engineering mannesmann Rexroth

Drives with DIAX03/04 or ECODRIVE03 Controllers and Third-Party Motors

Project Planning and Commissioning

DOK-DRIVE*-3RDPART*MOT-AW01-EN-P

2 8 4 1 1 9

Indramat

Title

Drives with DIAX03/04 or ECODRIVE03 Controllers and Third-Party Motors

Type of Documentation

Project Planning and Commissioning

Document code

DOK-DRIVE*-3RDPART*MOT-AW01-EN-P

Internal file reference

- 120-0850-B301-01/EN

The purpose of the document

This document is intended

- to help to select the controller needed for a third-party motor.
- to help a third-party motor maintain the controller requirements or the demands of any planned motor.
- to check any planned position encoder for the ability to be evaluated by the controller or operate a third-party motor in terms of the specific position encoder.
- to determine the special motor parameters needed for commissioning and bring the motor into operation.

This document supports the checking, project planning and commissioning of a third-party motor with the help of forms.

Editing sequence

Document codes of previous editions	Status	Comments
DOK-DRIVE*-3RDPART*MOT-AW01-EN-P	06/99	1st edition

Copyright

Validity

Published by

INDRAMAT GmbH • Bgm.-Dr.-Nebel-Str. 2 • D-97816 Lohr a. Main

Phone: 09352/40-0 • Tx 689421 • Fax 09352/40-4885

Dept. ECD5 (MR), ECD1 (OS)

Note

This document printed on chlorine-free paper.

Contents

1 Answering Some Basic Questions

1.1 Why a Third-Party Motor Control?

Machine axes today are primarily moved with the use of electrical drives. In most cases, standard motors are used as these are more cost-effective.

Special demands

Due to the special demands of machine axes, in terms of construction or safety, a machine manufacturer may find it necessary to deviate from the standard construction.

Not available types

In such cases, the drive supplier is confronted with the needed to supply, in addition to the drive made up of a standard motor, controller, cable and possible machine control, also drives with motors which he generally does not supply.

With INDRAMAT controllers of the drive family DIAX03, DIAX04 and ECODRIVE03 third-party motors as needed for exceptional cases can be controlled.

Checking third-party motor control capabilities

For the successful control of a third-party motor it is necessary to first check:

- Which controller, including supply, is suited for the motor power to be generated?
- Whether the motor to be controlled meets controller demands?
- Whether the mounted position encoder system can be evaluated by the controller of which one should be chosen for built-in motors?

How to project

In the section on project planning the above addressed topics are discussed in detail. The attachment further assists with

- forms that list output data of synchronous and asynchronous motors
- and a form that helps select the controller by outlining criteria on the combinations of motor and controllers.

How to commission

The commissioning section explains the procedures for determining drive parameters and commissioning. The document of the special drive parameters to be determined is also in the attachment.

1.2 Which Guidelines are Important?

As per directives

- EG directives 89/336/EWG or
- German EMC laws

the facilities and machine must meet the above present day standards as specified. To meet the „Electromagnetic Compatibility" (EMC) guidelines, a conformity check of the drive system (motor with controller and connections) has to run. The machine manufacturer is responsible for this.

1.3 Which Third-Party Motors can be controlled?

Motor types

The following motors can be controlled:

- asynchronous motors, rotary
- asynchronous motors, linear
- synchronous motors, rotary
- synchronous motors, linear

If the motor has a holding brake then such can be controlled if they meet the demands as specified for the selected controller as well.

Star-delta switchable motors can also be used. The controller commands it.

Note: The guarantee from Indramat goes not apply to the power data of the motor shaft if third-party motors are used.

Position encoder system needed

The motors must be equipped with a position encoder system that can be evaluated by an INDRAMAT controller even if the drive is run in speed or torque control mode.

1.4 Which Position Encoder System can be used for which Motor Type?

Asynchronous motors		synchronous motors		Can be combined with position encoder system		
Rotary	linear	rotary	linear	Enc. Type	Manufacturer	Enc. type[5]
X		X	X	EnDat	Heidenhain	built-in and mounted type
X		X		GDS/GDM	Indramat	built-in type
X[4]				high-res. enc.	Indramat	mounted type, „hol. shaft“
X		X[1]		gearwheel enc. $1V_{SS}$	e.g. ‚Woelke Lenord & Bauer	mounted type, „hol. shaft“
X	X	X[1]	X[1]	incremental enc. Sinusoidal $1V_{SS}$ o. $11\mu A_{SS}$[4]	e.g., Heidenhain, Stegmann	built-in and mounted type
X	X			incremental enc. square wave $5V_{TTL}$	e.g., Heidenhain, Stegmann	built-in and mounted type
X[2]		X[3]		Resolver	e.g., Siemens	built-in and mounted type

[1] only with DIAX03/04 as of firmware SSE03VRS, SHS03VRS
[2] only with ECODR03 as of firmware SMT02V12
[3] only single-pole resolvers
[4] only with DIAX03/04
[5] built-in type: encoder with shaft (rotary) bearings
mounted type: encoder for mounting into mechanical system, no own bearings

Fig. 1-1: Allowed motor/position encoder

1.5 The Power Ranges of the Controller Families

Controller families

- ECODRIVE03
  single drives with controller DKC**.3 for direct mains connection
- DIAX04
  Modular drives with controllers HDD/HDS connected to HVE/HVR
- DIAX03
  -Modular drives with controllers DDS**.2 connected to TVD, TVR, KVR and KDV,
  -single drives with controller DKR for direct mains connection

Maximum data

RG family	P_{d_mech} kW	I_{max} A	P_{d_reg} kW	Mains regeneration
ECODRIVE03	10 (18)	100 (200)	1,0	no
DIAX04, with HVE an 3x400V	24 (60)	200 (300)	1,5	no
DIAX04, with HVE an 3x480V	28 (72)	200 (300)	1,5	no
DIAX04, with HVR	36	200 (300)	36	yes
DIAX03	93	400	66	yes

(...) values in brackets mean „In preparation“

P_{d_mech} = continuous mech. power at motor shaft
I_{max} = peak current of controller
P_{d_reg}= mechanical regeneration continuous power at motor shaft

Fig. 1-2: Maximum data of controller families

1.6 Which Connectors and Cables to use

Power Connections

To achieve the best resistance to interference for the motor or minimum emission of electromagnetic interference it is necessary to shield the power cables coming out of the motor. The sensor supply lines for temperature sensors must be separately shielded. The shielding does not, however, ensure that the EMC guidelines are met or the demands as set in the CE symbol.

Motor power cables

Core cross sec. in mm^2	Current load to VDE 0298, part4 for INDRAMAT cables, type of installation B2 in A	Type designations INDRAMAT cables
1,0	13,0	INK0653
1,5	15,7	INK0650
2,5	22,6	INK0602
4	29,3	INK0603
6	38,3	INK0604
10	53,0	INK0605
16	71,3	INK0606
25	93,9	INK0607
35	117,4	INK0667

Fig. 1-3: Data of motor power cables - INDRAMAT at ambient temp. 40°C

Motor power cable contacts on the motor

Controllers-		Possible motor contacts		
Family	Type	Connection box	Plug-in conn. INS192/INS172	Plug-in conn. INS380/INS381 INS480/INS481
ECODR. 03	DKC**.3	X		X
DIAX04	HDD HDS	X		X
DIAX03	DDS**.2	X	X	
	DKR	X		X

Fig. 1-4: Table - Power connections of motors

Position Encoder Connections

The position encoder connection cable that a customer makes must meet the demands of the standard Indramat cable (see the wiring diagrams of the motor feedback cable). The resistance to interference can otherwise not be ensured!

Pos. enc. type	ECODRIVE03 Interf.	DIAX03/04 Interf.	standard cable
EnDat	X8	DAG01.2M	IKS0142
GDS/GDM	X4	X4	IKS0374 IKS4374
high-res. enc. of INDRAMAT	--	DZF02.1M	IKS0314
gearwheel enc. $1V_{SS}$	X8	DZF03.1M	IKS0314
incremental enc. Sinusoidal $1V_{SS}$ or $11\mu A_{SS}$	X8 --	DLF01.1M DLF01.1M	IKS0384 IKS0130
incremental enc. square-wave $5V_{TTL}$	X8	DEF01.1M	-
Resolver	X4	X4	IKS0103
X4, X8 are standard controller interfaces, Dxx are plug-in modules for DIAX03/04			

Fig. 1-5: Interfaces and standard position encoder connection cables

Notes

2 Project Planning

2.1 Pre-requisites and Procedures

First, the user should have all output data of the third-party motor. Then please fill out „Form for Output Data of Asynchronous Motors“ (see sec. 4.3) or „Form for Output Data of Synchronous Motors“ (see sec. 4.4)!

For selecting the controller or checking on motor, controller and position encoder system combinations, use form „Form Controller Selection for Third-Party Motors“ (see sec. 4.5)!

2.2 Selecting the Controller

Output current Criteria

The drive applications required for an application must match the output current characteristics of the controller.

With machine tools there is always the difference between servo and main drives:

- Servo drives move tools or tools moved by the spindle on the path specified by the controller. They do the feed work when machining and conduct the rapid movements, e.g., tool change.
- Main drives generate cutting power in the machine. They run either the workpiece (lathe spindle) or the tool (milling spindle).

Both servo and main drives work cyclically.

Servo Applications

Output current diagram of controllers for servo applications

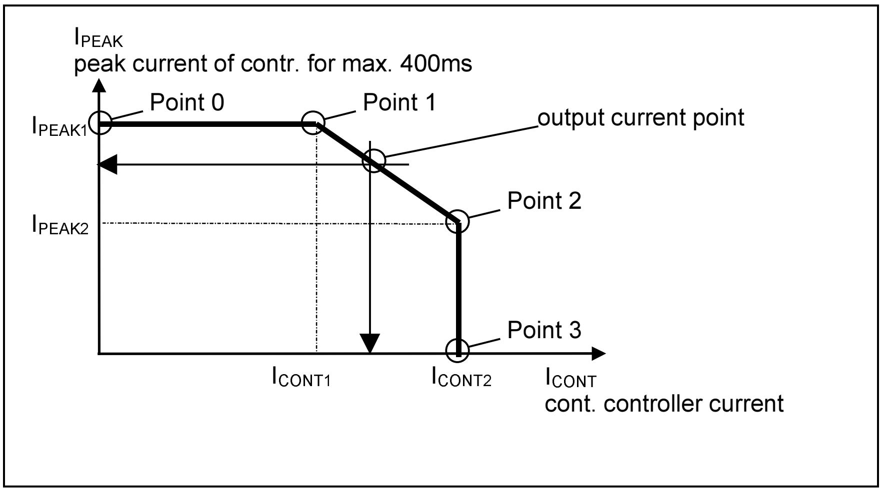


Fig. 2-1: Output current diagram of controllers (RG)

The output current (peak current I_{PEAK} and the continuous current I_{CONT}) of controllers can be set via drive parameters to limit curves between „Point 0“ and „Point 3“. This means that the controller can be matched to the motor and the operating demands.

Chronology of the output current

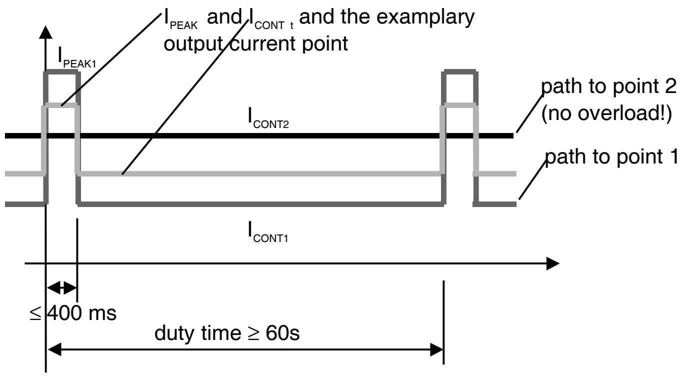


Fig. 2-2: Chronology of above output current diagram

Criteria of servo applications

A drive in servo applications has to meet demands in terms of

- peak torque/force for acceleration procedures (<400ms) and
- short term torque/force for machining (>>400ms).

The rms torque of the machining cycle must be smaller than the continuous torque of the motor.

Dimensioning for servo applications

The controller must be selected so that the motor including the coupled mechanical system can generate with

- I_{PEAK} the required accel torque or accel force and with the corresponding
- I_{CONT} the required feed torque or force.

$$I_{PEAK} \geq 1{,}1 * \frac{M_{acc}}{M_{Max}} * I_{Max}$$

$$I_{CONT} \geq 1{,}1 * \frac{M_{feed}}{M_{nom}} * I_{nom} \leq 2{,}2 * I_{nom}$$

I_{PEAK}: peak current of the controller in A (threshold)
M_{acc}: req. accel torque of machine axis in Nm
M_{max}: maximum motor torque in Nm
I_{max}: for M_{max} required current in A (threshold)

I_{CONT}: continuous current of the controller in A (threshold)
M_{feed}: required feed torque of the machine axis in Nm
M_{nom}: nominal torque of the motor in Nm
I_{nom}: for M_{nom} req. current in A (threshold)

Fig. 2-3: Advisable size of the controller current for rotary motors

$$I_{PEAK} \geq 1{,}1 * \frac{F_{acc}}{F_{Max}} * I_{Max}$$

$$I_{CONT} \geq 1{,}1 * \frac{F_{feed}}{F_{nom}} * I_{nom} \leq 2{,}2 * I_{nom}$$

I_{PEAK}: peak current of the controller in A (threshold)
F_{acc}: req. accel force of the machine axis in N
F_{max}: maximum motor torque in N
I_{max}: for F_{max} req. current in A (threshold)

I_{CONT}: cont. current of the controller in A (threshold)
F_{feed}: req. feed force of the machine axis in N
F_{nom}: nominal force of the motor in N
I_{nom}: for F_{nom} req. current in A (threshold)

Fig. 2-4: Advisable size of the controller current for linear motors

Controller selection

To select the controller in terms of the current data, see attachment in which current data of controllers for servo applications is listed.

Main Spindle Applications

Criteria for main spindle motors on lathes

For main spindle motors on lathes typically for cyclic processing 1.5 fold drive continuous power is set for cutting at about 44% operating time (OT).

Typical output current path with lathe spindles

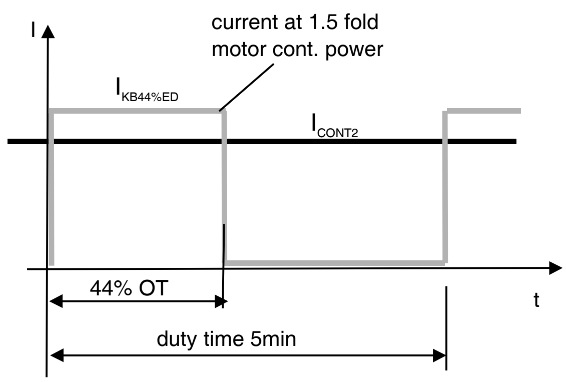


Fig. 2.5: Typical output current in spindle drives of lathes

Dimensioning for lathes

The controller must be selected so that the motor runs with 1.5 fold nominal current at 44% operating time for five minutes duty cycle time. This means that the controller continuous current I_{CONT2} must be at least 1.25 times the motor nominal current!

$$I_{CONT2} \geq 1{,}25 * \sqrt{2} * I_{nom}$$

I_{CONT2}: max. cont. current of the controller in A (threshold)
I_{nom}: nominal current of the motor in A (rms value)

Fig. 2-6: Advisable size of the controller current for lathes

Criteria for milling spindles

Of milling spindles, a minimum cut-to-cut time for the tool exchange is anticipated. This is why accel and decel times must be minimal. For machining speeds, there must be sufficient power available.

Typical output current curve for milling spindles

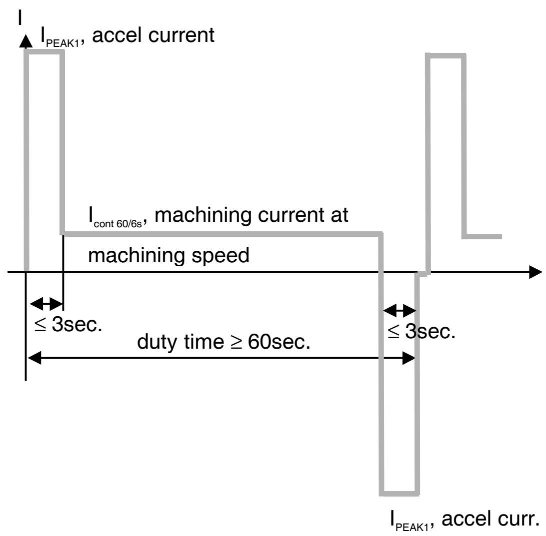


Fig. 2.7: Typical output current curve for milling spindles

Dimensioning for milling spindles

The controller must be selected so that the peak current I_{PEAK1} is greater or equal to the accel of the needed motor current. Accel and decel must also be accounted for, available continuous current of the controller greater or equal to the motor current needed during machining at high speeds.

$$accel/decel: \sqrt{2} * I_{acc/dec} \leq I_{PEAK1} \leq 2{,}5 * I_{nom}$$

$$machining: I_{CONT60/6s} \geq \sqrt{2} * I_{Machining}$$

$I_{acc/dec}$: accel/decel current of the motor in A (rms value)
I_{PEAK1}: peak current of the controller in A (threshold)
I_{nom}: nominal current of the motor in A (rms value)
$I_{CONT60/6s}$: available cont. current of the controller in A (threshold) about I_{PEAK1} for ≤6sec. and ≥60sec. duty cycle time
$I_{Machining}$: machining current of the motor in A (rms value)

Fig. 2-8: Advisable size of the controller current for milling spindles

The continuous rms current of a machining cycle must always be smaller than the motor nominal current.

Controller selection

When selecting the controller in terms of current data, then see the current data for the controller for spindle applications in the attachment.

Attention: The current data specified for the controllers are threshold values. For spindle motors generally rms values are specified. Conversion may be necessary!

Criteria of Output Voltage

Dimensioning motor windings

For dimensioning motor windings the nominal output voltage of the controller must be known.

Controller	Nominal output voltage
DDS02.2	3 x AC $220V_{eff}$
DKR, HDD/HDS an HVE (3xAC400V) DKC**.3 (3xAC400V)	3 x AC $380V_{eff}$
DKC**.3 (3xAC480V) HDD/HDS at HVE (3xAC480V)	3 x AC $430V_{eff}$
HDD/HDS at HVR	3 x AC $520V_{eff}$

Fig. 2.9: Output voltages of controllers

Criteria Maximum Output Frequency

Rotary motor

The maximum speed of a rotary motor depends on pole pair number, maximum output frequency of the controller and the allowed mechanical maximum speed.

Contr.	Max. speed n_{max} (PPZ=no. of pole pairs)	max. output frequency f_{max}	set PWM frequency
DKC**.3	< 24000min^{-1}/PPZ	400 Hz	4 kHz
	< 48000min^{-1}/PPZ	800 Hz	8 kHz
DDS02.2 DKR HDD/HDS	< 48000min^{-1}/PPZ (< 36000min^{-1} /PPZ) [1]	800 Hz (600 Hz)[1]	4 kHz
DKR HDD/HDS	< 96000min^{-1}/PPZ (< 72000min^{-1} /PPZ) [1]	1600 Hz (1200 Hz)[1]	8 kHz
[1] values in brackets apply to for synchronous motors, values without brackets for asynchronous motors			

Fig. 2.10: Achievable maximum speeds for rotary motors

Linear motor

The maximum speeds of a linear motor depends on pole width, maximum output frequency of controller and allowed mechanical maximum speed.

Contr.	Max. velocity V_{max} (PWT=pole width in m)	max. output frequency f_{max}	set PWM frequency
DKC**.3	< 24000/min*PWT[2]	400 Hz	4kHz
	< 48000/min* PWT[2]	800 Hz	8 kHz
DDS02.2 DKR HDD/HDS	< 48000/min* PWT[2] (< 36000/min* PWT[2]) [1]	800 Hz (600 Hz)[1]	4 kHz
DKR HDD/HDS	< 96000/min* PWT[2] (< 72000/min* PWT[2]) [1]	1600 Hz (1200 Hz)[1]	8 kHz
[1] values in brackets apply to synchronous motors, values without brackets to asynchronous motors [2] pole width is the distance between magnetic poles of the same name, i.e., northpole/northpole			

Fig. 2.11: Achievable maximum speeds for linear motors

Number of pole pairs/pole width

The number of pole pairs/pole width must lie within the defined value range.

Controller family	No. of pole pairs (rot. motors)		Pole width in mm (linear motors)	
	min.	max.	min.	max.
ECODRIVE03	1	100	1	100
DIAX03/04	1	100	1	100

Fig. 2-12: Value range for settable number of pole pairs or pole width

Criteria Output Power of Drive

The maximum output power of a drive depends on, in addition to the output current of the controller

- the supply module and the number of axes with a modular drive system,
- the power capacity of the supply section in controllers for direct mains connection and
- on the mains connection voltage in controllers with unregulated DC bus voltage

Servo drives

The continuous output power of the combination of controller and supply must be greater same to servo basic power of the motor.

$$P_{Out\_CONT} \geq M_{feed} * n_{feed} * \pi / 30000 = P_{Servo\_Eck}$$

or

$$P_{Out\_CONT} \geq F_{feed} * v_{feed} / 60000 = P_{Servo\_Eck}$$

P_{Out_CONT} : contin. output power, as relates to axis mechanics in kW

M_{feed} : Feed torque in Nm

n_{feed} : Feed speed in 1/min

F_{feed} : Feed force in N

v_{feed} : Feed velocity in m/min

P_{Servo_Eck} : Basic servo power of the motor

Fig. 2-13: Continuous output power and basic servo power

Main spindle drives

The short-term output power of the supply unit or of the controller for direct mains connection must be greater same as short-term operating power (44%ED at 5min duty cycle time) or the accel power of the motor.

$$P_{Out\_KB} \geq M_{KB\,44\%ED} * n_{nom} * \pi / 30000 = P_{KB\,44\%ED}$$

$$P_{Out\_KB} \geq M_{acc} * n_{nom} * \pi / 30000 = P_{ACC}$$

P_{Out_KB}: short-term operating output power of supply unit or of the controller as relates to motor shaft in kW

$M_{KB\,44\%ED}$: short-term operating torque n = n_{Nenn} in Nm

n_{nom}: Nominal speed in 1/min

$P_{KB\,44\%ED}$: Short-term operating power of the motor in kW

M_{ACC}: Accel torque at n = n_{Nenn} in Nm

P_{ACC}: Accel power of the motor in kW

Fig. 2-14: Output power and short-term or accel power

If the supply unit can only make short-term operating power available for a short time, then the dimensioning should be as per the continuous output power.

The continuous output power and the useable short-term operating output power is listed in the Project Planning Manual of the supply module or of controllers for direct mains connection.

Criteria for Regenerated Power

The regenerated power generated when decelerating a drive can, depending on the type of supply module or of the controller for direct mains connection

- either be fed back into the supply network or
- changed to heat via the bleeder.

Always check whether the anticipated values for the

- mean regenerated power and
- the occurring regenerated peak power or maximum regenerated power

of the drive or drive system are acceptable to the supply module or the controller for direct mains connection.

Critieria Star-delta switch

DIAX03/04 controllers can be used to run star-delta switchable motors. The control emits the command and the controller conducts the switching procedure. Wiring and function are described in the relevant handbook of the main spindle firmware.

ECODRIVE03 controllers cannot control these types of motors.

2.3 Demands Made of Third-party motors

Windings Voltage Resistance

The windings voltage resistance of third-party motors has to be checked. Loads are different depending on the controller.

Contr. type	Max. voltage amplitude $\hat{u}_{max}$ between motor clamps	Voltage increment du/dt
DDS02.2	850V	5kV/µs
DKR, HDD/HDS at HVE (3xAC400V) DKC**.3 (3xAC400V)	1200V	8kV/µs
HDD/HDS at HVR DKC**.3 (3xAC480V)	1500V	10kV/µs

Fig. 2.15: Voltage demands of motors as dependent on controllers

Motor Inductance

The motor must have a minimum inductance depending on the controller. The actually existing motor inductance can be measured directly between two motor clamps. The reading must be taken with the complete ready-to-operate but not running motor (measured value only usable with asynchronous motors if rotor has no closed slots!).

Controller	$L_{\sigma min}$ at 4kHz	$L_{\sigma min}$ at 8kHz
DDS	$60/I_{PEAK1}$ (mH)	$30/I_{PEAK1}$ (mH)
DKR, HDD/HDS at HVE (3xAC400V) DKC**.3 (3xAC400V)	$80/I_{PEAK1}$ (mH)	$40/I_{PEAK1}$ (mH)
HDD/HDS at HVR HDD/HDS at HVE (3xAC480V) DKC**.3 (3xAC480V)	$116/I_{PEAK1}$(mH)	$58/I_{PEAK1}$ (mH)

Fig. 2.16: Minimum inductance depending on controllers (I_{PEAK1} = Type current of selected controllers)

If the inductance of a third-party motor is smaller than the above table specifies, then a three-phase choke has to installed in the motor supply line. It increases inductance between two motor clamps to the minimum value.

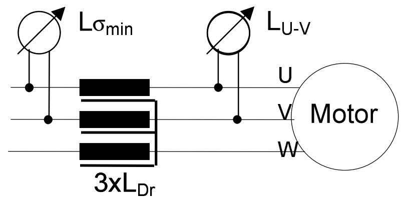
Present third-party motor	Planned
 L_{Dr}= 0,5*(L_{min} - $L_{U\text{-}V}$) (Inductance measure with 1kHz) Mounting 3xL_{Dr} (3-phase choke)	computing stray inductance of third-party motor using single-phase replacement diagrams (manufacturer's data). If choke is needed, contact INDRAMAT!
Demands made of choke: - $I_{nDr} \geq I_{nMot}$, (choke nominal current greater same than motor nominal current) - f_l =$f_{output,\ max.;}$ f_{PWM}, (choke load depends on max. speed with relevant output and PWM frequency of the controller) - Insulation class F (insulation class at least that of motor or for higher temperatures) - The voltage demands of choke depend on controller.	

Fig. 2.17: Date of choke

Temperature Evaluation

Asynchronous motors

For asynchronous motors an NTC resistor type K227 (Manufacturer Siemens, 1.8kOhm at 20°C) should be used (for servicing a double NTC resistor is advisable).

The controller can issue a warning, if the resistor is in place, if the windings temperature exceed a set threshold. The drive control is also matched to a thermal status of the motor.

The motor is shutdown if the maximum allowed winding temperature is reached (this can be programmed).

Synchronous motors

For synchronous motors and linear motors a PTC resistortype SNM150-DK (Manufacturer Thermik) or something similar must be used. With an SNM150-DK there are three single PTC resistors in a row.

The motor shutdowns when the ohmic resistance of the three exceeds 1.7kOhm. The corresponds to the recommended type with shutdown temperature of 150°C for motors with insulation class F.

Motors with other classes must be protected with a PTC resistor to met maximum windings temperature.

The ohmic resistance of a PTC resistor is 5 Kelvin below the shutdown temperature, smaller than 600 Ohm. The curve in the shutdown temperature range shows a jagged resistance increase. This is why a PTC resistor motor is not practical for prewarning.

2.4 Selecting a Position Encoder and Required Interference of Controller

Criteria Encoder Resolution

The resolution of the position measurement is the smallest detectable position difference. It is a relative variable and characterizes the repetitiveness of the position detection process.

Note: Absolute precision of position detection is fixed by the mechanical precision of the encoder system!

Position resolution depends on:

- cycle number of encoder revolution with rotary encoders or grid constants with linear encoders
- mechanical arrangement of position encoders
- resolution of electronic position signal evaluation

Spindle Motor, Position Encoder and Rotor on the same Shaft

Encoder with sinusoidal signals

$$position\ \ resolution = \frac{1}{Z * A}$$

$$A = 32768,\ \ if\ \ \frac{2^{31}}{Z} \geq 2^{15},\ \ else$$

$$= 2^{n}\,(next\ \ smallest\ \ 2^{n}\,than\ \ \frac{2^{31}}{Z})$$

Z: cycle number of electrical signals of a position encoder track per revolution of position encoder

A: factor, see above

Fig. 2-18: Resolution calculation for spindle motors with direct measuring system and position encoder with sinusoidal signals

Encoder with square-wave signals ($5V_{TTL}$)

$$position\ \ resolution = \frac{1}{4 * Z}$$

Z: cycle number of electrical signals of a position encoder track per revolution of position encoder

Fig. 2-19: Resolution calculation for spindle motors with direct measuring system and position encoder with square-wave signals ($5V_{TTL}$)

Rotary Servo Motors, Position Encoder on the Motor Shaft

Encoder with sinusoidal signals

$$position\ resolution = \frac{c_{feed}}{Z * A}$$

$$A = 32768,\ if\ \frac{c_{feed} * 2^{31}}{X_{total} * Z} \geq 2^{15},\ else$$

$$= 2^{n} (next\ smallest\ 2^{n}\ than\ \frac{c_{feed} * 2^{31}}{X_{total} * Z})$$

c_{feed}: feed constant in mm/motor revolution
Z: cycle number of electrical signals of a position encoder track per revolution of position encoders
X_{total}: total travel path in mm
A: factor, see above

Fig. 2-20: Resolution calculation in servo motors with position encoder on the motor shaft and sinusoidal signals

Encoder with square-wave signals ($5V_{TTL}$)

$$postion\ resolution = \frac{c_{feed}}{4 * Z}$$

c_{feed}: feed constant in mm/motor revolution
Z: cycle number of electrical signals of a position encoder track per revolution of position encoders

Fig. 2-21: Resolution calculation in servo motors with position encoder on the motor shaft and square-wave signals

Note: The control of servo motors via a position encoder with square-wave signals is not to be recommended. Control via position encoder with sinusoidal signals is better!

Linear Motor, Linear Encoder

Encoder with sinusoidal signals

$$position\ resolution = \frac{GK}{A}$$

$$A = 32768,\ if\ \frac{GK * 2^{31}}{X_{total} * 10^{3}} \geq 2^{15},\ else$$

$$= 2^{n} (next\ smallest\ 2^{n}\ than\ \frac{GK * 2^{31}}{X_{total} * 10^{3}})$$

GK: Grid constant of position encoder in µm
X_{total}: total travel path in mm
A: factor, see above

Fig. 2-22: Resolution computation of linear motors with linear encoder and sinusoidal signals

Encoder with square-wave signals ($5V_{TTL}$)

Note: The control of linear motors via position encoder with square-wave signals is not to be recommended.

Criteria Max. Speed / Max. Velocity

Position encoder makes the position of a movable mechanical arrangement available in the form of a signal or a combination of several electrical signals.

Position changes are detected due to the change of the position encoder signal. Continuous changes of the position cause cyclic changes of the position encoder signals. Constant speed or velocity generate constant output frequencies of the position encoder signals.

Rotary position encoder

$$f = \frac{n * Z}{60}$$

f: output frequency of the position encoder signals in Hz
n: speed of position encoders in min^{-1}
Z: cycle number of electrical signals of a position encoder track per revolution of encoder shaft

Fig. 2-23: Output frequency of the electrical signals with rotary encoders

Linear position encoder

$$f = \frac{v * 10^6}{GK * 60}$$

f: output frequency of the position encoder signals in Hz
v: travel speed in m/min
GK: Grid constant of position encoder in µm

Fig. 2-24: Output frequency of the electrical signals in linear encoders

At maximum speed or velocity the maximum allowed input frequency of the position encoder interface may not be exceeded!

Pos. enc. type	ECODRIVE03		DIAX03/04	
	Interface	**f_{Max} /kHz**	**Interf.**	**f_{Max} /kHz**
EnDat	X8	200	DAG01.2M	200
GDS/GDM	X4	75	X4	75
High-res. enc.	-	-	DZF02.1M	110
Gearwheel enc. $1V_{SS}$	X8	110	DZF03.1M	110
Incremental enc. sinusoidal $1V_{SS}$ or $11\mu A_{SS}$	X8	200 150	DLF01.1M	400 150
Incremental enc. Square-wave $5V_{TTL}$	X8	500	DEF01.1M	1000
Resolver	X4	4	X4	4

X4, X8 are standard interfaces of controllers, D●● are special plug in modules that can be used with DIAX03/04.

Fig. 2-25: Maximum input frequencies of position encoder interfaces

3 Commissioning

3.1 Some Basics

Commissioning third-party motors with INDRAMAT controllers is the responsibility of the customer who must also take care of documentation and administration of all parameters.

Commissioning the motor

This section supports the management of this task. The help, however, relates only to specific motor parameter aspects during the commissioning of the drive.

Note: Indramat does not guarantee the power data of the motor shaft of third-party motors!

Commissioning drive functions

When commissioning drive functions use the document on the drive firmware used. The function descriptions of various firmware types are available as either Windows help files or manuals.

Indramat's customer service can help with commissioning. Indramat also offers training in this area.

3.2 Procedures

1st Determine parameter values

The values for specific parameters of asynchronous motors and synchronous motors should be determined before commissioning and be based on the information from the motor manufacturer.

This means it is necessary to use the form on the output data of the motor supplied by the manufacturer („Form for Output Data of Asynchronous Motors", see section 4.3 or „Form for Output Data of Synchronous Motors", see section 4.4)

To determine specific parameter values for

- asynchronous motors, see sec. 3.3,
- synchronous motors, see sec. 3.4 and
- position encoder, see sec. 3.5

of this document.

Documentation on the values determined, see attached forms for parameters of asynchronous and synchronous motors („Form Parameter for Asynchronous Motors“, see section 4.6 respectively „Form Parameter for Synchronous Motors“, see section 4.7).

Note: With star-delta switchable motors, the delta switch data are relevant to determining parameters. The controller (only DIAX03/04!) converts drive parameters automatically in this case!

2nd Connecting and commissioning aids

Motor, temperature sensor and position encoder must be wired as specified in the controller documentation.

The commissioning tool DRIVETOP 10VRS (or high versions) must be placed on a PC. Ensure the correct interface connections. Controllers without SERCOS interface must have a battery box for the command value defaults ready!

3rd Switching control voltage on

Once the control voltage is on basic parameter values can be loaded and the determined specific parameter values for the third party motors can be input into the controller.

4th Position encoder function check

Once the control voltage is on, it is also possible to check whether the position encoder valuation is functioning properly or not.

Attention: Make sure that no power can be connected!

In this case, turn the motor shaft of rotary motors manually or the axis carriage with linear motors.

DRIVETOP reads

- the current possibly not-yet referenced actual position values are displayed. Upon moving the position encoder the path covered or the angle must agree with the difference of the actual position value (before and after the movement)!
- the current velocity. With rotary motors there must be positive speed when turning in a clockwise direction (view from the front onto the motor shaft).
  Linear motors must have a positive velocity once the primary section is turned in the direction of the power connection

Attention: Do not switch drive ready for power until the position encoder evaluation is functioning properly!

The signals of the position encoders can be output for tests at the analog outputs as voltage signals (see Function Description of the firmware used).

5th Initial run of the motor

With synchronous motors first the command „D300 Commutation adjustment command“ must be run. If the drive firmware does not supports this command then replace it with the most current firmware version!

The power-ready drive is first run to check the correct command value acceptance using a smaller command value in the seed or velocity control loops.

If this test is positive, then specific parameter values must be checked with load on the motor (see below). If the test is negative, then determine parameter values or the correctness of the output data.

6th Checking parameter values with load

The load test can generally be checked by evaluating speed or velocity and the current paths when accelerating or decelerating the drive as a motor test bench is usually not available.

Checking specific parameter values, see

- asynchronous motors, sec. 3.6
- synchronous motors, sec. 3.7

3.3 Determining Specific Parameter Values for Asynchronous motors

Motor parameters

S-0-0141, Motor type

Type designation of the motor must be entered.

P-0-4014, Motor type

The following motor types can be set:

Motor type	P-0-4014
rotary asynchronous motors with NTC temperature sensor	2
linear asynchronous motor with PTC temperature sensor	4
rotary asynchronous motors with PTC temperature sensor	6

Fig. 3-1: Parameter values „Motor type“

P-0-4011, Switching frequency

See completed form „Form Controller Selection for Third-Party Motors“.

P-0-0018, Number of pole pairs/pole pair distance

See completed form „Form for Output Data of Asynchronous Motors“ respectively „Form for Output Data of Synchronous Motors“.

S-0-0113, Maximum motor speed (nmax)

The velocity command value generated by the controller is limited to this value which may not exceed maximum allowed velocity/speed!

P-0-4004, Magnetizing current

The value for P-0-4004 is the threshold of the magnetizing current of the motor.

$$P-0-4004=\sqrt{2}*I_{Mag}$$

P-0-4004: threshold of the magnetizing current in A

I_{Mag}: specified magnetizing current, rms value in A

Fig. 3-2: Calculating the value for P-0-4004

If there is no value entered in the output data of the asynchronous motor, then the computation can be used to approximate it.

$$P-0-4004=\sqrt{2}*\sqrt{1-(\cos\varphi)^2}*I_{nom}$$

P-0-4004: threshold of the magnetizing current in A

I_{nom}: nominal current of the motor, rms value in A

$\cos\varphi$: power factor with nominal mode

Fig. 3-3: Approximate calculation of value for P-0-4004

P-0-0532, Premagnetization factor

This parameter effects the extent of the idle current (magnetizing current). The value specifies the per cent of the magnetizing current with a motor with no load.

The following values should be used:

Drive applications	Value for P-0-0532
Servo application	100
Spindle application	50

Fig. 3-4: Recommended values for the premagnetization factor

100% premagnetization factors effects high-dynamic torque development of the motor, 50% means less dynamic development and lower heat development of unloaded motor and less noise.

S-0-0111, Motor current at standstill

The standstill current of motor is the threshold of the torque-generating share of the continuous motor current.

The value specified in this parameter is the 100% reference value for die torque limit value S-0-0092 and P-0-0109 (see below).

$$S-0-0111=\sqrt{2}*\sqrt{I_{nom}^2-I_{Mag}^2}$$

S-0-0111: threshold of the torque-generation share of the continuous motor current in A

I_{nom} : nominal current, rms value in A

I_{Mag} : Magnetizing current, rms value, in A

Fig. 3-5: Calculation for spindle motors

$$S-0-0111=\sqrt{2}*\sqrt{I_d^2-I_{Mag}^2}$$

S-0-0111: threshold of the torque-generation share of the continuous motor current in A

I_d : continuous current at standstill, rms value in A

I_{Mag} : Magnetizing current, rms value in A

Fig. 3-6: Linear motor calculation

S-0-0109, Motor peak current

The peak current of the motor is the threshold of the maximum allowed total motor current (magnetic field and torque-generating current!).

A value for the maximum allowed peak current for asynchronous motors is generally not specified. For thermal reasons, the following limit is advisable:

$$S-0-0109=2{,}5*\sqrt{2}*I_{nom}$$

S-0-0109: threshold maximum total motor current in A

I_{nom} : nominal current, rms value in A

Fig. 3-7: Recommendation for rotary motors

$$S-0-0109=2{,}5*\sqrt{2}*I_d$$

S-0-0109: threshold maximum total motor current in A

I_d : continuous current at standstill, rms value in A

Fig. 3-8: Recommendation for linear motors

P-0-4012, Slip factor

The slip factor is the rotor frequency which can generate 100A torque-generating current (threshold) in the motor supply line.

$$P-0-4012=(f_{nom}-\frac{N_{nom}*PPZ*\min}{60*s})*\frac{100}{S-0-0111}$$

P-0-4012:	Slip factor in Hz/100A
S-0-0111:	see above (computation for spindle motors)
f_{nom} :	nominal frequency in Hz
N_{nom} :	Nominal speed in min^{-1}
PPZ:	no. of pole pairs

Fig. 3-9: Calculation for rotary motors

$$P-0-4012=\frac{f_{Id}*100}{S-0-0111}$$

P-0-4012:	Slip factor in Hz/100A
S-0-0111:	see above (computation for linear motors)
f_{Id} :	standstill frequency in Hz

Fig. 3-10: Calculation for linear motors

Current Limit Parameters

S-0-0092, Bipolar torque/force limit value

P-0-0109, Torque/force peak limit

Both parameters effect the maximum current that the controller can generate. The value of these parameters specifies the per cent of the current standstill S-0-0111.

The upper limit of the value range is fixed with the peak motor current S-0-0109 (reduced by the magnetizing current).

The following values should be used:

Drive applications	Value for S-0-0092	Value for P-0-0109
Servo application	max. val.	max. val.
Spindle application	150*)	150*)
*) This value limits peak torque or peak power to 150% of continuous data and ensures a 1.5 fold overload in short-term mode (see current load of controllers).		

Fig. 3-11: Recommended values for S-0-0092 and P-0-0109

Current Control Parameters

S-0-0106, Current loop proportional gain 1

This value depends on the inductance of the motor (including an required chokes) between the motor clamps.

$$S-0-0106=2{,}2*(L_{U-V}+2*L_{Dr})$$

S-0-0106:	Current loop P-gain1 in V/A
L_{U-V} :	inductance of the motor between the clamps in mH
L_{Dr} :	phase inductance of choke ($3xL_{Dr}$) in mH

Fig. 3-12: Calculating the value for S-0-0106

Attention: The value for inductance between the motor clamps can only be used if the rotor has no closed slots (manufacturer's data)!

S-0-0107, Current loop integral action time 1

- For DIAX03/04 set a value of 1.5 ms!
- For ECODRIVE03 the following calculation applies:

$$S-0-0107=\frac{L_{U-V}}{R_{U-V}}$$

S-0-0106:	Current loop P-gain 1 in V/A
L_{U-V}:	inductance of the motor between the clamps in mH
R_{U-V}:	resistance of the motor between the clamps in mΩ

Fig. 3-13: Calculating the value for S-0-0106 for ECODRIVE03

Field weakening Range Parameters

P-0-0530, Slip increase

This parameter determines the strength of the slip in the motor in terms of heat development of the motor windings. The slip increase is only effective if the temperature sensor K227 (NTC) has been mounted in the winding heat of the motor.

The following values depending on the cooling mode of the motor:

Cooling type of the motor	Value for P-0-0530
Uncooled	1.4
Cooled	1.5
Liquid cooling	1.8
Motor without temperature sensor K227	1.0

Fig. 3-14: Values for P-0-0530

P-0-0531, Stall current factor

At high speeds it is necessary to limit the current that the controller can generate to the so-called stall current of the motor. This parameter is used for achieving the highest motor power under favorable effects.

$$P-0-0531=\frac{3600}{PPZ(L_{U-V}+2*L_{Dr})}$$

P-0-0531:	Stall current factor in A/(min*V)
L_{U-V}:	inductance of the motor between the clamps in mH
L_{Dr}:	phase inductance of choke (3xL_{Dr}) in mH
PPZ:	no. of pole pairs of the motor

Fig. 3-15: Calculating the value for P-0-0531

Note: This parameter is relevant for linear motors. It must be left at the default value!

P-0-0533, Flux loop prop. gain

Parameter for flux weakening function for spindle drives.

Value set: 0,5 V/A

Note: This parameter is relevant for linear motors. It must be left at the default value!

P-0-0534, Flux loop integral action time

Parameter for flux weakening function with spindle drives.

Value set: 6000ms

Note: This parameter is relevant for linear motors. It must be left at the default value!

P-0-0535, Motor voltage at no load

Parameter for flux weakening function with spindle drives.

Value set: 80%

Note: This parameter is relevant for linear motors. It must be left at the default value!

P-0-0536 Motor voltage max.

Parameter for flux weakening function with spindle drives.

Value set: 90%

Note: This parameter is relevant for linear motors. It must be left at the default value!

Motor Data Parameters

P-0-4047, Motor inductance

$$P-0-4047 = (L_{U-V} + 2 * L_{Dr})$$

P-0-4047: total inductance of connected motor in mH

L_{U-V}: inductance of the motor between the clamps in mH

L_{Dr}: phase inductance of choke (3xL_{Dr}) in mH

Fig. 3-16: Value for P-0-4047

P-0-4048, Stator resistance

$$P-0-4048 = (R_{U-V} + 2 * R_{Dr})$$

P-0-4048: total resistance of connected motor in Ohm

R_{U-V}: resistance of the motor between clamps at 20°C in Ohm

R_{Dr}: phase resistance of choke at 20°C in Ohm

Fig. 3-17: Value for P-0-4048

Temperature Monitoring Parameters

S-0-0201, Motor warning temperature

Value in °C at which the controller issues a prewarning because of threatening overtemperature shutdown. This value should be set 10K lower than the motor shutdown temperature. This function is only available with NTC temperature sensor (K227).

S-0-0204, Motor shutdown temperature

Value in °C at which the controller shuts the drive down because of overheating. The motor shutdown temperature may equal the maximum allowed temperature for the motor insulation class.

Max. temperature insul. cl. F	**155°C**
Value for S-0-0204	155°C
Value for S-0-0201	145°C

Fig. 3-18: Example of setting for S-0-0201 and S-0-0204 for motor with insulation class F

Velocity Loop Parameters

Initially, the default values are set for the velocity loop parameters. These values must be optimized at the time of commissioning using the function description document of the drive firmware used.

S-0-0100, Velocity loop proportional gain
Default value: 1.0 Asec/rad

S-0-0101, Velocity loop integral action time
Default value: 10ms

P-0-0004, Velocity loop smoothing time constant
Default value: Minimum value of the value range

3.4 Determining Spec. Parameter Values for Synchronous Motors

Motor parameters

S-0-0141, Motor type
Enter type designation of the motor.

P-0-4014, Motor type
The following motor types can be set:

Motor type	P-0-4014
lin. synchronous motors with PTC temperature sensor	3
rot. synchronous motors with PTC temperature sensor	7

Fig. 3-19: Values for Parameter „Motor type“

P-0-4011, Switching frequency
See completed form „Form Controller Selection for Third-Party Motors“.

P-0-0018, Number of pole pairs/pole pair distance
See completed form „Form for Output Data of Asynchronous Motors“ respectively „Form for Output Data of Synchronous Motors“.

S-0-0113, Maximum motor speed (nmax)
The velocity command value generated by the controller is limited to this value which may not exceed the maximum allowed velocity (speed) of the motor!

P-0-0508, Commutation offset
This value that ensures the correct commutation of the synchronous motors is determined at commissioning.

S-0-0111, Motor current at standstill
The standstill current of motor is the threshold of the allowed continuous motor current.

The value entered in this parameter is the 100% reference value for die torque limit value S-0-0092 and P-0-0109 (see below).

$$S-0-0111 = I_{nom}$$

S-0-0111: threshold of the continuous motor current in A
I_{nom}: nominal current, threshold in A

Fig. 3-20: Value for spindle motors

$$S-0-0111 = I_d$$

S-0-0111: threshold of the continuous motor current in A
I_d: continuous current at standstill, threshold in A

Fig. 3-21: Value for linear motors

S-0-0109, Motor peak current

The peak current of the motor is the threshold of the maximum allowed motor current.

The value for the maximum allowed peak current for synchronous motors is generally fixed with the de-magnetizing current.

$$S-0-0109 \leq I_{max}$$

S-0-0109:	threshold maximum total motor current in A
I_{max} :	maximum current, threshold in A

Fig. 3-22: Maximum current for synchronous motors

Current Limit Parameters

S-0-0092, Bipolar torque/force limit value, P-0-0109, Torque/force peak limit

Both parameters effect the maximum current that the controller can generate. The values of this parameter specify the per cent of the standstill current S-0-011.

The upper value range limit is fixed by the peak current of the motor S-0-0109.

Use the following values:

Drive applications	**Value for S-0-0092**	**Value for P-0-0109**
Servo application	max. val.	max. val.
Spindle application	150*)	150*)
*) This value limits peak torque or peak power to 150% of continuous data and ensures a 1.5 fold overload in short-term mode (see current load of controllers).		

Fig. 3-23: Recommended values for S-0-0092 and P-0-0109

Current Control Parameters

S-0-0106, Current loop proportional gain 1

This value depends on the motor inductance (including chokes) between the motor clamps.

$$S-0-0106 = 2{,}2*(L_{U-V} + 2 * L_{Dr})$$

S-0-0106:	Current loop proportional gain 1 in V/A
L_{U-V} :	inductance of the motor between the clamps in mH
L_{Dr} :	phase inductance of choke (3xL_{Dr}) in mH

Fig. 3-24: Calculating the value for S-0-0106

S-0-0107, Current loop integral action time 1

- For DIAX03/04 set value at 1.5ms!
- For ECODRIVE03 the following calculation applies:

$$S-0-0107 = \frac{L_{U-V}}{R_{U-V}}$$

S-0-0107:	Current loop integral action time 1 in ms
L_{U-V} :	inductance of the motor between the clamps in mH
R_{U-V} :	resistance of the motor between the clamps in mΩ

Fig. 3-25: Calculating the value for S-0-0107 at ECODRIVE03

Motor Data Parameters

P-0-4047, Motor inductance

$$P - 0 - 4047 = (L_{U-V} + 2 * L_{Dr})$$

P-0-4047:	total inductance of connected motor in mH
L_{U-V} :	inductance of the motor between the clamps in mH
L_{Dr} :	phase inductance of choke (3xL_{Dr}) in mH

Fig. 3-26: Value for P-0-4047

P-0-4048, Stator resistance

$$P - 0 - 4048 = (R_{U-V} + 2 * R_{Dr})$$

P-0-4048:	total resistance of connected motor in Ohm
R_{U-V} :	resistance of the motor between clamps at 20°C in Ohm
R_{Dr} :	phase resistance of choke at 20°C in Ohm

Fig. 3-27: Value for P-0-4048

P-0-0051, Torque/force constant

Torque constants in warm motors and nominal current or continuous current at standstill.

- Value in Nm/$A_{(threshold)}$ for rotary motors (constant torque range!)
- Value in N/$A_{(threshold)}$ for linear motors

Temperature Monitoring Parameters

S-0-0201, Motor warning temperature

Value in °C at which controller generates a prewarning as overtemperature shutdown is threatening. This value should be set to 10°C below the motor shutdown temperature. This function cannot be used in synchronous motors because of the features of the PTC temperature sensor!

S-0-0204, Motor shutdown temperature

Value in °C at which controller shuts drive down due to overheating. The motor shutdown temperature may equal the maximum allowed temperature for the motor insulation class.

Max. temperature of insulation class F	**155°C**
Value for S-0-0204	155°C
Value for S-0-0201	145°C

Fig. 3-28: Example of setting for S-0-0201 and S-0-0204 for motor with insulation class F

Velocity Loop Parameters

Initially only default values are used for the velocity loop parameters. When commissioning, see the function description of the drive firmware used.

S-0-0100, Velocity loop proportional gain

Default value: 1.0 Asec/rad

S-0-0101, Velocity loop integral action time

Default value: 10ms

P-0-0004, Velocity loop smoothing time constant

Default value: Minimum value of the value range

3.5 Determine Specified Parameter Values for the Position Encoder System

To correctly evaluate the position encoder system the specified parameters must be set to the relevant values.

These values are listed for commissioning in the function description of the drive firmware used in terms of the hardware.

The specified parameters are:

- P-0-0074, Feedback 1 type
- S-0-0116, Feedback 1 Resolution
- S-0-0277, Position feedback 1 type

3.6 Checking Specified Parameter Values for Asynchronous Motors

(In preparation)

3.7 Checking Specified Parameter Values for Synchronous Motors

(In preparation)

Notes

4 Attachment

4.1 Current Data of Controllers for Servo Applications

Output current diagram of controllers for servo applications

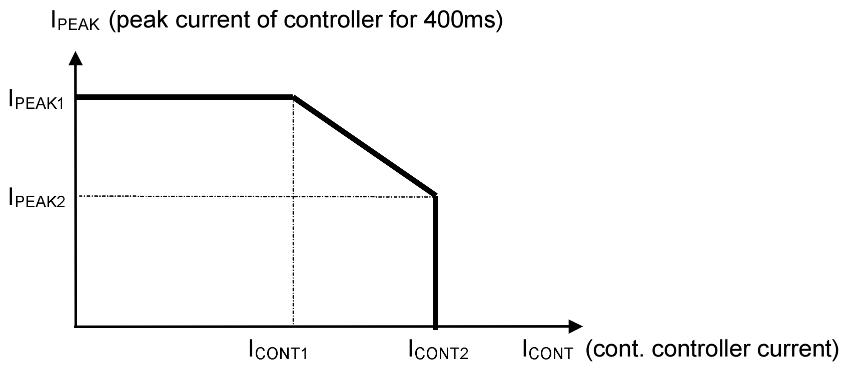


Fig. 4-1: Output current diagram of controllers

DDS	PWM	i_{PEAK1}	i_{CONT1}	i_{PEAK2}	i_{CONT2}
DDS2.2-W50	4 kHz	50 A	50 A	50 A	50 A
DDS2.2-W100	4 kHz	100 A	60 A	80 A	80 A
DDS2.2-W200	4 kHz	200 A	65 A	90 A	90 A
DDS2.2-A100	4 kHz	100 A	100 A	100 A	100 A
DDS2.2-A200	4 kHz	200 A	100 A	120 A	120 A

Fig. 4-2: Output current data for DDS2.2

HDS	PWM	i_{PEAK1}	i_{CONT1}	i_{PEAK2}	i_{CONT2}
HDD2.2-W040	4 kHz	40.0 A	9.3 A	15.0 A	15.0 A
	8 kHz	40.0 A	4.0 A	9.5 A	9.5 A
HDS2.2-W040	4 kHz	40.0 A	15.0 A	20.0 A	20.0 A
	8 kHz	40.0 A	9.8 A	15.0 A	15.0 A
HDS3.2-W075	4 kHz	75.0 A	25.0 A	40.0 A	40.0 A
	8 kHz	75.0 A	21.0 A	30.0 A	30.0 A
HDS3.2-W100	4 kHz	100.0 A	30.0 A	50.0 A	50.0 A
	8 kHz	100.0 A	17.5 A	35.0 A	35.0 A
HDS4.1-W200	4 kHz	200.0 A	45.0 A	84.0 A	84.0 A
	8 kHz	200.0 A	25.0 A	50.0 A	50.0 A
HDS4.2-W200	4 kHz	200.0 A	70.0 A	120.0 A	120.0 A
	8 kHz	200.0 A	45.0 A	80.0 A	80.0 A

Fig. 4-3: Output current data for HDD/HDS

DKR	PWM	i_{PEAK1}	i_{CONT1}	i_{PEAK2}	i_{CONT2}
DKR2.1-W200	4 kHz	200.0 A	167 A	169.0 A	169.0 A
	8 kHz	200.0 A	114 A	134.0 A	134.0 A
DKR2.1-W300	4 kHz	300.0 A	180 A	200.0 A	200.0 A
	8 kHz	300.0 A	123 A	157.0 A	157.0 A
DKR3.1-W100	4 kHz	100.0 A	100 A	100.0 A	100.0 A
	8 kHz	100.0 A	82 A	85.0 A	85.0 A
DKR3.1-W200	4 kHz	200.0 A	111 A	130.0 A	130.0 A
	8 kHz	200.0 A	87 A	110.0 A	110.0 A
DKR4.1-W300	4 kHz	300.0 A	251 A	261.0 A	261.0 A
	8 kHz	300.0 A	155 A	186.0 A	186.0 A
DKR4.1-W400	4 kHz	400.0 A	278 A	301.0 A	301.0 A
	8 kHz	400.0 A	168 A	212.0 A	212.0 A

Fig. 4-4: Output current data for DKR

DKC	PWM	i_{PEAK1}	i_{CONT1}	i_{PEAK2}	i_{CONT2}
DKC**.3-40	4 kHz	40.0 A	13.0 A	16.0 A	16.0 A
	8 kHz	40.0 A	9.0 A	12.5 A	12.5 A
DKC**.3-100	4 kHz	100.0 A	32.0 A	40.0 A	40.0 A
	8 kHz	100.0 A	21.0 A	32.0 A	32.0 A

Fig. 4-5: Output current data for DKC

4.2 Current Data of Controllers for Main Spindle Applications

Output current path for lathes

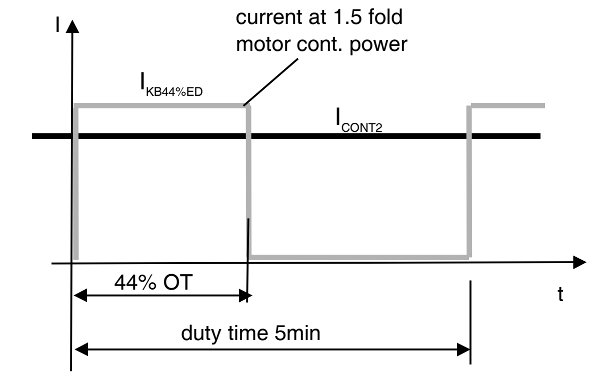


Fig. 4.6: Output current path for main spindle drives

I_{CONT2} threshold of the continuous current

$I_{KB44\%ED}$ threshold of the short term operating current at 44% operating time

Output current path for milling spindles

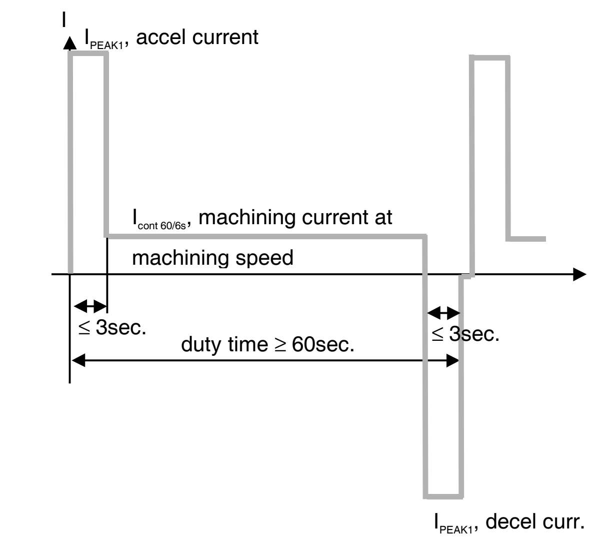


Fig. 4.7: Typical output current path for milling spindle drives

I_{PEAK1} threshold of peak current

$I_{CONT60/6s}$ threshold of the available continuous current at I_{PEAK1} for ≤6sec. and ≥60sec. duty cycle time

Note: For spindle motors the rms values of the nominal current are usually specified. Note conversion of thresholds!

$$I = \sqrt{2} * I_{nom}$$

I_{nom}: nominal current of the spindle motor, rms value in A
I: threshold

Fig. 4.8: Threshold computation

Controller (PWM freq. 4kHz)	Data for lathes (Duty cycle time ≤5min)		Data for milling spindles (Duty cycle time ≥60s)	
	I_{CONT2} (A)	$I_{KB44\%ED}$(A)	I_{PEAK1} (A) ≤6sec.	$I_{CONT\ 60/6s}$(A)
DDS02.2-W050	50	50	50	50
DDS02.2-W100	75	80	100	56
DDS02.2-W200	92	100	200	34
DDS02.2-A100	100	100	100	97
DDS02.2-A200	120	136	200	44

Fig. 4.9: Current data for DDS02.2 with 4kHz PWM frequency

Controller (PWM freq. 4kHz)	Data for lathes (Duty cycle time ≤5min)		Data for milling spindles (Duty cycle time ≥60s)	
	I_{CONT2} (A)	$I_{KB44\%ED}$(A)	I_{PEAK1} (A) ≤6sec.	$I_{CONT\ 60/6s}$(A)
HDD02.1-W040N HDD02.2-W040N	15	16	40	--
HDS02.1-W040N HDS02.2-W040N	20	21	40	9
HDS03.1-W075N HDS03.2-W075N	40	48	75	23
HDS03.1-W100N HDS03.2-W100N	50	60	100	28
HDS04.1-W200N HDS04.2-W200N	84 120	110 140	200 200	45 73

Fig. 4.10: Current data for HDD/HDS with 4kHz PWM frequency

Controller (PWM freq. 8kHz)	Data for lathes (Duty cycle time ≤5min)		Data for milling spindles (Duty cycle time ≥60s)	
	I_{CONT2} (A)	$I_{KB44\%ED}$(A)	I_{PEAK1} (A) ≤6sec.	$I_{CONT\ 60/6s}$(A)
HDD02.1-W040N HDD02.2-W040N	9,5	11	26	--
HDS02.1-W040N HDS02.2-W040N	15	16	40	1
HDS03.1-W075N HDS03.2-W075N	30	36	75	8
HDS03.1-W100N HDS03.2-W100N	35	42	100	6
HDS04.1-W200N HDS04.2-W200N	50 80	65 95	200 200	0 7

Fig. 4.11: Current data for HDD/HDS with 8kHz PWM frequency

Controller (PWM freq. 4kHz)	Data for lathes (Duty cycle time ≤5min)		Data for milling spindles (Duty cycle time ≥60s)	
	I_{CONT2} (A)	$I_{KB44\%ED}$(A)	I_{PEAK1} (A) ≤6sec.	$I_{CONT\ 60/6s}$(A)
DKR03.1-W100-...	100	100	100	100
DKR03.1-W200-...	130	159	200	78
DKR02.1-W200-...	169	200	200	150
DKR02.1-W300-...	200	247	300	132
DKR04.1-W300-...	261	300	300	235
DKR04.1-W400-...	301	400	400	238

Fig. 4.12: Current data for DKR with 4kHz PWM frequency

Controller (PWM freq. 8kHz)	Data for lathes (Duty cycle time ≤5min)		Data for milling spindles (Duty cycle time ≥60s)	
	I_{CONT2} (A)	$I_{KB44\%ED}$(A)	I_{PEAK1} (A) ≤6sec.	$I_{CONT\ 60/6s}$(A)
DKR03.1-W100-...	85	100	100	76
DKR03.1-W200-...	110	136	200	45
DKR02.1-W200-...	134	160	200	72
DKR02.1-W300-...	157	191	300	53
DKR04.1-W300-...	186	247	300	107
DKR04.1-W400-...	212	288	400	93

Fig. 4.13: Current data for DKR with 8kHz PWM frequency

Controller (PWM freq. 4kHz)	Data for lathes (Duty cycle time ≤5min)		Data for milling spindles (Duty cycle time ≥60s)	
	I_{CONT2} (A)	$I_{KB44\%ED}$(A)	I_{PEAK1} (A) ≤6sec.	$I_{CONT\ 60/6s}$(A)
DKC**.3-040-...	16	22,5	40	5
DKC**.3-100-...	40	60	100	12

Fig. 4.14: Current data for DKC with 4kHz PWM frequency

Controller (PWM freq. 8kHz)	Data for lathes (Duty cycle time ≤5min)		Data for milling spindles (Duty cycle time ≥60s)	
	I_{CONT2} (A)	$I_{KB44\%ED}$(A)	I_{PEAK1} (A) ≤6sec.	$I_{CONT\ 60/6s}$(A)
DKC**.3-040-...	12,5	17,5	40	--
DKC**.3-100-...	32	48,5	100	--

Fig. 4.15: Current data for DKC with 8kHz PWM frequency

4.3 Form for Output Data of Asynchronous Motors

Manufacturer, Motor type:________________________ Customer, Facility, Axis designation:________________

Electrical data of the asynchronous motor

Name	Symbol	Unit	Value	See pg.
nominal power[1)]	P_{nom}	kW		
nominal torque[1)]	M_{nom}	Nm		
nominal current[1)]	I_{nom}	A_{eff}		
power factor[1)]	cos□□			
magnetizing curr.	I_{Mag}	A_{eff}		
nominal speed[1)]	n_{nom}	min^{-1}		
nominal frequency[1)]	f_{nom}	Hz		
nominal voltage[1)]	U_{nom}	V_{eff}		
continuous current at standstill[2)]	I_d	A_{eff}		
frequency for I_d[2)]	f_{Id}	Hz		
max. speed[1)]/ velocity[2)]	n_{Max} v_{Max}	min^{-1} m/min		
Max. frequency	f_{Max}	Hz		
no. of pole pairs[1)] or pole width[2)]	PPZ	-		
	PWT (N.pole-N.pole)	mm		
circuit type	(Y,Δ)	-		
inductance	L_{U-V} /L_{V-W} /L_{W-U}	mH		2-9
Windings resistance	R_{U-V} /R_{V-W} /R_{W-U}	mΩ		
Allowed periodic peak voltage	$\hat{u}_{Max\ all.}$	V_{SS}		2-8
Allowed voltage increase	du/dt $_{all.}$	kV/Δs		2-8
Cooling type	(without/with blower/ liquid cooling)	-		
Motor type	rotary / linear	-		
do rotor/secondary part have closed slots?		Y / N		

Fig. 4.16: Motor data ([1)] only with spindle motors; [2)] only with linear motors)

Temperature sensor data

PTC? NTC? Switch contact?	
Type designations?	
How often and where built-in?	
Features?	

Fig. 4.17: Temperature sensor data

Motor feedback

Already fixed? yes / no (if „yes“, Please fill out!)

Type/Standard?	
Signal amplitude?	
Signal form?	
Cycles/revolution? increments/µm?	
Construct? (built-on/mounted type?)	
Manufacturer?	

Fig. 4.18: Motor feedback data

Name Data Signature

4.4 Form for Output Data of Synchronous Motors

Manufacturer, Motor type:________________________ Customer, Facility, Axis designation:________________

Electrical data of synchronous motors

Name	Symbol	Unit	Value	See pg.
Nominal power[1)]	P_{nom}	kW		
nominal torque[1)]	M_{nom}	Nm		
Nominal speed[1)]	N_{nom}	min^{-1}		
nominal current[1)]	I_{nom} (threshold)	A		
nominal voltage[1)]	U_{nom}	V_{eff}		
continuous current at standstill[2)]	I_d (threshold)	A		
nominal force[2)]	F_{nom}	Nm		
maximum current	I_{max} (threshold)	A		
maximum torque[1)] / maximum force [2)]	M_{max} F_{max}	Nm N		
max. speed[1)] / velocity[2)]	n_{Max} v_{Max}	min^{-1} m/min		
Max.frequency	f_{Max}	Hz		
no. of pole pairs[1)] or	PPZ	-		
pole width[2)]	PWT (N.pol-N.pol)	mm		
circuit type	(Y,Δ)	-		
inductance	L_{U-V} /L_{V-W} /L_{W-U}	mH		2-9
windings resistance	R_{U-V} /R_{V-W} /R_{W-U}	mΩ		
Allowed periodic peak voltage	$\hat{u}_{Max\ all.}$	V_{SS}		2-8
Allowed voltage increase	$du/dt_{all.}$	kV/µs		2-8
Cooling type	(without/with blower/ liquid cooling)	-		
Motor type	rotary / linear	-		

Fig. 4.19: Motor data ([1)] only with spindle motors; [2)] only with linear motors)

Temperature sensor data

PTC? NTC? Switch contact?	
Type designations?	
How often and where built-in?	
Features?	

Fig. 4.20: Temperature sensor data

Motor feedback

Already fixed? yes / no (if „yes“, Please fill out!)

Type/Standard?	
Signal amplitude?	
Signal form?	
cycles/revolution? increments/µm	
Construct? (built-on/mounted type?)	
Manufacturer?	

Fig. 4.21: Motor feedback data

Name Data Signature

4.5 Form Controller Selection for Third-Party Motors

Manufacturer, Motor type:________________________ Customer, Facility, Axis designation:________________

Checkpoints for motor/controller combinations	**Controller data**		**Motor data**		**ok?**
Output current of the controller (see sec. 2.2)					
Servo application	PWM/kHz				
(Attention: Controller current data are threshold values!)	I_{PEAK}/A		I_{accel}/A		
	I_{CONT}/A		I_{feed}/A		
Main spindle applications	PWM/kHz				
(Attention: Controller current data are threshold values!)			I_{nom}/A_{eff}		
	$I_{KB44\%ED}$/A		1,5x I_{nom} /$A_{SS/2}$		
Output voltage and output frequency (see sec. 2.2)					
Servo application	U_{ACOUT}/V_{eff}	3xAC	U_{Max}/V_{eff}	3xAC	
(Attention: for accel to maximum speed voltage drop in motor windings must be taken into account!)			n_{Max}/min^{-1} (v_{Max}/m/min)		
	f_{MaxOUT}/Hz		f_{Max}/Hz		
	max. Value		PPZ or PWT in mm		
Main spindle applications	U_{ACOUT}/V_{eff}	3xAC	U_{Nenn}/V_{eff}	3xAC	
(Attention: for short term modes nominal speed voltage drop in motor windings must be taken into account!)			P_{Nenn}/kW		
			n_{Nenn}/min^{-1}		
			f_{Nenn}/Hz		
	f_{MaxOUT}/Hz		f_{Max}/Hz		
	max. Value		PPZ		
Windings voltage resistance and motor Inductance (see sec. 2.3)					
	$\hat{u}_{max}$/V		$\hat{u}_{max\ all.}$ /V		
	du/dt / kV/µs		du/dt $_{zul.}$ / kV/µs		
	L_{min}/mH		L_{Mot}/mH		
Temperature evaluation (see sec. 2.3)					
(In SY motors up to three temperature sensors in a row are possible!)	SY-Mot.	SNM150-DK	Temperature sensor		
	ASY-Mot.	K227			
Position encoder evaluation (see sec. 1.4 and 2.4)					
Type/standard					
Signal amplitude					
Signal form					
Cycles/revolution					
Construct (built-on/mounted type)					
Manufacturer					
Selected controller/ power supply:________________________ (PWM frequency/kHz:____) direct mains voltage:____________					
Mechanical contin. Output power (also see Section 2.2)	$P_{mechRG+V}$		$P_{mech\ Mot.}$		
Continuous feedback power (also see Section 2.2)	P_{cont_back}		$P_{back\_\ Mot.}$		

____

Name Data Signature

4.6 Form Parameter for Asynchronous Motors

Manufacturer, Motor type:__________________________ Customer, Facility, Axis designation:_________________

Para. No.	Parameter Name	Det. Value	Progr. Value	Unit	see page
Motor parameters					
S-0-0141	Motor type				
P-0-4014	Motor type				3-3
P-0-4011	Switching frequency			kHz	Contr. sel.
P-0-0018	Number of pole pairs/pole pair distance			PPZ/mm	motor data
S-0-0113	Maximum motor speed (nmax)				motor data
P-0-4004	Magnetizing current			A	3-3, 3-3
P-0-0532	Premagnetization factor	100		%	3-4
S-0-0111	Motor current at standstill			A	3-4, 3-4
S-0-0109	Motor peak current			A	3-4, 3-4
P-0-4012	Slip factor			Hz/100A	3-5, 3-5
Current limit parameter					
S-0-0092	Bipolar torque/force limit value	(150)		%	3-5
P-0-0109	Torque/force peak limit	(150)		%	3-5
Current control parameters					
S-0-0106	Current loop proportional gain 1			V/A	3-5
S-0-0107	Current loop integral action time 1			ms	3-5
Field weakening range parameters					
P-0-0530	Slip increase			1/100K	3-6
P-0-0531	Stall current factor			A/Vmin	3-6
P-0-0533	Flux loop prop. Gain	0.500		A/V	3-6
P-0-0534	Flux loop integral action time	6000.0		ms	3-7
P-0-0535	Motor voltage at no load	80.0		%	3-7
P-0-0536	Motor voltage max.	90.0		%	3-7
Motor data					
P-0-4047	Motor inductance			mH	3-7
P-0-4048	Stator resistance			Ohm	3-7
Temperature monitoring parameters					
S-0-0201	Motor warning temperature			°C	3-7
S-0-0204	Motor shutdown temperature			°C	3-7
Velocity loop parameters					
S-0-0100	Velocity loop proportional gain	1,0		Asec/rad	3-8
S-0-0101	Velocity loop integral action time	10.0		ms	3-8
P-0-0004	Velocity loop smoothing time constant	Min. value		µs	3-8
Position encoder parameters					
P-0-0074	Feedback 1 type				3-11
S-0-0116	Feedback 1 Resolution				3-11
S-0-0277	Position feedback 1 type				3-11

4.7 Form Parameter for Synchronous Motors

Manufacturer, Motor type:___________________________ Customer, Facility, Axis designation:__________________

Parameter no.	Parameter name	Determined Value	Programmed Value	Unit	See page
Motor parameters					
S-0-0141	Motor type				
P-0-4014	Motor type				3-3
P-0-4011	Switching frequency			kHz	
P-0-0018	Number of pole pairs/pole pair distance			PPZ/mm	
S-0-0113	Maximum motor speed (nmax)				
P-0-0508	Commutation offset				
S-0-0111	Motor current at standstill			A	
S-0-0109	Motor peak current			A	
Current limit parameter					
S-0-0092	Bipolar torque/force limit value			%	3-9
P-0-0109	Torque/force peak limit			%	3-9
Current control parameters					
S-0-0106	Current loop proportional gain 1			V/A	3-9
S-0-0107	Current loop integral action time 1			ms	3-9
Motor data					
P-0-4047	Motor inductance			mH	3-10
P-0-4048	Stator resistance			Ohm	3-10
P-0-0051	Torque/force constant			N(m)/A	
Temperature monitoring parameters					
S-0-0201	Motor warning temperature			°C	3-10
S-0-0204	Motor shutdown temperature			°C	3-10
Velocity loop parameters					
S-0-0100	Velocity loop proportional gain	1,0		Asec/rad	3-8
S-0-0101	Velocity loop integral action time	10.0		ms	3-8
P-0-0004	Velocity loop smoothing time constant	Min. value		µs	3-8
Position encoder parameters					
P-0-0074	Feedback 1 type				3-11
S-0-0116	Feedback 1 Resolution				3-11
S-0-0277	Position feedback 1 type				3-11

Name Data Signature

5 Index

I

L

M

N

O

P

R

S

T

V

W

Notes

Kundenbetreuungsstellen - Sales & Service Facilities

Deutschland – Germany

vom Ausland: (0) nach Landeskennziffer weglassen!!
from abroad: don't dial (0) after country code!

Vertriebsgebiet Mitte Germany Centre ☒ SALES ☒ Service INDRAMAT GmbH Bgm.-Dr.-Nebel-Str. 2 D - 97816 Lohr am Main Telefon: +49 (0)9352/40-0 Telefax: +49 (0)9352/40-4885	Vertriebsgebiet Ost Germany East ☒ SALES ☒ Service INDRAMAT GmbH Beckerstraße 31 D - 09120 Chemnitz Telefon: +49 (0)371/35 55-0 Telefax: +49 (0)371/35 55-333	Vertriebsgebiet West Germany West ☒ SALES ☒ Service Mannesmann Rexroth AG Vertrieb Deutschland Regionalzentrum West Borsigstrasse 15 D - 40880 Ratingen Telefon: +49 (0)2102/409-0 Telefax: +49 (0)2102/409-406	Vertriebsgebiet Nord Germany North ☒ SALES ☐ Service INDRAMAT GmbH Kieler Straße 212 D - 22525 Hamburg Telefon: +49 (0)40/85 31 57-0 Telefax: +49 (0)40/85 31 57-15
Vertriebsgebiet Süd Germany South ☒ SALES ☐ Service INDRAMAT GmbH Ridlerstraße 75 D-80339 München Telefon: +49 (0)89/540138-30 Telefax: +49 (0)89/540138-10 indramat.mue@t-online.de	Gebiet Südwest Germany South-West ☒ SALES ☒ Service INDRAMAT GmbH Böblinger Straße 25 D-71229 Leonberg Telefon: +49 (0)7152/9 72-6 Telefax: +49 (0)7152/9 72-727	Vertriebsgebiet Mitte Germany Centre ☒ SALES ☐ Service Mannesmann Rexroth AG Geschäftsbereich INDRAMAT Lillistraße 14-18 D – 63067 Offenbach Telefon: +49 (0) 62/82 00 90-0 Telefax: +49 (0) 62/82 00 90-80	Vertriebsgebiet Nord Germany North ☒ SALES ☐ Service Mannesmann Rexroth AG Vertriebsniederlassung Region Nord Geschäftsbereich INDRAMAT Schützenstraße 20 D – 30853 Langenhagen Telefon: +49 (0) 511/72 66 57-0 Telefax: +49 (0) 511/72 66 57-93
			INDRAMAT Service-Hotline INDRAMAT GmbH Telefon: +49 (0)172/660 04 06 oder/or Telefon: +49 (0)171/333 88 26 Hotline ERSATZTEILE: - nur an Werktagen von 15 -18 Uhr - +49 (0) 93 52/40 42 22

Kundenbetreuungsstellen in Deutschland - Service agencies in Germany

Europa – Europe

<u>vom Ausland</u>: (0) nach Landeskennziffer weglassen, 0 nach Landeskennziffer mitwählen!
<u>from abroad</u>: don't dial (0) after country code, dial 0 after country code!

Austria ☒ SALES ☐ Service Mannesmann Rexroth Ges.m.b.H. Geschäftsbereich INDRAMAT Hägelingasse 3 A - 1140 Wien Telefon: +43 (0)1/9852540-400 Telefax: +43 (0)1/9852540-93	Austria ☒ SALES ☐ Service Mannesmann Rexroth G.m.b.H. Geschäftsbereich INDRAMAT Industriepark 18 A - 4061 Pasching Telefon: +43 (0)7221/605-0 Telefax: +43 (0)7221/605-21	Belgium ☒ SALES ☒ Service Mannesmann Rexroth N.V.-S.A. Geschäftsbereich INDRAMAT Industrielaan 8 B-1740 Ternat Telefon: +32 (0)2/5823180 Telefax: +32 (0)2/5824310	Denmark ☒ SALES ☒ Service BEC AS Zinkvej 6 DK-8900 Randers Telefon: +45 (0)87/11 90 60 Telefax: +45 (0)87/11 90 61
England ☒ SALES ☒ Service Mannesmann Rexroth Ltd. INDRAMAT Division Broadway Lane, South Cerney GB - Cirencester, Glos GL7 5UH Telefon: +44 (0)1285/863000 Telefax: +44 (0)1285/863030	Finland ☒ SALES ☐ Service Rexroth Mecman OY INDRAMAT division SF-017 40 Vantaa Telefon: +358 (0)9/84 91 11 Telefax: +358 (0)9/84 91 13 60	France ☒ SALES ☒ Service Mannesmann Rexroth S.A. Division INDRAMAT Parc of the Barbanniers 4, Place du Village F-92632 Gennevilliers Cedex Telefon: +33 (0)141 47 54 30 Telefax: +33 (0)147 94 69 41 Hotline: +33 (0)6 08 33 43 28	France ☒ SALES ☐ Service Mannesmann Rexroth S.A. Division INDRAMAT 270, Avenue de Lardenne F - 31100 Toulouse Telefon: +33 (0)5 61 49 95 19 Telefax: +33 (0)5 61 31 00 41
France ☒ SALES ☐ Service Mannesmann Rexroth S.A. Division INDRAMAT 91, Bd. Irène Joliot-Curie F - 69634 Vénissieux – Cedex Telefon: +33 (0)4 78 78 53 65 Telefax: +33 (0)4 78 78 52 53	Italy ☒ SALES ☒ Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Via G. Di Vittoria, 1 I - 20063 Cernusco S/N.MI Telefon: +39 02/92 36 52 70 Telefax: +39 02/92 36 55 12	Italy ☒ SALES ☒ Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Via Borgomanero, 11 I - 10145 Torino Telefon: +39 011/7 50 38 11 Telefax: +39 011/7 71 01 90	Italy ☒ SALES ☐ Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Via del Progresso, 16 (Zona Ind.) I - 35020 Padova Telefon: +39 049/8 70 13 70 Telefax: +39 049/8 70 13 77
Italy ☐ SALES ☒ Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Via de Nicola, 12 I - 80053 Castellamare di Stabia NA Telefon: +39 081/8 72 30 37 Telefax: +39 081/8 72 30 18	Italy ☒ SALES ☐ Service Mannesmann Rexroth S.p.A. Divisione INDRAMAT Viale Oriani, 38/A I - 40137 Bologna Telefon: +39 051/34 14 14 Telefax: +39 051/34 14 22	Netherlands ☒ SALES ☐ Service Hydraudyne Hydrauliek B.V. Kruisbroeksestraat 1 (P.O. Box 32) NL - 5281 RV Boxtel Telefon: +31 (0)411/65 19 51 Telefax: +31 (0)411/65 14 83 e-mail: indramat@hydraudyne.nl	Netherlands ☐ SALES ☒ Service Hydrocare B.V. Kruisbroeksestraat 1 (P.O. Box 32) NL - 5281 RV Boxtel Telefon: +31 (0)411/65 19 51 Telefax: +31 (0)411/67 78 14
Norway ☒ SALES ☐ Service Rexroth Mecman AS INDRAMAT Division Berghagan 1 or Box 3007 N–1405 Ski-Langhus N-1402 Ski Telefon: +47 (0)64 86 41 00 Telefax: +47 (0)64 86 90 62	Poland ☒ SALES ☐ Service Mannesmann Rexroth Sp.zo.o. Biuro Poznan ul. Dabrowskiego 81/85 PL – 60-529 Poznan Telefon: +48 061/847 67 99 Telefax: +48 061/847 64 02	Russia ☐ SALES ☒ Service Tschudnenko E.B. Arsenia 22 RUS - 153000 Ivanovo Rußland Telefon: +7 093/223 96 33 oder/or +7 093/223 95 48 Telefax: +7 093/223 46 01	Spain ☒ SALES ☒ Service Mannesmann Rexroth S.A. Divisiòn INDRAMAT Centro Industrial Santiga Obradors s/n E-08130 Santa Perpetua de Mogoda Barcelona Telefon: +34 937 47 94 00 Telefax: +34 937 47 94 01
Spain ☒ SALES ☒ Service Goimendi S.A. División Indramat Jolastokieta (Herrera) Apartado 11 37 E - 20017 San Sebastian Telefon: +34 9 43/40 01 63 Telefax: +34 9 43/39 17 99	Sweden ☒ SALES ☒ Service Rexroth Mecman Svenska AB INDRAMAT Division Varuvägen 7 S - 125 81 Stockholm Telefon: +46 (0)8/727 92 00 Telefax: +46 (0)8/647 32 77	Slowenia ☒ SALES ☒ Service INDRAMAT elektromotorji d.o.o. Otoki 21 SLO - 64 228 Zelezniki Telefon: +386 64/61 73 32 Telefax: +386 64/64 71 50	Turkey ☒ SALES ☒ Service Mannesmann Rexroth Hidropar A..S. Fevzi Cakmak Cad No. 3 TR - 34630 Sefaköy Istanbul Telefon: +90 212/541 60 70 Telefax: +90 212/599 34 07
Switzerland -East- ☒ SALES ☒ Service Mannesmann Rexroth Schweiz AG Geschäftsbereich INDRAMAT Gewerbestraße 3 CH-8500 Frauenfeld Telefon: +41 (0)52/720 21 00 Telefax: +41 (0)52/720 21 11	Switzerland -West- ☒ SALES ☐ Service Mannesmann Rexroth Suisse SA Département INDRAMAT Rue du village 1 CH-1020 Renens Telefon: +41 (0)21/632 84 20 Telefax: +41 (0)21/632 84 21		

Europäische Kundenbetreuungsstellen (ohne Deutschland)
European Service agencies (without Germany)

Außerhalb Europa - outside Europe

vom Ausland: (0) nach Landeskennziffer weglassen!
from abroad: don't dial (0) after country code!

Argentina ☒ SALES ☐ Service Mannesmann Rexroth S.A.I.C. Division INDRAMAT Acassusso 48 41/7 RA - 1605 Munro (Buenos Aires) Telefon: +54 (0)11/4756 01 40 Telefax: +54 (0)11/4762 6862 e-mail:mannesmann@impsat1.com.ar	Argentina ☒ SALES ☒ Service NAKASE Servicio Tecnico CNC Calle 49, No. 5764/66 RA - 1653 Villa Balester Prov. - Buenos Aires Telefon: +54 (0) 11/4768 36 43 Telefax: +54 (0) 11/4768 24 13 e-mail: nakase@usa.net nakase@infovia.com.ar	Australia ☒ SALES ☒ Service AIMS - Australian Industrial Machinery Services Pty. Ltd. Unit 3/45 Horne ST Campbellfield , VIC 3061 AUS - Melbourne Telefon: +61 (0)3/93 59 02 28 Telefax: +61 (0)3/93 59 02 86	Australia ☒ SALES ☐ Service Mannesmann Rexroth Pty. Ltd. No. 7, Endeavour Way Braeside Victoria, 31 95 AUS – Melbourne Telefon: +61 (0)3/95 80 39 33 Telefax: +61 (0)3/95 80 17 33 Email: mel@rexroth.com.au
Brazil ☒ SALES ☒ Service Mannesmann Rexroth Automação Ltda. Divisão INDRAMAT Rua Georg Rexroth, 609 Vila Padre Anchieta BR - 09951-270 Diadema-SP [Caixa Postal 377] [BR-09901-970 Diadema-SP] Telefon: +55 (0)11/745 90 60 +55 (0)11/745 90 70 Telefax: +55 (0)11/745 90 50 e-mail: awittwer@rexroth.com.br	Brazil ☐ SALES ☒ Service Mannesmann Rexroth Automação Ltda. Divisão INDRAMAT Rua Umberto Pinheiro Vieira, 100 Distrito Industrial BR - 09220-390 Joinville - SC [Caixa Postal 1273] Tel./Fax: +55 (0)47/473 55 833 Mobil: +55 (0)47 974 6645 e-mail: prochnow@zaz.com.br	Canada ☒ SALES ☒ Service Basic Technologies Corporation Burlington Division 3426 Mainway Drive Burlington, Ontario Canada L7M 1A8 Telefon: +1 905/335 55 11 Telefax: +1 905/335-41 84	China ☐ SALES ☒ Service Mannesmann Rexroth (China) Ldt. Shanghai Parts & Service Center 199 Wu Cao Road, Hua Cao Minhang District PRC - Shanghai 201 103 Telefon: +86 21/62 20 00 58 Telefax: +86 21/62 20 00 68
China ☒ SALES ☐ Service Mannesmann Rexroth (China) Ldt. 15/F China World Trade Center 1, Jianguomenwai Avenue PRC - Beijing 100004 Telefon: +86 10/65 05 03 80 Telefax: +86 10/65 05 03 79	China ☒ SALES ☐ Service Mannesmann Rexroth (China) Ldt. A-5F., 123 Lian Shan Street Sha He Kou District PRC - Dalian 116 023 Telefon: +86 411/46 78 930 Telefax: +86 411/46 78 932	Hongkong ☒ SALES ☒ Service Rexroth (China) Ldt. 1/F., 19 Cheung Shun Street Cheung Sha Wan, Kowloon, Hongkong Telefon: +852 22 62 51 00 Telefax: +852 27 44 02 78	India ☒ SALES ☒ Service Mannesmann Rexroth (India) Ltd. INDRAMAT Division Plot. 96, Phase III Peenya Industrial Area IND - Bangalore - 560058 Telefon: +91 (0)80/8 39 73 74 Telefax: +91 (0)80/8 39 43 45
India ☒ SALES ☒ Service Mannesmann Rexroth (India) Ltd. INDRAMAT Division Plot. A-58, TTC Industrial Area Thane Turbhe Midc Road Mahape Village IND - Navi Mumbai - 400 701 Telefon: +91 (0)22/7 61 46 22 Telefax: +91 (0)22/7 68 15 31	Indonesia ☒ SALES ☐ Service PT. Rexroth Wijayakusuma Jl. Raya Bekasi Km 21 Pulogadung RI - Jakarta Timur 13920 Telefon: +62 21/4 61 04 87 +62 21/4 61 04 88 Telefax: +62 21/4 60 01 52	Japan ☐ SALES ☒ Service Rexroth Automation Co., Ltd. Service Center Japan Yutakagaoka 1810, Meito-ku, NAGOYA 465-0035, Japan Telefon: +81 (0)52/777 88 41 +81 (0)52/777 88 53 +81 (0)52/777 88 79 Telefax: +81 (0)52/777 89 01	Japan ☒ SALES ☒ Service Rexroth Automation Co., Ltd. INDRAMAT Division 1F, I.R. Building Nakamachidai 4-26-44, Tsuzuki-ku YOKOHAMA 224-0041, Japan Telefon: +81 (0)45/942 72 10 Telefax: +81 (0)45/942 03 41
Mexico ☒ SALES ☐ Service Mannesmann Rexroth Mexico S.A. de C.V. Calle Neptuno 72 Unidad Ind. Vallejo MEX - 07700 Mexico, D.F. Telefon: +52 5 754 17 11 +52 5 754 36 84 +52 5 754 12 60 Telefax: +52 5 754 50 73 +52 5 752 59 43 e-mail: gsoria@rexroth-mexico.com	Korea ☒ SALES ☒ Service Mannesmann Rexroth-Seki Co Ltd. 1500-12 Da-Dae-Dong ROK - Saha-Ku, Pusan, 604-050 Telefon: +82 (0)51/2 60 06 18 Telefax: +82 (0)51/2 60 06 19	Korea ☒ SALES ☒ Service Seo Chang Corporation Ltd. Room 903, Jeail Building 44-35 Yeouido-Dong Yeoungdeungpo-Ku C.P.O.Box 97 56 ROK - Seoul Telefon: +82 (0)2/7 80 82 08 +82 (0)2/7 80 82 09 Telefax: +82 (0)2/7 84 54 08	South Africa ☒ SALES ☒ Service TECTRA Automation (Pty) Ltd. 28 Banfield Road,Industria North RSA - Maraisburg 1700 Telefon: +27 (0)11/673 20 80 Telefax: +27 (0)11/673 72 69
Taiwan ☒ SALES ☐ Service Rexroth Uchida Co., Ltd. No.1, Tsu Chiang Street Tu Cheng Ind. Estate Taipei Hsien, Taiwan, R.O.C. Telefon: +886 2/2 68 13 47 Telefax: +886 2/2 68 53 88			

Kundenbetreuungsstellen außerhalb Europa - Service agencies outside Europe

Außerhalb Europa / USA - outside Europe / USA

USA ☒ SALES ☒ Service Mannesmann Rexroth Corporation INDRAMAT Division 5150 Prairie Stone Parkway USA -Hoffman Estates, IL 60192-3707 Telefon: +1 847/6 45 36 00 Telefax: +1 847/6 45 62 01 E-MAIL: service@indramat.com Service HOTLINE: +1-800-860-1055 -7 days/24hrs-	USA ☒ SALES ☒ Service Mannesmann Rexroth Corporation INDRAMAT Division Central Region Technical Center USA - Auburn Hills, MI 48326 Telefon: +1 248/3 93 33 30 Telefax: +1 248/3 93 29 06	USA ☒ SALES ☒ Service Mannesmann Rexroth Corporation INDRAMAT Division Southeastern Technical Center 3625 Swiftwater Park Drive USA - Suwanee Georgia 30174 Telefon: +1 770/9 32 32 00 +1 770/9 32 19 03	USA ☒ SALES ☒ Service Mannesmann Rexroth Corporation INDRAMAT Division Northeastern Technical Center 99 Rainbow Road USA - East Granby, Connecticut 06026 Telefon: +1 860/8 44 83 77 +1 860/8 44 85 95
USA ☒ SALES ☒ Service Mannesmann Rexroth Corporation INDRAMAT Division Charlotte Regional Sales Office 14001 South Lakes Drive USA - Charlotte, North Carolina 28273 Telefon: +1 704/5 83 97 62 +1 704/5 83 14 86			

Kundenbetreuungsstellen außerhalb Europa / USA
Service agencies outside Europe / USA

Notes

Notes

Notes

Indramat