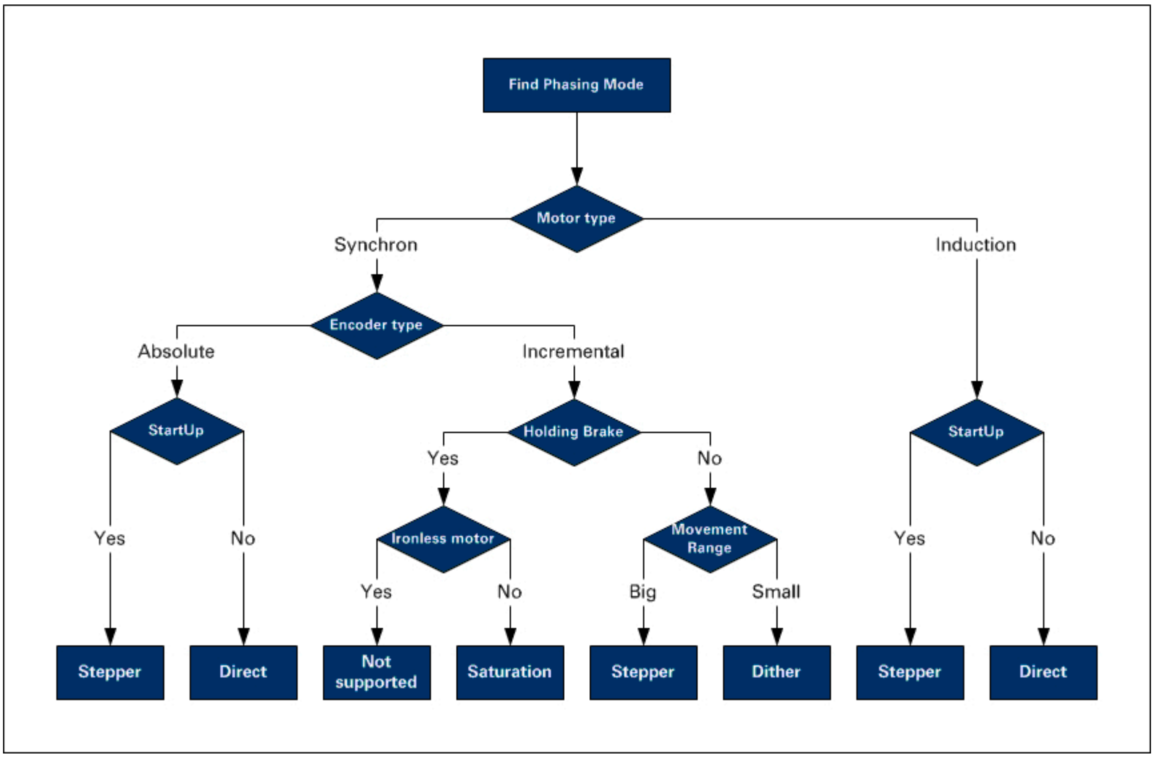

Figure 27: Phasing: Decision tree

Parameter ID	Function	Permissible values
PHASING_MODE (ParID 276)	Phasing mode	• Saturation mode, Saturation (0) • Stepper mode (1) • Dither mode (2) • Direct mode (3)
CMD_PHASING (ParID 334)	Starting and stopping phasing	• ncSWITCH_ON • ncSWITCH_OFF
MOTOR_COMMUT_OFFSET (ParID 63)	Commutation offset for direct mode (3)	• -2 PI .. 2 PI [rad]

Table 6: Parameter IDs required for phasing

Modes 0 – 2 are used to determine the commutation offset, whereas direct mode is used to set the commutation offset to the value of the parameter MOTOR_COMMUT_OFFSET (ParID 63).

The phasing procedure should be repeated and checked 2-3 times to prevent measurement errors.

Once a satisfactory result has been achieved, the value can be stored as a motor parameter in the parameter table when using an absolute value encoder.

When using an incremental encoder, phasing must be repeated each time the ACOPOS is restarted or after each encoder error. This way phasing is performed every time the machine is "switched-on". The advantage of this is that phasing is also performed whenever the motor or encoder is replaced.

Phasing is not necessary when using B&R motors because the commutation offset is either 0 (resolver) or is stored in the EnDat memory.

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Drive identification \ Motor \ Phasing \ Parameter IDs

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Drive identification \ Motor \ Phasing \ Function (Requirements, Selection criteria)

6 Controller settings

Once the motor is in operation, the control quality can be improved by fine-tuning the settings for the controller cascade. Additional information can be found in Training module TM450 and in the Automation Help.

An integrated autotuning process simplifies the process of identifying the control parameters. Autotuning is also supported for hanging loads.

Motion control \ ACP10/ARNC0 \ Commissioning \ Autotuning

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Drive control

Motion control \ ACP10/ARNC0 \ Reference manual \ ACOPOS drive functions \ Drive control \ Position controller \ Function \ Feed forward controller

Motion control \ ACP10/ARNC0 \ Reference manual \ ACP10 \ NC objects \ NC object "ncAXIS" \ Setup \ Setup for controller (autotuning)

7 Commissioning checklist

Component compatibility

Element	Subcategory	Note	OK
2.1.1 "Motor"	Type of motor, type of movement		☐
	Dielectric strength of the insulation		☐
	Rate of rise in voltage		☐
2.1.2 "Encoder"	Encoder interface		☐
2.1.3 "Temperature sensor"	Sensor type		☐
2.1.4 "Holding brake"	Nominal voltage		☐
	Maximum current		☐

Table 7: Component compatibility

Installation

Subcategory	Note	OK
Motor cable properly connected		☐
Motor cable shielded		☐
Encoder cable properly connected		☐
Encoder cable shielded, drive system grounded		☐

Table 8: Installation

Configuration

Element	Subcategory	Note	OK
4 "Parameter identification and configuration"	4.1 "Synchronous motor" 4.2 "Induction motor" 4.3 "Synchronous linear motor"		☐
4.4 "Encoder interface"	Plug-in card		☐
	Interface type		☐
4.5 "Temperature sensor"	Sensor type / Name		☐
4.6 "Holding brake"			☐

Table 9: Configuration

Commissioning

Element	Subcategory	Note	OK
5.1 "Holding brake"	"Clicking" sound when switching		☐
	Shaft able to be rotated by hand		☐
5.2 "Temperature sensor"	Measure room temperature		☐
	Cable break		☐
5.3 "Encoder"	Direction of rotation → LEDs		☐
	Encoder resolution		☐
5.4 "Motor phasing"	Phasing mode → Phasing		☐
	6 "Controller settings"		☐

Table 10: Commissioning

8 Exercise

Exercise: Induction motor configuration

Configure the following motor and its components:

1) Induction motor in a delta circuit

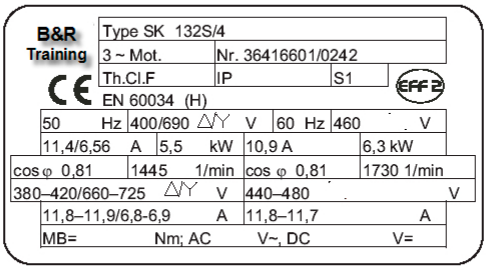

Figure 28: Induction motor parameter chip

2) Temperature sensor: KTY83-110

AMBIENT TEMPERATURE (°C)	AMBIENT TEMPERATURE (°F)	TEMP. COEFF. (%/K)	KTY83-110 RESISTANCE (Ω) MIN.	KTY83-110 RESISTANCE (Ω) TYP.	KTY83-110 RESISTANCE (Ω) MAX.	KTY83-110 TEMP. ERROR (K)	KTY83-120 RESISTANCE (Ω) MIN.	KTY83-120 RESISTANCE (Ω) TYP.	KTY83-120 RESISTANCE (Ω) MAX.	KTY83-120 TEMP. ERROR (K)
–55	–67	0.97	485	500	515	±3.08	480	500	520	±4.11
–50	–58	0.96	510	525	540	±2.99	504	525	545	±4.04
–40	–40	0.93	562	577	592	±2.81	556	577	598	±3.88
–30	–22	0.91	617	632	647	±2.62	611	632	654	±3.72
–20	–4	0.88	677	691	706	±2.42	670	691	713	±3.56
–10	14	0.85	740	754	768	±2.2	732	754	776	±3.37
0	32	0.83	807	820	833	±1.97	798	820	841	±3.18
10	50	0.80	877	889	902	±1.72	868	889	910	±2.97
20	68	0.78	951	962	973	±1.45	942	962	983	±2.74
25	77	0.76	990	1000	1010	±1.31	980	1000	1020	±2.62
30	86	0.75	1027	1039	1050	±1.44	1017	1039	1060	±2.77
40	104	0.73	1105	1118	1132	±1.7	1093	1118	1143	±3.07
50	122	0.71	1185	1202	1219	±1.98	1173	1202	1231	±3.39
60	140	0.69	1268	1288	1309	±2.27	1255	1288	1321	±3.73
70	158	0.67	1355	1379	1402	±2.58	1341	1379	1416	±4.08
80	176	0.65	1445	1472	1500	±2.9	1430	1472	1515	±4.44
90	194	0.63	1537	1569	1601	±3.24	1522	1569	1617	±4.82
100	212	0.61	1633	1670	1707	±3.59	1617	1670	1723	±5.22
110	230	0.60	1732	1774	1816	±3.95	1714	1774	1834	±5.63
120	248	0.58	1834	1882	1929	±4.34	1815	1882	1948	±6.06
125	257	0.57	1886	1937	1987	±4.53	1867	1937	2006	±6.28
130	266	0.57	1939	1993	2046	±4.73	1919	1993	2066	±6.5
140	284	0.55	2047	2107	2167	±5.14	2026	2107	2188	±6.96
150	302	0.54	2158	2225	2292	±5.57	2136	2225	2314	±7.43
160	320	0.52	2272	2346	2420	±6.02	2249	2346	2444	±7.92
170	338	0.51	2389	2471	2553	±6.47	2364	2471	2578	±8.43
175	347	0.51	2449	2535	2621	±6.71	2423	2535	2646	±8.68

Figure 29: Value table - KTY83-110

3) Encoder

Incremental encoder with 1024 inc/rev

See "Solution: Configuration for induction motor exercise".

9 Summary

Understanding how the various motor parameters work allows us to configure any motor to be used with an ACOPOS system. The quality of the motor parameters and the encoder signal play a key role in determining the control quality of an axis.

A motor should commissioned step by step, with testing at each step along the way. This is the only quick and effective path to success.

10 Solutions

Solution: Synchronous motor configuration

Motorparameter				
MOTOR_VOLTAGE_RATED	48	330	V	Motor: Rated voltage
MOTOR_VOLTAGE_CONST	49	36.6	mV*min	Motor: Voltage constant
MOTOR_SPEED_RATED	50	3000	1/min	Motor: Rated speed
MOTOR_SPEED_MAX	51	9000	1/min	Motor: Maximum speed
MOTOR_TORQ_STALL	52	4.5	Nm	Motor: Stall torque
MOTOR_TORQ_RATED	53	3	Nm	Motor: Rated torque
MOTOR_TORQ_MAX	54	10	Nm	Motor: Peak torque
MOTOR_TORQ_CONST	55	0.70	Nm/A	Motor: Torque constant
MOTOR_CURR_STALL	56	6.4	A	Motor: Stall current
MOTOR_CURR_RATED	57	4.4	A	Motor: Rated current
MOTOR_CURR_MAX	58	14	A	Motor: Peak current
MOTOR_WIND_CROSS_SECT	59	0	mm²	Motor: Line cross section
MOTOR_STATOR_RESISTANCE	60	0.9	Ohm	Motor: Stator resistance
MOTOR_STATOR_INDUCTANCE	61	0.0003	Henry	Motor: Stator inductance
MOTOR_INERTIA	62	0.57	kgm²	Motor: Moment of inertia
MOTOR_COMMUT_OFFSET	63	0	rad	Motor: Commutation offset
MOTOR_TAU_THERM	849	0	s	Motor: Thermal time constant

Figure 30: Synchronous motor parameter table

Solution: Induction motor configuration

Motorparameter				
MOTOR_VOLTAGE_RATED	48	460	V	Motor: Rated voltage
MOTOR_VOLTAGE_CONST	49	0	mV*min	Motor: Voltage constant
MOTOR_SPEED_RATED	50	3440	1/min	Motor: Rated speed
MOTOR_SPEED_MAX	51	10000	1/min	Motor: Maximum speed
MOTOR_TORQ_STALL	52	23.78	Nm	Motor: Stall torque
MOTOR_TORQ_RATED	53	23.78	Nm	Motor: Rated torque
MOTOR_TORQ_MAX	54	183.78	Nm	Motor: Peak torque
MOTOR_TORQ_CONST	55	0	Nm/A	Motor: Torque constant
MOTOR_CURR_STALL	56	15.3	A	Motor: Stall current
MOTOR_CURR_RATED	57	15.3	A	Motor: Rated current
MOTOR_CURR_MAX	58	93.73	A	Motor: Peak current
MOTOR_WIND_CROSS_SECT	59	0	mm²	Motor: Line cross section
MOTOR_STATOR_RESISTANCE	60	0.78	Ohm	Motor: Stator resistance
MOTOR_STATOR_INDUCTANCE	61	0.00378	Henry	Motor: Stator inductance
MOTOR_INERTIA	62	0	kgm²	Motor: Moment of inertia
MOTOR_COMMUT_OFFSET	63	0	rad	Motor: Commutation offset
MOTOR_ROTOR_RESISTANCE	76	0.78	Ohm	Motor: Rotor resistance
MOTOR_ROTOR_INDUCTANCE	77	0.00378	Henry	Motor: Rotor inductance
MOTOR_MUTUAL_INDUCTAN...	78	0.1205	Henry	Motor: Mutual inductance
MOTOR_MAGNETIZING_CURR	79	5.6	A	Motor: Magnetizing current
MOTOR_TAU_THERM	849	0	s	Motor: Thermal time constant

Figure 31: Induction motor parameter table

Solution: Synchronous linear motor configuration

Motorparameter				
MOTOR_VOLTAGE_RATED	48	230	V	Motor: Rated voltage
MOTOR_VOLTAGE_CONST	49	27.17	mV*min	Motor: Voltage constant
MOTOR_SPEED_RATED	50	10000	1/min	Motor: Rated speed
MOTOR_SPEED_MAX	51	10000	1/min	Motor: Maximum speed
MOTOR_TORQ_STALL	52	5.66	Nm	Motor: Stall torque
MOTOR_TORQ_RATED	53	5.66	Nm	Motor: Rated torque
MOTOR_TORQ_MAX	54	22.65	Nm	Motor: Peak torque
MOTOR_TORQ_CONST	55	0.32	Nm/A	Motor: Torque constant
MOTOR_CURR_STALL	56	25.03	A	Motor: Stall current
MOTOR_CURR_RATED	57	25.03	A	Motor: Rated current
MOTOR_CURR_MAX	58	100.13	A	Motor: Peak current
MOTOR_WIND_CROSS_SECT	59	0	mm²	Motor: Line cross section
MOTOR_STATOR_RESISTANCE	60	1.3	Ohm	Motor: Stator resistance
MOTOR_STATOR_INDUCTANCE	61	0.001	Henry	Motor: Stator inductance
MOTOR_INERTIA	62	0.0001014	kgm²	Motor: Moment of inertia
MOTOR_COMMUT_OFFSET	63	0	rad	Motor: Commutation offset
MOTOR_TAU_THERM	849	0	s	Motor: Thermal time constant

Figure 32: Linear motor parameter table

Solution: Encoder configuration

SS2			8AC123.00
ENCOD_TYPE	97	ncINC	Encoder1: Type
SCALE_ENCOD_INCR	109	2048	Encoder1: Encoder scaling: increments per SCALE_ENCOD_MOTOR_REV motor revolutions
ENCOD_LINE_CHK_IGNORE	727	0	Encoder1: Ignore check

Figure 33: Incremental encoder configuration

SS2			8AC123.00
ENCOD_TYPE	97	ncINC	Encoder1: Type
SCALE_ENCOD_INCR	109	24576000	Encoder1: Encoder scaling: increments per SCALE_ENCOD_MOTOR_REV motor revolutions
ENCOD_LINE_CHK_IGNORE	727	0	Encoder1: Ignore check

Figure 34: Sin/Cos encoder configuration

Solution: Temperature sensor configuration

Thermo-Sensor-Parameter			
MOTOR_TEMPSENS_PAR1	64	567	Temperature sensor: Parameter 1
MOTOR_TEMPSENS_PAR2	65	2211	Temperature sensor: Parameter 2
MOTOR_TEMPSENS_PAR3	66	40	Temperature sensor: Parameter 3
MOTOR_TEMPSENS_PAR4	67	0.91	Temperature sensor: Parameter 4
MOTOR_TEMPSENS_PAR5	68	30.36	Temperature sensor: Parameter 5
MOTOR_TEMPSENS_PAR6	69	57.42	Temperature sensor: Parameter 6
MOTOR_TEMPSENS_PAR7	70	81.71	Temperature sensor: Parameter 7
MOTOR_TEMPSENS_PAR8	71	104.15	Temperature sensor: Parameter 8
MOTOR_TEMPSENS_PAR9	72	126.33	Temperature sensor: Parameter 9
MOTOR_TEMPSENS_PAR10	73	150	Temperature sensor: Parameter 10

Figure 35: Thermistor configuration

Thermo-Sensor-Parameter			
MOTOR_TEMPSENS_PAR1	64	0	Temperature sensor: Parameter 1
MOTOR_TEMPSENS_PAR2	65	0	Temperature sensor: Parameter 2
MOTOR_TEMPSENS_PAR3	66	120	Temperature sensor: Parameter 3
MOTOR_TEMPSENS_PAR4	67	0	Temperature sensor: Parameter 4
MOTOR_TEMPSENS_PAR5	68	0	Temperature sensor: Parameter 5
MOTOR_TEMPSENS_PAR6	69	0	Temperature sensor: Parameter 6
MOTOR_TEMPSENS_PAR7	70	0	Temperature sensor: Parameter 7
MOTOR_TEMPSENS_PAR8	71	0	Temperature sensor: Parameter 8
MOTOR_TEMPSENS_PAR9	72	0	Temperature sensor: Parameter 9
MOTOR_TEMPSENS_PAR10	73	0	Temperature sensor: Parameter 10

Figure 36: PTC switch configuration

Solution: Holding brake configuration

Brake parameters				
MOTOR_BRAKE_CURR_RATED	42	1.4	A	Motor holding brake: Rated current
MOTOR_BRAKE_TORQ_RATED	43	7.5	Nm	Motor holding brake: Rated torque
MOTOR_BRAKE_ON_TIME	44	0.007	s	Motor holding brake: Engaging delay
MOTOR_BRAKE_OFF_TIME	45	0.04	s	Motor holding brake: Release delay

Figure 37: Holding brake configuration

Solution: Configuration for induction motor exercise

Name	ID	Value	Unit	Description
IF3.ST2				8V1090.00-2
SS2				8AC123.00
ENCOD_TYPE	97	ncINC		Encoder1: Type
SCALE_ENCOD_INCR	109	4096		Encoder1: Encoder scaling: increments per SCALE_ENCOD_MOTOR_REV motor revolutions
ENCOD_LINE_CHK_IGNORE	727	0		Encoder1: Ignore check
M1				FFM_ASM_123
General parameters				
MOTOR_TYPE	30	0x0001		Motor: Type
MOTOR_COMPATIBILITY	31	0x0203		Motor: Software compatibility
MOTOR_WIND_CONNECT	46	1		Motor: Winding connection
MOTOR_POLEPAIRS	47	2		Motor: Number of pole-pairs
Brake parameters				
MOTOR_BRAKE_CURR_RATED	42	0	A	Motor holding brake: Rated current
MOTOR_BRAKE_TORQ_RATED	43	0	Nm	Motor holding brake: Rated torque
MOTOR_BRAKE_ON_TIME	44	0	s	Motor holding brake: Engaging delay
MOTOR_BRAKE_OFF_TIME	45	0	s	Motor holding brake: Release delay
Thermo sensor parameters				
MOTOR_TEMPSENS_PAR1	64	632		Temperature sensor: Parameter 1
MOTOR_TEMPSENS_PAR2	65	2471		Temperature sensor: Parameter 2
MOTOR_TEMPSENS_PAR3	66	-30		Temperature sensor: Parameter 3
MOTOR_TEMPSENS_PAR4	67	10.76		Temperature sensor: Parameter 4
MOTOR_TEMPSENS_PAR5	68	44.53		Temperature sensor: Parameter 5
MOTOR_TEMPSENS_PAR6	69	74.33		Temperature sensor: Parameter 6
MOTOR_TEMPSENS_PAR7	70	101.11		Temperature sensor: Parameter 7
MOTOR_TEMPSENS_PAR8	71	125.67		Temperature sensor: Parameter 8
MOTOR_TEMPSENS_PAR9	72	148.56		Temperature sensor: Parameter 9
MOTOR_TEMPSENS_PAR10	73	170.00		Temperature sensor: Parameter 10
MOTOR_THERMAL_CONST	75	0	s	Motor: Thermal time constant (for MOTOR_COMPATIBILITY 0x0202)
Motor parameters				
MOTOR_VOLTAGE_RATED	48	230	V	Motor: Rated voltage
MOTOR_VOLTAGE_CONST	49	0	mV*min	Motor: Voltage constant
MOTOR_SPEED_RATED	50	1445	1/min	Motor: Rated speed
MOTOR_SPEED_MAX	51	6000	1/min	Motor: Maximum speed
MOTOR_TORQ_STALL	52	36.35	Nm	Motor: Stall torque
MOTOR_TORQ_RATED	53	36.35	Nm	Motor: Rated torque
MOTOR_TORQ_MAX	54	216.49	Nm	Motor: Peak torque
MOTOR_TORQ_CONST	55	0	Nm/A	Motor: Torque constant
MOTOR_CURR_STALL	56	11.4	A	Motor: Stall current
MOTOR_CURR_RATED	57	11.4	A	Motor: Rated current
MOTOR_CURR_MAX	58	55.24	A	Motor: Peak current
MOTOR_WIND_CROSS_SECT	59	0	mm²	Motor: Line cross section
MOTOR_STATOR_RESISTANCE	60	0.755	Ohm	Motor: Stator resistance
MOTOR_STATOR_INDUCTANCE	61	0.00673	Henry	Motor: Stator inductance
MOTOR_INERTIA	62	0	kgm²	Motor: Moment of inertia
MOTOR_COMMUT_OFFSET	63	1e+006	rad	Motor: Commutation offset
MOTOR_ROTOR_RESISTANCE	76	0.755	Ohm	Motor: Rotor resistance
MOTOR_ROTOR_INDUCTANCE	77	0.00673	Henry	Motor: Rotor inductance
MOTOR_MUTUAL_INDUCTAN...	78	0.1354	Henry	Motor: Mutual inductance
MOTOR_MAGNETIZING_CURR	79	5.03	A	Motor: Magnetizing current
MOTOR_TAU_THERM	849	0	s	Motor: Thermal time constant
Isolation parameters				
MOTOR_WIND_TEMP_MAX	74	0	°C	Temperature sensor: Limit temperature

Figure 38: Induction motor configuration in delta circuit

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