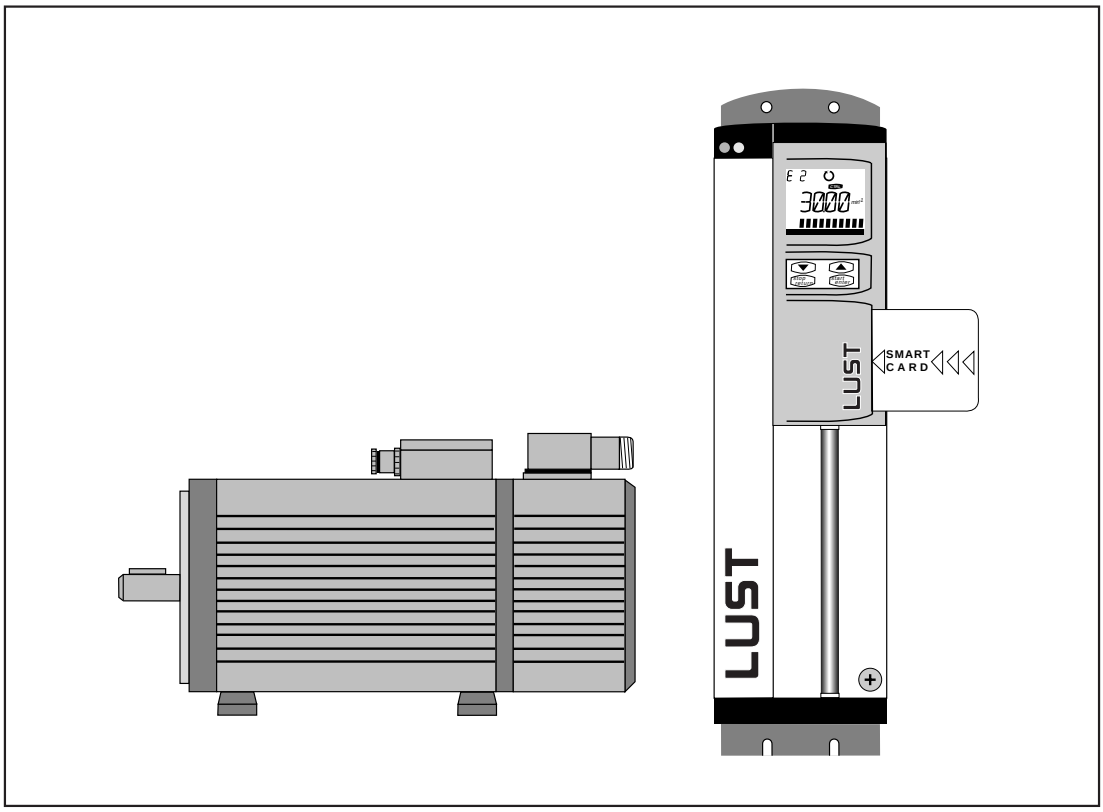
LUST
ANTRIEBSTECHNIK

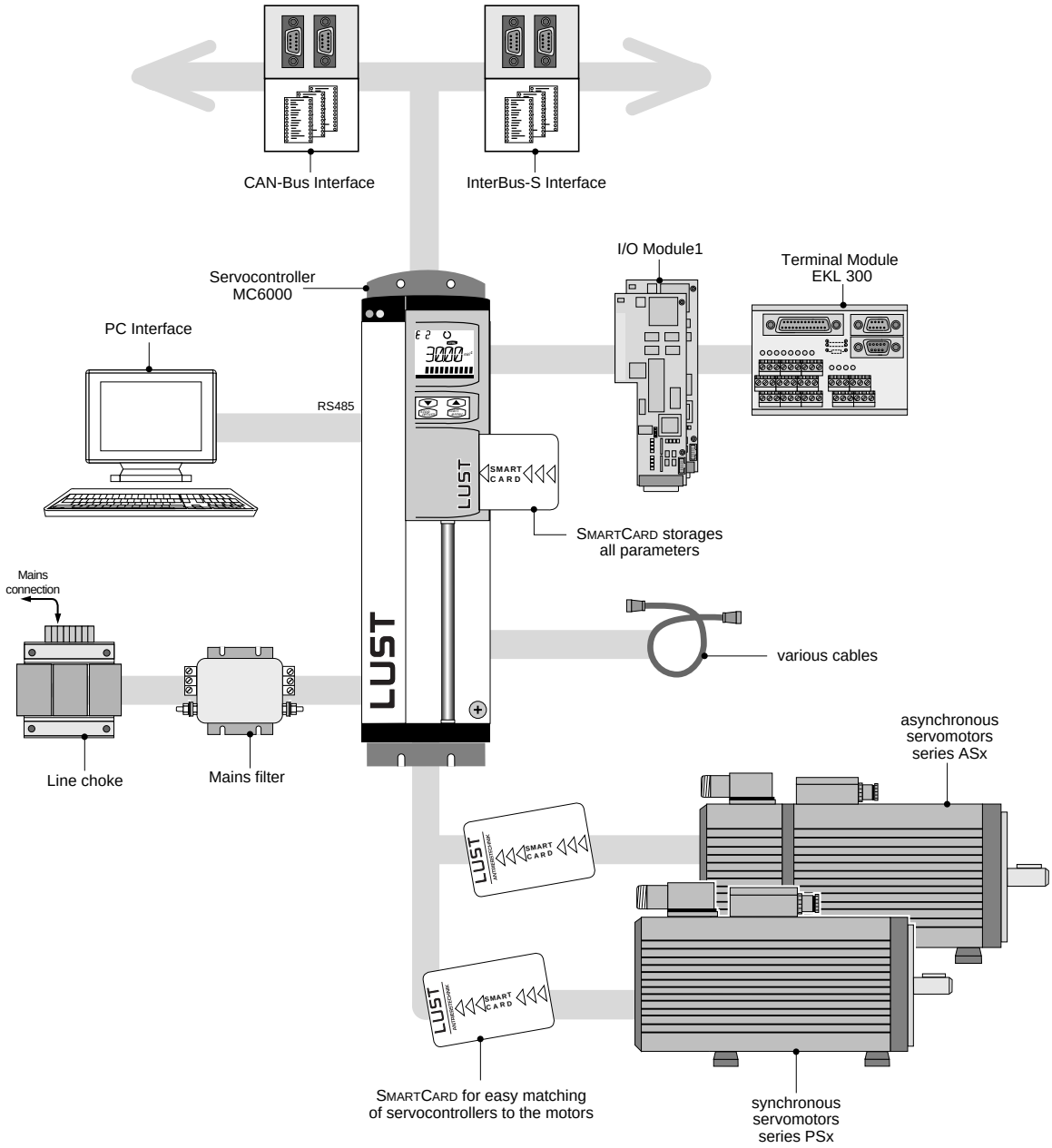
MASTERCONTROL MC6000

Servocontroller 4 - 64 A



Instruction Manual

The MASTERDRIVE System



Instruction Manual
for MC6000 Series
Servocontrollers

Valid from Software-Version: V1.1

Item Number: 0792.20B.0-02
Version: December 1995

We reserve the right to make technical changes

Dear Customer

Thank you for the trust that you have placed in us by purchasing the LUST MASTERDRIVE drive system.

Installation and commissioning must only be carried out by a trained engineer. Please take the time to read the instructions carefully. Following the instructions meticulaously will you time and avoid uncertainty and questions at the commissioning stage.

It is essential to read the Instruction Manual because incorrect use of the servodrive can damage both the servodrive itself and also other parts of the installation. Because of the rotating parts of the drive and the high voltages involved, this type of equipment is potentially hazardous to human life.

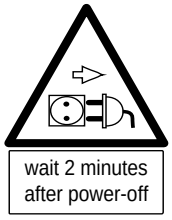
If after reading the instructions you still have questions, do please contact us.

Lust Antriebstechnik GmbH
Gewerbestr. 5-9
D-35631 Lahnau
Germany
Tel: +49 6441 966 -0
Fax: +49 6441 966 -137

Symbols

⇒ Danger! Danger of death by electrocution or rotating machinery.

⇒ Warning: you must follow this instruction.



⇒ Warning: before opening the equipment, disconnect from the mains and wait approximately two minutes for the DC link capacitors to discharge.

⇒ Prohibited: incorrect operation may cause damage to equipment.

⇒ Useful tip, Note.

Signposts

Especially important for commissioning:

Safety Instructions
General, Manufacturer's Declaration, CE and EMC **1**

Technical Specifications of Servocontrollers
Installation Instructions **2**

Installation, Commissiong
Important Instructions for Operation **3**

Electrical Connections **4**
EMC, Connection to the mains power supply, motor, terminals, encoder, RS485 and Bus system

Software Overview **5**

Using KeyPad and SmartCard **6**

Configuration **7**
Assigning input and output functions
Processing of reference values, Emergency Stop etc

Structure of controls **8**
Torque control, speed control and position control

Displays and Error Messages **9**

Parameter Description
by Subject Area **10**

I/O Module 1 and EKL300 **11**

Servomotor Project Data **12**
Technical specifications, dimensional drawings, axial and radial loads, cooling, holding brake, etc

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Parameter Overview (Table)

Quick Finder

1 General

1.1 Safety Instructions

Servodrives have high voltage exposed metal components and may also have moving or rotating parts and hot surfaces, so they do of course represent a danger to human life.

To prevent serious injury or major damage, only qualified personnel who are trained in working on electrical drives may work on the equipment. To be qualified in this sense a person must be familiar with the arrangement, installation, commissioning and operation of Servodrives and possess appropriate qualifications to work on them. He must read the instruction manual in detail before installation and commissioning and must follow the safety instructions at all times. (IEC 364 and CENELEC HD 384 or DIN VDE 0100 and IEC-Report 664 or VDE 0110 and national health and safety regulations or VBG 4)

Repairs to Servodrive components may only be carried out by the manufacturer or by repair centres authorized by the manufacturer. Unauthorized opening of the equipment and unskilled repairs may result in injuries and damage.

1.2 Intended use

Servodrives are equipment designed for incorporating in electrical installations or machines. The commissioning of the Servodrive (ie commencing operation as intended) is prohibited until such time as it has been confirmed that the machine complies with the requirements of EC Directive 89/392/EEC (Machinery Directive). EN60204 must be observed.

Commissioning (ie starting normal intended operation) is only permitted under conditions of strict adherence to the EMC Directive (89/336/EEC).

For the Low Voltage Directive 73/23/EEC the harmonized standards in the series prEN 50178/ DIN VDE 0160 in conjunction with EN 60439-1/DIN VDE 0660 part 500 and EN 60146/DIN VDE 0558 are used for Servodrives.

Technical specifications and connection details should be read off the nameplate and from the documentation and must be strictly observed.

Servodrives must be protected from excessive loads. In particular no components must be distorted or insulation/separation arrangements be changed during transport and handling. Servocontrollers and Servomotors contain electrostatic components which are vulnerable and can easily be damaged by inappropriate handling. Electrical components must not be mechanically damaged or destroyed.

Any work on Servodrives which are live must be strictly in accordance with with currently valid national health and safety regulations (eg VBG 4).

Electrical installation must be carried out in accordance with the applicable regulations (relating to conductor cross section, protection, and protective conductor connection etc). Further details are contained in the documentation.

Electronic equipment is not inherently fail-safe, so the user must accept responsibility for ensuring that the drive cannot become dangerous in case of failure.

If the Servodrive is to be used for special applications (eg in an explosive environment) then the relevant standards and regulations (eg EN50014 and EN50018) **must** be followed.

1.3 Manufacturer's Declaration for Servocontrollers

LUST
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EC - MANUFACTURER'S DECLARATION

(to Art. 4, para. 2 of EC Directive 89/392/EEC)

Document No.:	HE 025
Month, year :	September 1995
Manufacturer:	Company Lust Antriebstechnik GmbH
Address:	Gewerbestrasse 5 - 9 35633 Lahnau (Germany) Tel.: ++49 6441 / 966-0
Product description:	Servocontroller
Type:	MC6404 article no. 0792.V03.0 MC6408 article no. 0792.000.0 MC6412 article no. 0792.V02.0 MC6416 article no. 0792.V01.0

The product described is intended exclusively to be installed in another machine. Commissioning is prohibited until conformity of the end product with Directive 89/392/EEC is established.

We confirm conformity of the product described above with the standards listed in the annex to this declaration.

Issued by:	Company Lust Antriebstechnik GmbH
Place,date:	Lahnau, 07.09.1995
Legally binding signature:	K.H. Lust, Managing Director

Annex AHE 025 forms part of this declaration.
This declaration does not imply any assured characteristics.
The safety instructions supplied with the product documentation must be observed.

HE_025.D-E 28.09.1995

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LUST
ANTRIEBSTECHNIK

ANNEX
TO EC MANUFACTURER'S DECLARATION

Document No. /	AHE 025
Month, year:	September 1995
Product description:	Servocontroller
Type:	MC6404 article no. 0792.V03.0 MC6408 article no. 0792.000.0 MC6412 article no. 0792.V02.0 MC6416 article no. 0792.V01.0

Compliance of the product described with the provisions of Directive No. 73/23EEC and 89/336/EEC is demonstrated by the complete adherence to the following standards :

Harmonized European Standards:

Reference No.	Date of issue	Reference No.	Date of issue
EN 61010-1, 6.2	1993	EN 55014	1987
EN 61010-1, 6.5.1	1993	EN 60801-2	
EN 61010-1, 6.7	1993	EN 50140	
EN 61010-1, 6.8.4	1993	EN 0843 part 5	
prEN 50082-2	1994	ENV 50141	
EN 50081-1	1992		
EN 55011	1991		
EN 55022	1987		

National standards (to LVD or MD, Art. 5, para. 1, clause 2):

Reference No.	Date of issue	Reference No.	Date of issue
VDE 0160, 5.5.1	1990	VDE 0875 part 1	1988
VDE 0160, 5.7	1990	VDE 0843 part 2	1987
VDE 0160, 7.6.1	1990	VDE 0847 part 3	
VDE 0160, 5.7.3	1990	VDE 0843 part 4	
VDE 0875 part 11	1992		
VDE 0878 part 3	1987		

IEC standards (LVD only)

Reference No.	Date of issue	Reference No.	Date of issue
IEC 801		IEC 801-4	1988
IEC 801-2		IEC 801-5	

AHE_25.D-E 28.09.1995

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1.4 Manufacturer's Declaration for Servomotors

LUST
ANTRIEBSTECHNIK

EC - MANUFACTURER'S DECLARATION

(to Art. 4, para. 2 of EC Directive 89/392/EEC)

Document No.:	HE 024
Month, year :	September 1995
Manufacturer:	Company Lust Antriebstechnik GmbH
Address:	Gewerbestrasse 5 - 9 35633 Lahnau (Germany) Tel.: ++49 6441 / 966-0
Product description:	AC-Servomotors for Servocontroller MASTERCONTROL
Type:	PSx-xx Asx-xx

The product described is intended exclusively to be installed in another machine. Commissioning is prohibited until conformity of the end product with Directive 89/392/EEC is established.

We confirm conformity of the product described above with the standards listed in the annex to this declaration.

Issued by:	Company Lust Antriebstechnik GmbH
Place,date:	Lahnau, 07.09.1995
Legally binding signature:	K.H. Lust, Managing Director

Annex AHE 024 forms part of this declaration.
This declaration does not imply any assured characteristics.
The safety instructions supplied with the product documentation must be observed.

HE_024.D-E 17.10.1995

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LUST
ANTRIEBSTECHNIK

ANNEX
TO EC MANUFACTURER'S DECLARATION

Document No. /	AHE 024
Month, year:	September 1995
Product description:	AC-Servomotors for Servocontroller MASTERCONTROL
Type:	Psx-xx ASx-xx

The low voltage directive does apply to electrical motors hence the machinery directive does not apply. The requirements of the machinery directive are covered by the LVD respectively.

National Standards (to LVD or to MD para 5, clause 2):

Reference No.	Date of issue
DIN VDE 0530	09/93
DIN VDE 0470	11/92
DIN 42955	12/81

IEC standards (LVD only)

Reference No.	Date of issue	Reference No.	Date of issue

1.5 MC6000 with CE Mark

Copy of the CE Test Certificate as as exaple for MC6404 and MC6408:

Prüfzentrum für Umweltsimulation und Typprüfungen der CARL SCHENCK AG

SCHENCK

AKKREDITIERT VON DER DEUTSCHEN AKKREDITIERUNGSSTELLE TECHNIK (DATech) e.V.

Prüfbericht
Test report

Bericht-Nr. 812

Deutscher AkkreditierungsRat
DAR
DAT-P-028/92-00

Gegenstand Object	Servoregler	Die Prüfung erfolgte auf der Grundlage des zwischen der Deutschen Akkreditierungsstelle Technik (DATech) und CSD geschlossenen Vertrags. Dieser Prüfbericht dokumentiert die Rückführbarkeit auf die relevanten europäischen Richtlinien durch die Anwendung der von den Sektorkomitees des DATech vorgegebenen technischen Begutachtungsbausteine.
Hersteller Manufacturer	Fa. Lust Antriebstechnik GmbH Gewerbestr. 5-9 D-35631 Lahnau	
Typ Item	MC 6404, MC 6408	
Auftraggeber Customer	Fa. Lust Antriebstechnik GmbH	
Auftragsnummer Order No.	1 HID 3711	
Anzahl der Seiten des Prüfberichts Report volume	148	
Datum der Anlieferung Date of delivery	20.02.95	
Datum der Prüfung Date of test	20.02.95-09.03.95	

Dieser Prüfbericht darf nur vollständig und unverändert weitergegeben werden. Auszüge bedürfen der Genehmigung des Prüfzentrums für Umweltsimulation und Typprüfungen (QST). Prüfberichte ohne Unterschrift und Stempel haben keine Gültigkeit. Die Prüfergebnisse beziehen sich ausschließlich auf den oben genannten Prüfgegenstand.
This test report may only be reproduced in full lenght. Extracts puplishing needs permission of the issuing laboratory. Test result without signature and seal are not valid. The test results relating only the tested device.

Stempel	Leiter der Prüfstelle	Bearbeiter
geprüft und getestet	i.A. (Pätschke)	(Hielscher)

QEZ0006

Copy of Summary of Test Results as an example for MC6404 and MC6408:

Prüfzentrum für Umweltsimulation u. Typprüfung SCHENCK

3 Zusammenfassung der Prüfergebnisse

Allgemein:
Die für das Produkt relevanten Prüfungen und Prüfergebnisse sind den Prüfergebnisformularen oder den Meßwerterfassungsprotokollen zu entnehmen.

Die Prüfergebnisse beziehen sich ausschließlich auf den unter "Beschreibung des Prüfgegenstand" geprüften Typ(en).

Tabelle Prüfergebnisse:

Titel	EG-Richtl. Norm	Formular	erfüllt Ja	erfüllt Nein
Niederspannungsrichtlinie (Sicherheit elektrischer Betriebsmittel)	73/23/EWG	QSF 10/004	x	
EMV-Richtlinie (Industriebereich) Störfestigkeit	89/336/EWG prEN 50082-2	QSF 10/011	x	
EMV-Richtlinie (Wohnbereich) Störaussendung	89/336/EWG EN 50081-1	QSF 10/013	x	

Bemerkungen zu den Prüfergebnissen Sicherheit elektrischer Betriebsmittel :

Bei den sicherheitsrelevanten Prüfungen gab es keine Probleme (siehe hierzu Prüfergebnisse SEB).

Bemerkungen zu den EMV-Prüfergebnissen:

Der Prüfling erwies sich als ausreichend störsicher und hält bei der Störausendung die Grenzwerte der Klasse B ein.

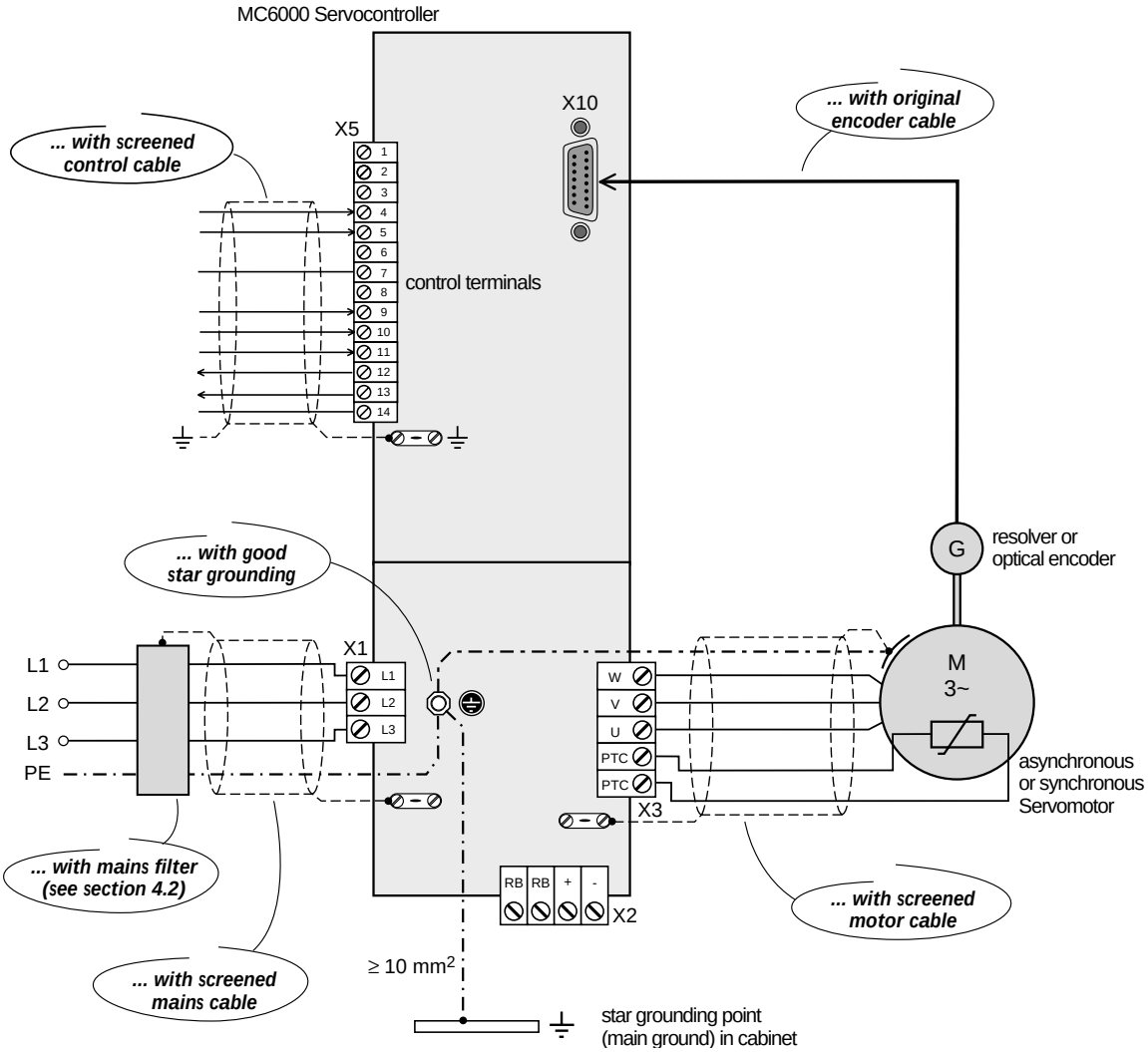
Ausgabe	Name	Datei	Seite
10.03.95	QST/Hielscher	812.TYP	8

1.6 Instructions for Correct EMC Installation

CE including EMC:
The MASTERDRIVE drive system has been designed such that it complies not only with the low voltage directive, but also the EMC directive (assuming appropriate installation) - and even the strict directive for domestic use. Conformance testing was carried out in the renowned Schenck laboratories under laboratory conditions and there is no guarantee that these findings can be transferred to a Servodrive installed in a specific machine or installation.

Instructions for the best possible installation are shown in the next diagram.

How to achieve correct EMC installation...



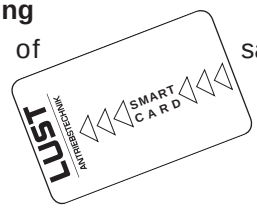
Note:
Complete instructions for wiring the Servodrive are contained in Section 4.

1.7 What are the main benefits of the MASTERDRIVE System?

- **One Servocontroller for asynchronisous and synchronisous motors**
  - ⇒ reduced training and documentation costs.
  - ⇒ reduced cost of spares in stock

- **KEYPAD - one controller for Servocontrollers and frequency inverters**
  - ⇒ reduced familiarization and documentation costs

- **Chipcard with motor specifications and complete controller matching**
  - ⇒ high level of safety when commissioning
  - ⇒ reduced commissioning costs



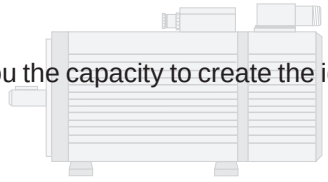
- **Equipment flexibility with retrofit accessories**
  - ⇒ high degree of flexibility for future requirements

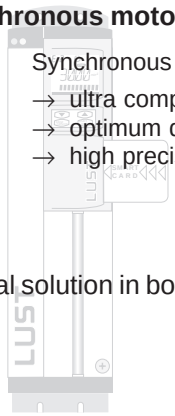
- **Servocontroller with integrated positioning and sequence control**
  - ⇒ reduced space requirements in cabinet
  - ⇒ reduced wiring costs
  - ⇒ reduced drag errors and reduced load on central control

- **System solution with asynchronous and synchronous motor range**

  Asynchronous Servomotors
  - → ideal economic solution
  - → wide speed setting range with constant maximum performance output
  - → maintenance-friendly

  Synchronous Servomotors
  - → ultra compact
  - → optimum dynamics
  - → high precision torque control





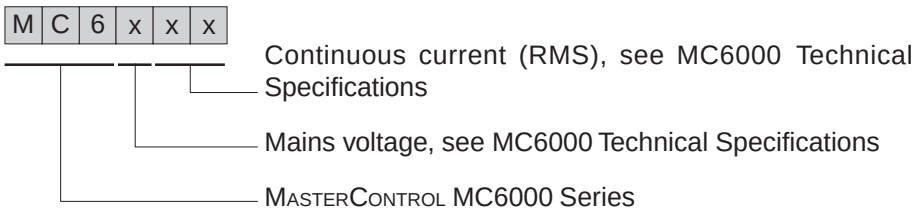
  - ⇒ this gives you the capacity to create the ideal solution in both technical and economic terms

- **CE conformity**
  - ⇒ this means that acceptance of your machine or installation will be straightforward without the drive being a concern.

1.8 Details for ordering the MC6000 Servocontroller

The Servocontroller model is identified by the order code. Non-standard versions are identified by the addition of model codes to the order code.
In the model combination represented, there is standardization on one model at each stage (eg control, encoder interface etc). Each model code has a special meaning; see Servocontroller models.
Non-listed controllers also use model codes which are not detailed here.

Order code/type code (standard version)

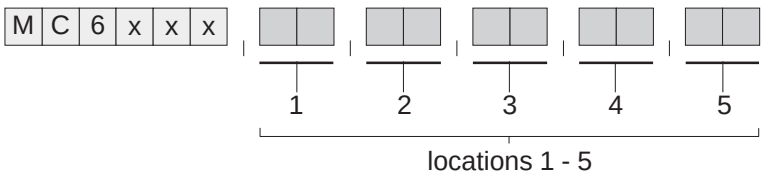


Standard model:

- with KP100 control unit
- with encoder interface for evaluating resolvers
- for MC6404 to MC6416: BR1 — with brake chopper power electronic (10% duty cycle) and braking resistor in heat sink

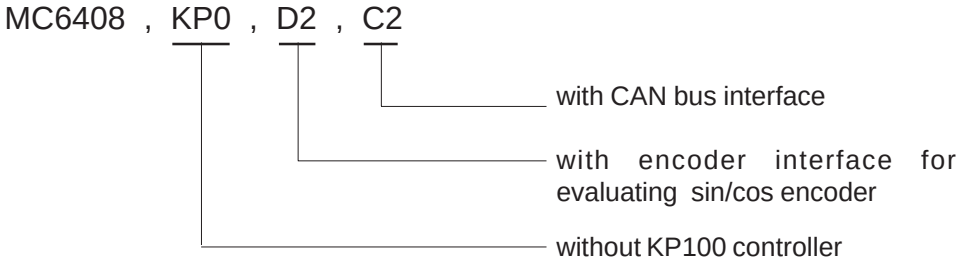
  for MC6432 and MC6464: BR3 — with braking chopper power electronic (100% duty cycle) for direct connection to an external braking resistor

Model code for non-standard models



The model code 1 - 5 is separated by a comma and these codes can be added in any order.

Example



1.9 MC6000 Servocontroller Models

Location	Version code	Short Description	Described in
1 Control	Standard	With KP100 multifunction control unit.	Section 6
	KP0	Without KP100 multifunction control unit	–
2 Encoder Interface	Standard	Encoder interface for evaluating resolvers.	Section 4.5
	D2	Encoder interface for evaluating the latest optical encoders, incremental sin/cos outputs and simultaneous absolute position information as single turn and multi turn variants.	Section 4.5
3 Application Hardware	Standard	Without application hardware in slot X7	–
	AH1	PLC compatible I/O expansion with 8 inputs and 4 outputs. The I/Os are fully programmable.	Section 11
4 Bus Interface	Standard	Without bus interface in slot X6	–
	C1	INTERBUS-S interface for local bus link (IBS-L)	Section 4.8
	C2	CAN-Bus interface (CAN)	Section 4.9
	C7	INTERBUS-S interface for remote bus connection (IBS-F)	Section 4.8
5 Braking chopper version	Standard (BR1)	Braking chopper power electronics (10% duty cycle) and braking resistor in heat sink.	Section 4.3.4
	BR3	Braking chopper power electronics (100% duty cycle) without braking resistor (standard version for MC6432 and MC6464).	Section 4.3.4

The model codes on the nameplate identify how the device is equipped.

1.10 Accessories for the MC6000 Servocontroller

Accessories for fitting to the Servocontroller

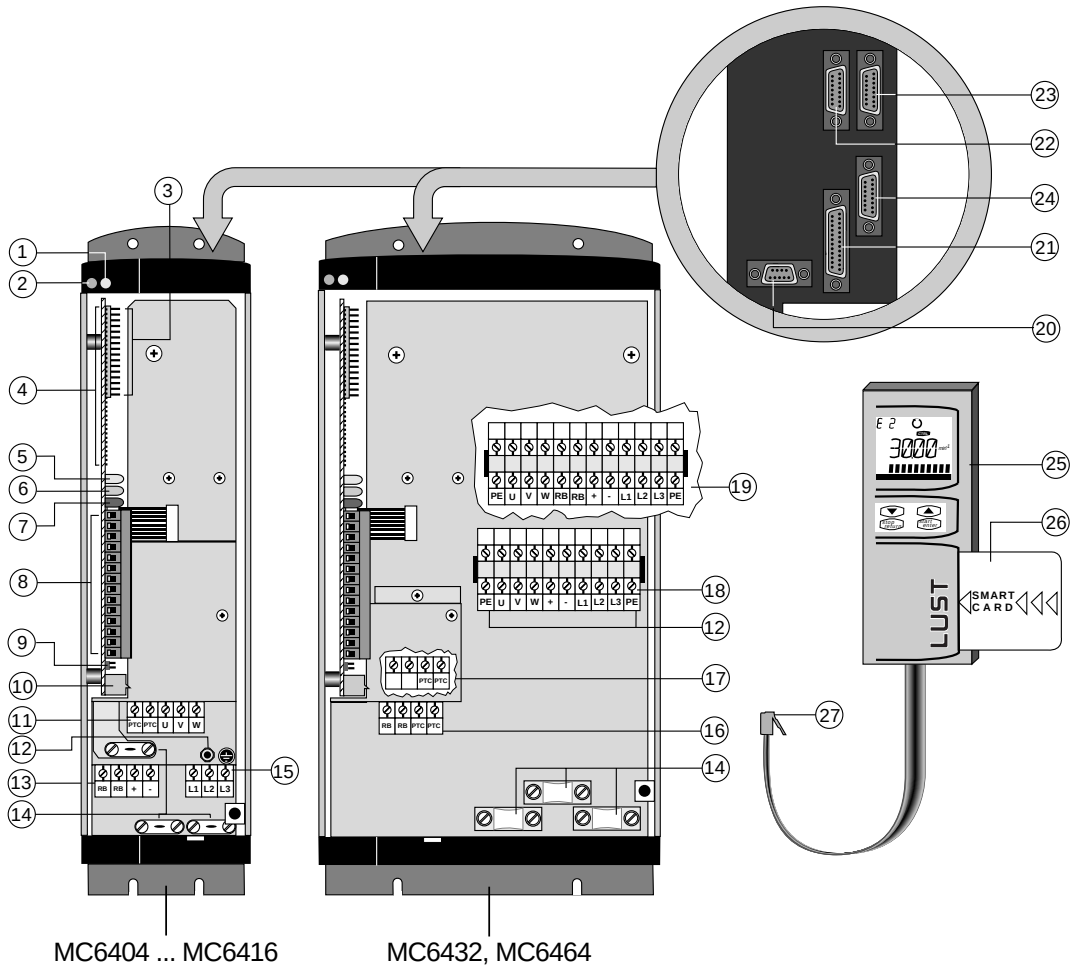
Order Code	Description
KP100	KP100 multifunction control unit for operating the Servocontroller and frequency inverter
0000.ZSC	SMARTCARD without data
0792.ZSC, xxx-xx-xxxx	SMARTCARD for adapting the MC6000 Servocontrollers to the Servomotor series ASx and PSx

Accessories for fitting externally

Order Code	Description
EKL300	Terminal module for external wiring of control terminals of application hardware AH1 and AH2. With connecting cable (KSS252).
KSS252	Connecting cable to link MC6000 Servocontroller and EKL300 terminal module . Connecting cable length 1.8m.
LBSKK200	Interface converter cable: RS485 to RS232. Cable length approximately 2m.

2 Technical Specifications for Servocontrollers

2.1 Design and Layout



No..	Function	No.	Function
1, 7	LED "Error", red (H2)	15	mains terminals (X1)
2, 6	LED "Ready", green (H1)	16	terminals for braking resistor & PTC MC6432
3	slot X6, e.g. for InterBus-S or CAN-Bus Interface	17	terminals for PTC MC6464
4	slot X7, e.g. for I/O Module 1, or PosMod1	18	supply terminals MC6432
		19	supply terminals MC6464
5	LED status display, gelb (H3)	20	RS485 serial interface (X8)
8	control terminals (X5)	21	encoder simulation port (X9)
9	jumper for analog ref. value input	22	encoder port (X10)
10	socket for KeyPad (X4)	23	interface port (X11) for InterBus-S or CAN-Bus interface
11	terminals for motor & thermistor (X3)		
12	grounding screw as star point for all grounding lead connections	24	Interface port (X12)
		25	KeyPad control unit KP100
13	terminals for braking resistor DC link circuit (X2)	26	SmartCard for matching the servocontroller to motors and storage media for all parameters
14	cable clips to reduce stress loading and for correct EMC cable screening		
		27	KeyPad connector plug

2.2 Output - motor

	Code	Unit	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Rated power (400V mains) 1	S	kVA	2,7	5,5	8,3	11	22	44
Voltage (RMS)	U	V	3 x 0 ... 400 / 460					
Cont. current (400V / 460V) 1	I	A	4 / 4	8 / 7	12 / 12	16 / 15	32 / 32	64 / 60
Cont. current (400V / 460V) 2	I	A	3 / 2	4,5 / 3,5	7,5 / 6	9,5 / 7,5	20 / 17	40 / 32
Pulse current for 10 sec	I	A	2 · I					1,5 · I
Switching frequency	f	kHz	4, 8, 16 (factory setting 8 kHz)					
Motor system			synchronous or asynchronous					
Protection against short circuit and ground fault			yes, but not at RB terminals					

1) assuming switching frequencies of 8 kHz (factory set) or 4 kHz
2) assuming switching frequency of 16 kHz

2.3 Input - power side

	Code	Unit	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Mains voltage	U	V	3 x 400 ... 460 ±10 %					
Asymmetry of mains voltage		%	3					
Frequency	f	Hz	48 ... 62					
Power factor of fundamental wave	cos		> 0,97					
Efficiency	η	%	> 95					
Power loss	P	W	115	180	250	310	600	1000

3) at rated voltage and rated current

2.4 Resolution of angle of rotation

	encoder simulation		internal angle resolution	
	pulses / rev	Null pulses / rev	pulses / rev.	degrees
G1 sin/cos Incremental	2048	1	2^{19}	0.00069°
G2 sin/cos single turn		0		
G3 sin/cos multi turn		0		
R1 Resolver 1 pole pair	1024	1	2^{12}	0.088°
R2 Resolver 2 pole pair	2048	2	2^{13}	0.044°
R8 Resolver 3 pole pair	3072	3	3 x 2^{12}	0.0293°

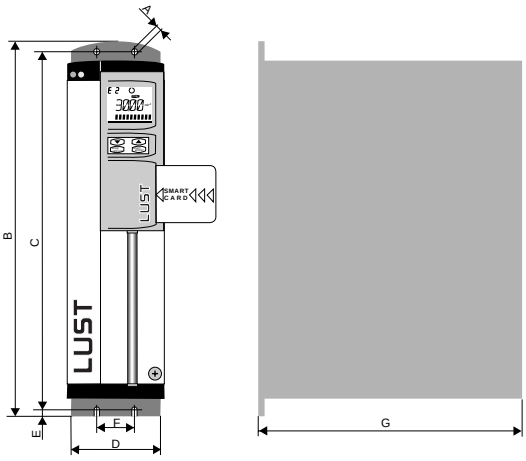
Note:
It is not possible to give general details with regard to resolution and precision of torque, speed and position as these values depend not only on Servocontroller but on all the drive elements.

2.5 Ambient conditions

	Code	Unit	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Cooling air temperature (up to 1000 m a.s.l.)	T	°C	0 - 40					
Type of cooling			forced cooling					
Relative humidity	rF	%	15 - 85, non condensing (VDE0160)					
Power reduction relative to cooling air temperature	P	%	5 %/°C above 40°C cooling air temperature max. 50°C					
Power reduction relative to installation height	P	%	5 % per 1000 m above 1000 m a.s.l., max. 2000 m a.s.l.					
Storage temperature	T	°C	-25 - +55 (VDE0160)					
Transport temparature	T	°C	-25 - +70 (VDE0160)					
Vibration (IEC 68-2-6)			2g (IEC68-2-6)					

5) When equipped with I/O Module 1 (version AH1) maximum cooling air temperature 40 degrees C

2.6 Dimensions and weights

	Code	Unit	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Protection			IP20, VBG4					
Mounting orientation			vertical, wall mounted					
Weight	m	kg	6		7,5		10	15
Dimensions	A	mm	5,8				7	
	B	mm	360				440	
	C	mm	345				425	
	D	mm	95		142,5		190	285
	E	mm	7,5					
	F	mm	60		100		150	240
	G	mm	260				290	
								

2.7 Mounting instructions

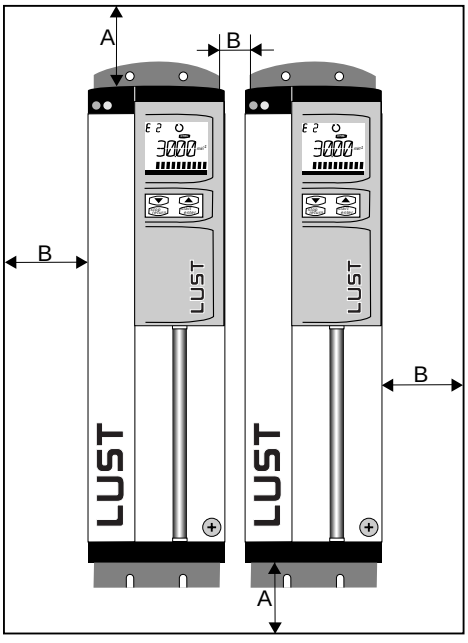
Note:
These instructions are applicable to the Servocontroller with heat sink and complete enclosure (Standard version).

General:
The location for installation must be free from conducting or corrosive materials and free from humidity. Servocontrollers are typically housed in cabinets with external air throughflow. They are attached to a mounting board with four M5 screws.

It is essential that the minimum separaration distances above and below the unit are observed to avoid overheating. The ventilation slots on the top surface must **not** be covered or closed off under any circumstances.

Warning:
Take care to ensure that no foreign bodies, such as metal swarf or screws, drop into the equipment, as it may be damaged beyond repair.

Equipment installation spacing:
The enclosure dimensions have been designed to allow for power losses in the form of heat dissipation *(see power table)*. To avoid overheating in the enclosure it is important to adhere strictly to the specified minimum installation separation distances. This will ensure long term reliability. There is no restriction however on mounting any number of units directly adjacent to each other with no separation. (Except when using I/O Module 1 AH1).



Minimum mounting distances:
A = 150 mm
B = 0 mm

Exceptions:

B =	20 mm	with version AH1 (I/O Module 1)
B =	20 mm	with Servocontrollers of different power i.e. 1 x MC6408, 1 x MC6412
B =	20 mm	with other equipment. Do observe minimum mounting distance of the other equipment if greater!

The Servocontroller is cooled adequately by its heat sink and a metal mounting plate is not required.

3 Installation and commissioning

The actual installation procedure must always be matched to the specific application. The instructions in this section are given for general guidance only .

3.1 Instructions for installation

1. Read these instructions thoroughly.

2. Installation and commissioning must be carried out only by a qualified electrical engineer.

3. Check the components supplied:
   - name plates in accordance with purchase order
   - do the encoder cable and Servocontroller match the name plates of the installed encoder type?

     It is essential to check that the encoder type and the encoder cable are compatible as detailed in the table below. Otherwise correct operation cannot be guaranteed.

     Example for motor name plate:

TYP: ASH22-20 G1 3-00

encoder G1 is installed

Therefore cable KG1-KSxx must be used and the Servocontroller must be fitted with optical encoder evaluation (version code D2)

Encoder interface	Ebncoder type suitable for:	Encoder cable normal	Encoder cable festoonable
analysis for resolvers (standard)	R1 p=1 3)	KRX-Nxx	KRX-KSxx
	R2 p=2 1)		
	R8 p=3 2)		
analysis for optical encoders (Code D2)	G1 sin/cos, incremental 1)	_	KG1-KSxx
	G2 sin/cos, single turn 3)		KG2/3-KSxx
	G3 sin/cos, multi turn 3)		KG2/3-KSxx

In each case the last two digits ("xx") indicate the length of the cable in metres. The following lengths are available as standard: 05, 10, 15, 20, 25 und 30 m.
Suitable for 1) ASx (asynchronous motors), 2) PSx (synchronous motors), 3) ASx und PSx.
p - pole pair number of resolver.

4. Before and during the installation of the Servocontroller the following procedure must be observed:
   - electrical connections must never be made or disconnected when live.
   - cables carrying heavy current must be of sufficient cross-section to comply with VDE0110
   - take all necessary measures for correct ENC installation *(see Section 4.2)*
   - provide Emergency Off facilities
   - ensure specified environmental conditions (e.g. cooling air) are provided

3.2 Installation of the drive system

1. When installing the Servomotor in the system or machine observe the instructions in *Sections 4.3.2 and 12*. If possible delay installing shaft end items (e.g. gears, pulleys, couplings etc.) until after commissioning, so that tests can be carried out without exposed system parts turning.

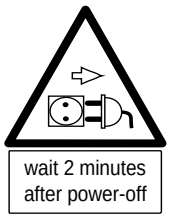
Note: Suitable devices must be used for fitting and removing shaft end items and there must be support at the A end of the shaft.

Warning! Safety instructions for Servomotors

- after installing the motor check that brake (if present) operates correctly
- before commissioning motors with a feather key in the shaft end, the feather key must be securred to prevent it being thrown out if this is not prevented by the presence of drive shaft items such as pulleys, couplings or similar
- these motors are designed for operation using a Servocontroller. Direct connection of such motors to the mains may result in their destruction
- surface temperatures above 100 degrees C may occur on the motors. Consequently no temperature-sensitive items may be placed or fixed on them. If necessary, measures to prevent people touching them must be provided
- the optional emergency hold brake is only designed for a limited number of emergency stops. It is not approved for use as a normal working brake
- the PTC in the windings must be connected to the Servocontroller to prevent overheating of the motor

2. Cabinet installation of the Servocontroller: follow installation instructions (heat, minimum mounting distances for installation) in *Section 2.7.*

3. Electrical installation of the Servocontroller: the electrical installation of the Servocontroller depends on its application. Wiring instructions are contained in *Section 4 "Electrical Connections"*.



   - open the MC6000 Servocontroller by undoing the screw on the front (bottom right).
   - wire up motor (including thermistor), do not mix up motor phases
   - connect encoder cable to motor and Servocontroller
   - wire up control terminals (observe power stage enable: ENPO)
   - wire up serial interface, encoder simulation, Bus system or application hardware, eg I/O module 1 (AH1) as appropriate
   - connect to the mains, but do **not** switch on yet

4. Check the electrical installation. Check all connections, then close the MC6000 cabinet again.

3.3 Commissioning of the Drive System

1. Function test (correct selftest sequence):
   - switch on mains power supply
   - during MC6000 selftest the display is backlit red and displays the message "TEST"
   - after successful completion of the self test the colour of the display changes to green and the current actual value is displayed in the VAL menu (torque speed or position depending on mode; parameter REFV in the VAL menu)
   - if the device detects an error during self testing, the red backlit display will indicate the cause of the fault *(see Section 9)*

2. Function Test (correct recognition of direction of rotation):
   - download the SmartCard supplied with the motor (DRIVE). This any previous will match the Servocontroller perfectly to the motor in use. Remember however that customer settings may be overwritten
   - in the KeyPad the symbols for the direction of rotation are displayed in the upper section when you turn the motor spindle (↻ for clockwise and ↺ for counterclockwise)
   - check that when you turn the motor shaft clockwise by hand, when viewed from the flange end of the shaft the symbol ↻ appears
   - if not, please check:
     - is the encoder cable connected to the motor and Servocontroller?
     - is the correct cable for the encoder being used?

3. Test correct operation of the protection device (Emergency Off).

4. Carry out the examples for setting parameters on the Servocontroller on *page 6-5*, to familiarize yourself with the use of the KeyPad:
   - Example 1 - setting the user level to MODE=3
   - Example 2 - setting the mode to position control

5. Set the parameters for the Servodrive for your application using the KeyPad.
   - for commissioning set user level MODE=3.
   - choose the required control mode CFCON in configuration (_CONF)
   - now it is a simple matter to control the drive using the CTRL menu and to carry out tests in the required control mode. **If the motor is already connected to the system, the user must ensure that the system will not be damaged by operating it.**

   - Set the parameters for the Servodrive in accordance with the Five Point Plan. *Section 7* gives further details.

Configuring the Servocontroller (Five Point Plan):

	Parameter	Area
1. Read in the SmartCard with the motor specifications (DRIVE area)		
2. Select control mode (torque, speed or position)	CFCON	_CONF
3. Select control location (Control via terminals, serial interface,, InterBus-S, CAN-Bus, etc.) 1)	CLSEL	_CONF
4. Program function selectors (Allocate functions to inputs and outputs, see Section 7.1)	FIS0x, FISAx, FOS0x, etc	_CONF
5. Program reference values (see Section 7.2)		_REF

1) Control location identifies the source of the control commands START and INV (invert reference value).

This sequence of points must be observed during configuration.

6. Test the drive with the application-specific settings.

7. If you have commissioned the equipment without the shaft items these should now be assembled on the shaft and the drive tested in conjunction with the whole installation.The moment of inertia of the installation in which the motor is being driven should be set in parameter SCJ (_SCON).

   If the moment of inertia of the installation in which the motor is being driven is known, or can be estimated, this value should now be set in parameter SCJ (_SCON).

8. The Servocontroller factory settings provide excellent drive behaviour for most applications without any further adjustment. This concludes the commissioning stage.

9. If the drive characteristics are unsatisfactory, (because the moment of inertia of the installation is not known for example) then adjust the control parameters *(see Section 8)*.Your specialist supplier will be pleased to assist, or you can contact the manufacturer direct:

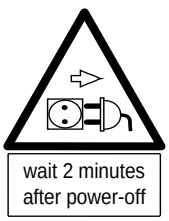
   Lust Antriebstechnik GmbH
   Dep. Application
   Tel . +49 64 41 / 9 66 - 1 57
   +49 64 41 / 9 66 - 1 87
   Fax +49 64 41 / 9 66 - 1 77

10. It is worth storing the changed parameter settings as a backup on a SmartCard.
    This SmartCard will make commissioning additional drives very easy.

3.4 Important Tips

Warning! Download from SmartCard first
If the motor is operated without the appropriate SmartCard (DRIVE) being downloaded first, the control characteristics are not usually as good. It can lead to the motor overspeeding or even being destroyed.

Warning! Do not remove encoder cable
Under no circumstances must the encoder cable ever be disconnected during operation because the Servocontroller would loose control of the motor. Uncontrolled rotatation of the drive may result in damage to the motor and to the installation and also danger to human life.

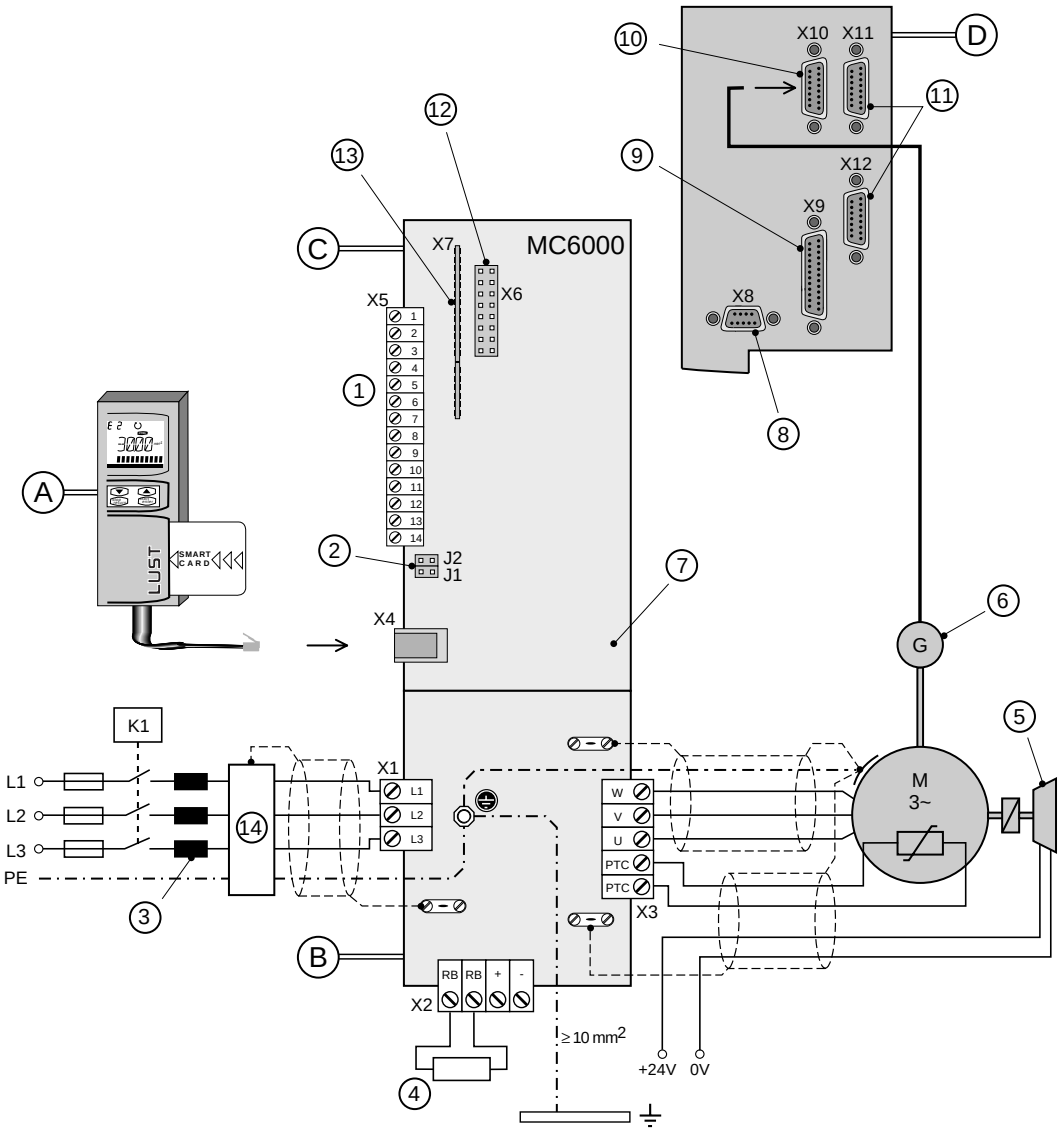


Warning! Danger of death
Disconnect from mains before working on the equipment. There are dangerously high voltages at the terminals. Wait approximately 2 minutes after disconnection from the mains supply until the DC link circuit capacitors have discharged.

Warning! Dange of death
Do not touch motor terminals even when the motor is coasting. Dangerously high induction voltages are present at motor terminals U, V and W.

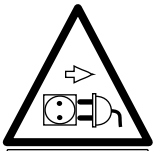
4 Electrical Connections

4.1 System Connection Diagram



Note:
Diagrammatic representation only

No.	Function	No.	Function
A	KeyPad KP100 control unit	6	Encoder
B	MC6000 PSU	7	EMC screen plate (star point)
C	MC6000 controller	8	Serial interface (RS485)
D	Detail of top	9	Encoder simulation port
1	Control terminals	10	Encoder port
2	Jumper for selecting current reference values (0-20 mA)	11	X11= output, X12= input for InterBus S or CAN Bus interface
3	Line reactor (accessory, not essential for operating controller)	12	X6 slot (e.g. for Interbus S or CAN Bus interface)
4	Braking resistor (internal or external)	13	X7 slot (e.g. for PosMod1 or I/O Module 1)
5	Electromagnetic brake (option)	14	Mains filter (accessory, not essential for operating controller



wait 2 minutes
after power-off

Warning! Safety Instructions
It is absolutely essential to disconnect the equipment from the mains before working on it. Do not work on the equipment within about 2 minutes of switching off, so that the DC circuit capacitors can discharge to a residual voltage of less than 65V.

Potential separation between the power section and the control section meets the VDE requirements for safety extra-low voltage.

The use of F1 ground fault circuit interrupts is not permissible because of the high leakage current (>3.5 mA).

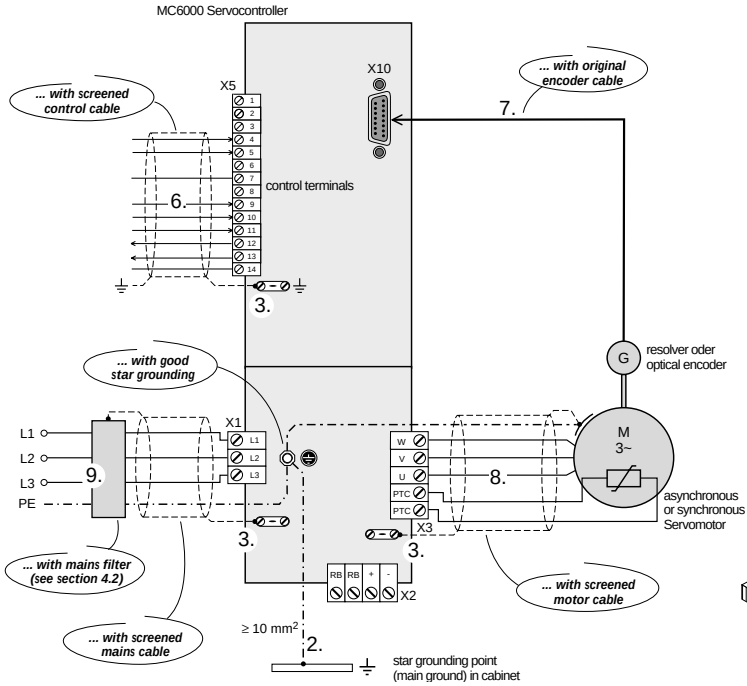
A good star type grounding of the equipment in accordance with VDE0160 must be achieved by connecting the equipment star point (EMC screening plate, *see System connection diagram in Section 4.1*) with the central star point of the cabinet using a grounding lead cross section of at least 10 mm²

4.2 Electromagnetic compatibility (EMC)

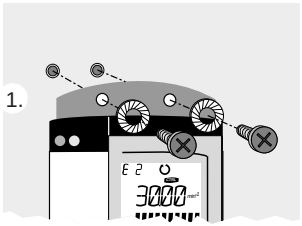
Series MC6000 Servocontrollers meet the EMC interference requirements of Standards EN50082-2, IEC801-4 (VDE0843). For the Servocontroller to comply with these interference standards the measures marked with a 'X' in Table A below are essential.
If these procedures are followed interference level 4 requirements will be met in accordance with IEC801-4 (Burst), but if a non-screened control cable is used, interference will be level 2.

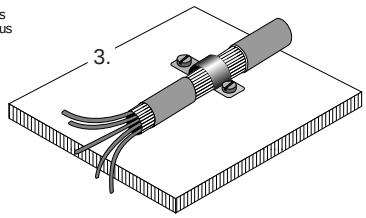
To comply with the radio interference regulations EN50081-2, EN55011 (emission of interference) the measures marked with a 'X' in Table B must be carried out.

	Measures	Effect/Reason	A	B
1.	Screw Servocontroller to metal mounting plate using serrated locking washers	Good conductivity, high surface area contact	X	X
2.	Ground lead contact across at least 10 mm² on the PE rail in the cabinet	Good star type grounding because leakage currents > 3,5 mA	X	X
3.	All cable screening to be grounded at both ends using cable clamp	Screening effect is lost if the screening is opened up into a pig tail	X	X
4.	Power cable and control cable must be physically separated	This avoids mutual induced interference	X	X
5.	Route mains and motor cables separately	This avoids mutual induced interference	X	X
6.	Use screened control cable	Avoid induced interference on control signals	X	X
7.	Use original encoder cable	Avoid induced interference on encoder signals	X	X
8.	Use screened motor cable	Avoid the emission of interference via motor connection		X
9.	Screw mount mains filter directly adjacent to Servocontroller on metal mounting plate using serrated locking washers (If the distance is < 20 cm screened cable is not usually required	Avoid the emission of interference via the mains connection; good conductivity, large surface area contact		X



Installation using serrated washers



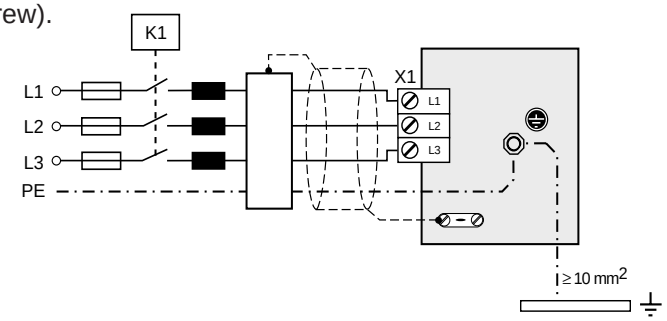


All cable screening must be grounded to the enclosure using cable clamps

4.3 Power Terminals

4.3.1 Mains power supply connection

Mains power supply to the MASTERCONTROL is via terminals L1, L2, L3 and PE (at the grounding screw).



The Servocontroller must be protected by fuses specified in the table below in order to meet VDE636, Part 1. The cross section of the cable conductor must be appropriate to the current loading.

Conductor cross sections for mains and motor connections:

	Unit	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Recommended conductor cross section	mm²	1,5	2,5	4	4	6 1)	16 1)
Maximum possible conductor cross section	mm²	4				10	35
Recommended mains fuse	A	10	20	25	35 (25)1)	50 (35)1)	100 (63)1)

1) if the overload capacity if not to be used (high pulse current for 10 seconds)

The Servocontroller may only be connected to the mains power supply at 120 second intervals. During commissioning and after an Emergency Off the voltage supply may be switched on again directly.

Mains filter for correct EMC connection of Servocontroller

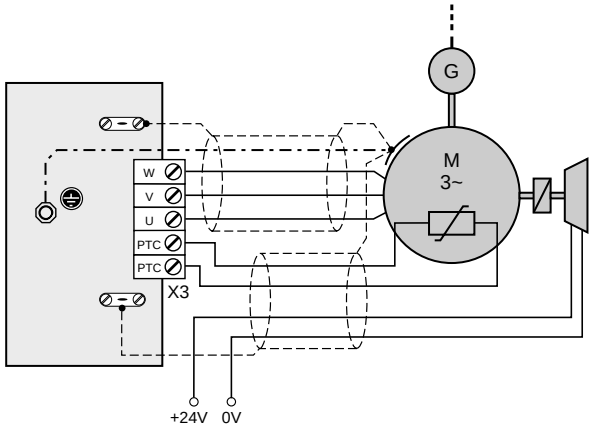
Mains filter	max. current	recommended for
FN351-8-29	8 A	MC6404
FN351-16-29	16 A	MC6408
FN351-25-33	25 A	MC6412
FN351-36-33	36 A	MC6416

4.3.2 Motor Connection

The motor connection is via terminals U, V, W and PE (grounding screw) on the Servocontroller (X3). The cross section of the cable conductor must be appropriate for the current loading.

The motor connection must be laid in **screened** to reduce interference effects. The screening is to be connected to the enclosure (PE) over a wide surface area and without reduction in cross section, **at both ends**. The best large surface area connection of the screening to the device is obtained using a cable clip.

The motor cable should **not be separated** (eg at terminals within the cabinet) because the screening effect is lost.



Warning: Danger of Death
Motor phases U, V and W must not be switched over at the motor end or device end. If the motor phases are switched over the Servocontroller loses control of the motor and the motor may buck or accelerate in an uncontrolled manner. This can result in damage to the whole installation. There may also be danger to human life.

Explanation:
In a controlled drive (frequency inverter) switching over of motor phases results in reversal of the rotating field and hence direction of rotation of the motor.
In a controlled drive of this type switch-over would cause a fault in the control loop of the control circuit.

Warning: Danger of Death
Do not touch motor terminals. Dangerously high induction voltages are present at motor terminals U, V and W, even during coasting..

Note: Long Motor Leads
Especially in the case of screened motor cables there are leakage currents which are not insignificant. The actual leakage current depends on the length of the cable, the structure of the cable, cable routing and motor type. The output currents quoted in Technical Specifications (Section 2) apply up to a cable length of 10m.

Above 10m cable length for screened motor cables it must be assumed that there will be a reduction in effective output current from the Servocontroller of

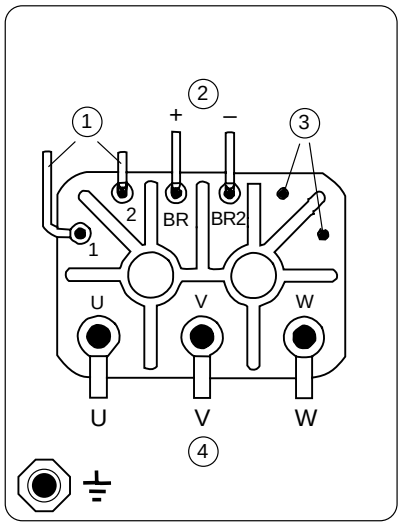
- approximately 50 mA per metre length (at 8kHz) and
- approximately 70 mA per metre lengfth (at 16 kHz).

Maximum length is 50m (longer lengths to order).

Motors with terminal boxes

For correct EMC wiring of motors, screw glands with large surface area screening contact should be used, such as TOP-T-S by Lütze. Various cable outlet arrangements can be obtained by turning the terminal box (square terminal boxes can be turned by 90° rectangular ones by 180°).

It is important to ensure correct sealing of cable outlets or IP65 protection cannot be ensured.

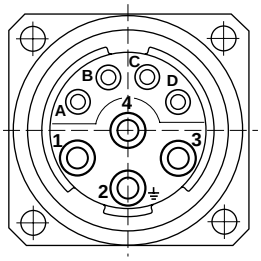


No.	Function
1	PTC Thermistor
2	Holding brake (option)
3	Not allocated
4	Motor

Motors with connector

IP65 protection is only provided in the case of approved wiring of connectors, both of them fully engaged.

Suitable matching connector:
eg Interconnectron, Type LPNA 08B NN

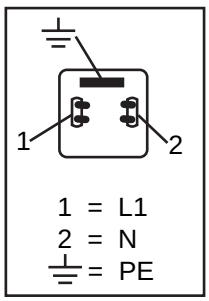


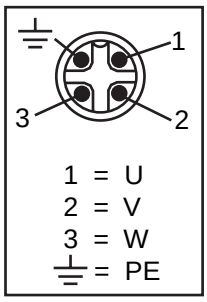
Contact No.	Allocation
1	U
2	PE
3	W
4	V
A	Brake +
B	Brake –
C	PTC
D	PTC

Motor cooling

Permissible environmental temperature of motors is -5 to 40°C. The motors must be mounted such that adequate heat dissipation is provided by convection and radiation. In the case of self cooling motors, overheating problems may result from cramped installation (eg in confined spaces or shafts).

If the motor has an external fan, this must be connected appropriately and the correct direction of rotatation of the fan checked (c.f. direction of rotation arrow on the fan casing).
An adequate supply of cooling air is required for effective cooling.





Warning: Dange of Fire

Surface temperatures of above 100°C occur on the motors. No temperature-sensitive items may be placed or fixed on them.

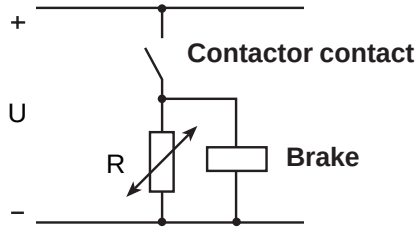
Motor maintenance

The only motor maintenance that is required is the cleaning of the surface of motor. The radial deep groove ball bearings of the motors are sealed bearings designed for 20,000 operating hours. Series ASx and PSx must not be dismantled.

Holding brake (if present)
The zero play permanent magnet single disk holding brake is fail-safe, ie the brake is on when there is no voltage.
The holding brake is switched on and off when the equipment is stationary. If the holding brake is used as an Emergency Stop brake, the permissible service life of the brake must be observed.

As a consequence of the inductivity of the holding brakes there is a voltage peak which occurs when the exciter current is switched off: this peak can be over 1000V. To avoid this voltage peak a suppressor circuit with a varistor should be used (recommended type Q69-X3022).

In the case of motors with integral holding brake a reduction in maximum speed may be required (see *Section 12 "Servomotor Design Specifications"*).



Suggestion for suppressor circuit for brake

Motors with integral IP65 shaft seal (option)
For motors with integral IP65 shaft seal (option) the permissible maximum speed must be observed (see *Section 12 "Servomotor Design Specifications"*). Operational reliability can only be achieved with adequate lubrication. Excessive speed of rotation will result in destruction of the seal lips.

Section 12 "Servomotor Design Specifications" contains further important guidance on motors.

4.3.3 Connection of thermistor

The thermistor (PTC), which is integral in the motor casing, is connected to the Servocontroller for thermal monitoring of the motor. Contacts 1 and 2 are connected in the motor terminal box to the 2 PTC terminals (X3) in the MC6000.

The PTC connection is screened and must be connected to ground at both ends.

PTC connection:
- via separate screened cable or
- together with motor cable or
- together with connection cable for electromagnetic holding brake (option).

At the rated response temperature the PTC resistor has a value >3 kΩ (see DIN44081 and 44082). On reaching this resistance value the Servocontroller responds with the error message Motor Over Temperature (E-OTM).

If the termistor is not connected both PTC terminals should be jumpered at the Servocontroller.

This jumper is factory fitted and should be removed when the thermistor is connected. If motors of different manufacture are used it is important to ensure that the PTC is electrically insulated in accordance with DIN VDE0530 Part 1.

Warning!

The motor PTC does not provide adequate thermal monitoring in the case of dynamic processes with overload in PSx motors, sizes M, N & O. In such cases you must please contact Lust to check design values to avoid destruction of the motor.

4.3.4 Connection of braking resistor

In regenerative operation, eg during braking of the drive, the motor feeds the energy back to the Servocontroller which increases the voltages in the DC link circuit. If the voltage exceeds approximately 745 V DC the internal braking transistor is switched on and the regenerative energy is converted into heat by the braking resistor.

If the DC link circuit exceeds the maximum permissible value of 780 V DC, the Servocontroller produces the error message Over Voltage E-OV and blocks the power stage. Over voltage can occur if large masses are braked and/or short braking times are set.

At terminals R_B the Servocontroller is not short circuit proof or ground fault resistant.
The MC6000 is available in the following versions:

The MC6000 Servocontroller is available in the following versions:

Model code	Braking transistor	Braking resistor	Peak braking power	Continuous duty factor cdf (EDi)
Standard (BR1)	internal	internal	for 8 s	10%
BR2	internal	external	for 8 s	10%
BR3	internal	external	continuous	100%

Notes:
ED_i is the on time of the internal braking transistor (duty cycle).
The MC6432 and MC6464 Servocontrollers are not available with internal braking resistor. An external braking resistor can be connected directly.

Braking the drive has implications for the safety of the machine and the installation

For this reason the design values of braking resistor and braking transistor must be checked with regard to the application before commissioning. During commissioning safe operation must be checked.

If the design values are incorrect (resulting in overload) the braking resistor and the braking circuit may be destroyed and the machine and the installation may be damaged.

Overload (failure of the braking system) can also injur or kill people, eg in the case of lifting application.
Braking chopper version selction and design values are shown on the next page.

Braking power	code	unit	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Peak braking power internal	P_{max}	kW	6				–	
cyclic braking operation 1)	P_{eff}	W	60	20	90	30	–	
continuous braking operation 1)	P_{effg}	W	115	180	250	310	–	
minimum resistance in Ohms of external braking resistors 2)	R_{min}	Ω	75		33		21	15

1) Applies to internal braking resistor. When using an external braking resistor (BR2, BR3) the continuous braking performance is determined by the continuous performance of the resistor.

2) Applies to version codes BR2 and BR3. The peak braking performance is determined by the value of the resistor.

Selection of braking chopper versions and design values:

1. Draw the operating profile of your drive (n/t, M/t, see Fig. 1a).

2. Calculate the required peak braking torque and peak braking performance (see Fig. 1b) :

$$M_{Br\,max} = \frac{(J_M + J_L)(n - n')}{9{,}55 \cdot t_{Br}} \mp M_L \quad)^*$$

$$P_{Br\,max} = \frac{M_{Br\,max} \cdot n}{9{,}55 \cdot \frac{s}{min}}$$

)* Formula applies to M_L = const., J_L = const.

J_M - moment of inertia of the motor

J_L - moment of inertia of the load, reduced to the motor shaft

M_L - load moment, prefix sign shows direction of effect

n' - speed before braking [min^{-1}]

n - speed after braking [min^{-1}]

t_{Br} - braking duration

Where $P_{Br\,max.} \geq 6$ kW then use external braking resistor:

$$R_{Br} \leq \frac{U_{ZK}^2}{P_{Br\,max}}$$

with U_{ZK} = 745 V,

Ensure that: $R_{Br} \geq R_{min}$ (see Table Page 4-5)

3. Calculate effective braking performance (see Fig. 1b):

$$P_{Br\,eff} = \frac{\frac{P_3}{2} \cdot t_3 + P_5 \cdot t_5 + \frac{P_6}{2} \cdot t_6}{t_{Sp}}$$

Where $P_{Br\,eff.} \leq P_{eff.}$ (see Table, z. B. 60 W for MC6404) ⇒ Version code standard

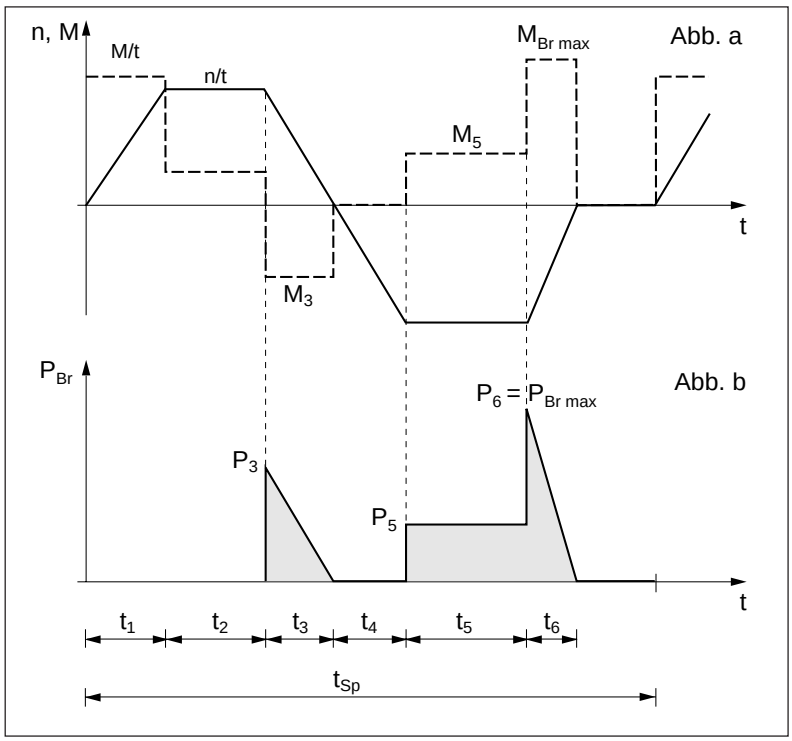
$\leq 10\,\% \cdot P_{max}$ ⇒ external resistor (BR2)

$\leq P_{max}$ [1)] ⇒ external resistor (BR3)

$> P_{max}$ [1)] ⇒ external braking chopper

1) P_{max} = 6 kW for R_B = 90 Ω; 7,4 kW (75 Ω); 16,7 kW (33 Ω); 26,4 kW (21 Ω); 37 kW (15 Ω).

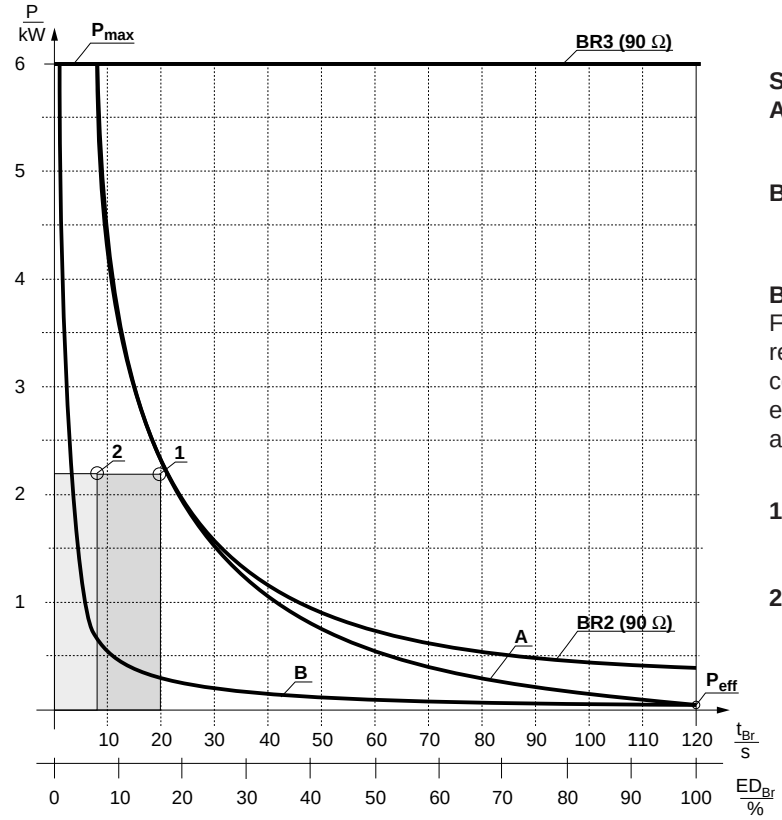
Fig. 1: Example for operating profile: a lifting application.



Warning - Danger of Death!

It is your responsibility to ensure that the braking process remains within the approved limits in the graph in diagram 2 and below the limit values in the table below. For longer periods of braking at higher braking power, the power stage will be blocked to protect it from overvoltage. When this occurs the Servocontroller will not control the motor in any way. The motor or the installation may be damaged. Danger of death!

Fig. 2: Permissible Braking Power related to braking duration ED_{Br}.



Standard version:

A - single braking process (waiting time ≥ 10 min., heat sink temperature ≤ 60° C).

B - Cyclic braking with braking duration ED_{Br}.

BR2 and BR3:

For details of other braking resistors see table below. The continuous performance of the external resistor must be appropriate!

1 - permissible operation for single braking (Example 1).

2 - operation for cyclic braking, use BR2 not permissible (Example 2).

Permissible Braking Power related to braking duration ED_{Br}									**BR3**	
Braking time t_{Br} . (only (applies to t_{Sp} = 120 s)	s	0 ... 8	10	20	30	40	60	120	0 ... 120	
Braking duration ED_{Br}	**%**	**0 ... 6,6**	**8,3**	**16,6**	**25**	**33,3**	**50**	**100**	**0 ... 100**	**E_{max}**1)
Braking power										
Curve A	kW	6	4,8	2,4	1,6	1,1	0,6	P	–	4.800 Ws
Curve B	kW	device dependent $P_{Br\,eff} = E_{max} / t_{Br}$							–	P_{eff} · 120 s
BR2 with 90 Ω	kW	6	4,8	2,4	1,6	1,2	0,8	0,4	6	48.000 Ws
BR2 with 75 Ω	kW	7,3	5,9	2,9	1,9	1,4	0,98	0,49	7,3	59.000 Ws
BR2 with 33 Ω 2)	kW	16,7	13,4	6,7	4,4	3,3	2,2	1,1	16,7	134.000 Ws
BR2 with 21 Ω 3)	kW	26,3	21,1	10,5	7	5,2	3,5	1,7	26,3	211.000 Ws
BR2 with 15 Ω 4)	kW	37	29,6	14,8	9,8	7,4	4,9	2,4	37	296.000 Ws

1) Any point on the curves can be calculated from the permissible braking energy Emax.
2) Only for MC6412 to MC6464; 3) only for MC6432, MC6464; 4) only for MC6464.

Note: It is important to differentiate between

- Internal ON duration ED_i : switch-on limit of internal braking transistor (duty cycle)
  ED_i= 10 % means max. 8 seconds braking with peak braking power per cycle
  ED_i= 100 % means no limit continuous peak braking performance possible..
- Braking duration ED_{Br}:

$$\text{Braking duration } ED_{Br} = \frac{\text{Sum of braking time}}{\text{Cycle duration}} \cdot 100\ \%$$

Using the internal braking resistor (Standard model):
For a single braking process within a ten minute period the peak braking power of 6kW may be applied for 8 seconds (see Diagram 2, curve A). This assumes that the temperature of the side-mounted heat sink is ≤ 60° C before the start of braking. For cyclic braking the braking poweer and duration can be read off curve B in Diagram 2.
Continuous braking power is shown in the table on page 4-5. In the case of regenerative applications, i.e. continuous braking (an exception) permissible continuous braking power corresponds to power loss.

Example : Checking an operating point for single braking processes (curve A)

A drive with an MC6404 is being used at occasional irregular intervals (always >10 min.) for raising and lowering a tool. The braking power required has been calculated at 2.2 kW for 20 seconds. Is the internal braking resistor adequate for this purpose?

1. Permissible braking energy: $E_{max\,A} = P_{max} \cdot 8\ s$

$E_{max\,A} = 6\ kW \cdot 8\ s = 48.000\ Ws.$

2. Condition for each operating point: $\boxed{P_{Br\,eff} \cdot t_{Br} \leq E_{max\,A}}$

in the example: $2{,}2\ kW \cdot 20\ s = 44.000\ Ws \leq E_{max\,A}$

⇒ The internal resistor is adequate if the temperature of the heat sink is ≤ 60° C before the braking operation. Check correct operation during commissioning.

Examplel : 2 Checking an operating point for cyclic braking (curve B)

Is the internal braking resistor still adequate if the lifting operation is to be every 90 seconds (including 6 seconds total braking time) on a regular basis?

1. Braking duration: $ED_{Br} = \frac{6\ s}{90\ s} = 6{,}7\ \%.$

Braking time: $t_{ED_{Br}} = 120\ s \cdot 6{,}7\ \% = 8\ s$ (assuming 120 s cycle)

2. Permissible braking energy: $E_{max\,B} = P_{eff} \cdot 120\ s$

for the MC6404: $E_{max\,B} = 60\ W \cdot 120\ s = 7.200\ Ws.$

3. Condition for each working point: $\boxed{P_{Br\,eff} \cdot t_{ED_{Br}} \leq E_{max\,B}}$

in the example: $2{,}2\ kW \cdot 8\ s = 17.600\ Ws > E_{max\,B}$ Internal braking resistor is not adequate

® from the table on pages 4-7, at the foot: $E_{max} = 48.000\ Ws$ for BR2 with $R_B = 90\ \Omega$.

⇒ An external braking resistor is in fact required.

Using an external braking resistor (BR2 and BR3):
BR2 only: Peak braking power is limited by the braking circuit to 8 seconds. The waiting time after a braking operation (or cyclic braking application) is shown in Fig. 2.

BR2 and BR3: The resistance value must be at least that shown in the table or damage to the braking transistor may result. Continuous braking power depends on the continuous and peak braking power of the resistance value of the resistor.

If there is an internal resistor, it must be disconnected and its connections insulated. As the braking resistor generates heat it is essential to ensure it is mounted with adequate separation from the servocontroller.

4.3.5 DC Link Circuit Terminals

An external braking chopper can be connected to these terminals in order to increase braking power especially in dynamic applications.

Following consultation with the manufacturers, LUST, you can:

1. feed in the DC link voltage or
2. connect the DC link circuits of several Servocontrollers.

All auxiliary supplies are generated from the DC link voltage.

Warning - Danger of Death!
Voltage at terminals > 500 V DC!

4.3.6 MC6000 Protection Functions

Electrical equipment is so designed that in an emergency rapid switch-off is possible to protect human life or to prevent damage to the installation. In the case of a Servodrive there is danger particularly from the rotating parts of the drive (both for people and also for installation componenents). The MC6000 Servocontroller offers two possibilities for switch-off if there is danger from the rotating drive:

1. **Blocking the power stage:** The power stage can be blocked directly (without software control) via input ENPO (X5). This separates the motor from control and it then coasts on uncontrolled or it can be braked using a mechanical brake (*see Section 4.4.4*).

   Warning: Cancel Start before switching on ENPO input again. Otherwise the system will try to correct the difference between the reference value and the actual value which has arisen in the meantime - i.e. the drive will start of its own accord.

2. **Emergency Stop:** This is triggered via a programmable input to which the function Emergency Stop has been allocated. The motor will then be braked to a stop at the set maximum torque value regeneratively and held in this position. It is also possible to use Emergency Stop via a programmable braking ramp (*see Section 7.3.1*).

These protection functions do not constitute safety arrangements in the sense of VDE0100

The usual Emergency Off arrangement in the mains supply is also possible if the Servocontroller has to be isolated from power in an emergency. Switching off the power supply disconnects the motor from the mains and it coasts on uncontrolled. However, it will only stop after some considerable delay because the stored energy has to be dissipated through friction alone.

It is possible to provide the MC6000 control section with an external 24V supply so that control functions and communication are maintained (supply at +24V and DGND terminals).

The Emergency Off safety arrangements of the Servodrive must meet the relevant standards and regulations specific to the application (e.g. VDE0100)!

4.4 Control Connections

The MC6000 Servocontroller can be linked via the terminal strip to a superordinate controller (e.g: PLC). The terminals carry:

- two analog inputs for reference value input
- three digital inputs, two of them fully programmable
- two digital outputs, fully programmable
- auxiliary voltages for reference value input (± 10 V)
- auxiliary voltages for digital inputs and outputs (+ 24 V)

The fully programmable inputs and outputs (IS00, IS01, ISA0, ISA1, OS00, OS01) can perform various functions. Each input and each output has a function selector which allocates the required function *(see Section 7).*

The analog reference value inputs can also be used as digital inputs. Output OS00 can also be used as a pulse width modulated output. The output signal (0 to +24V) is intended for slow response pointer instruments but not for processing in controls.

The control lines must be screened. The cable screen must be grounded **at both ends,** at the Servocontroller using the cable clamp provided for the purpose.

The control inputs and outputs have a common potential, which is isolated from the mains potential. The control inputs and outputs are not potential-isolated via optocouplers, as most programmable controls (PLC) are themselves potential-isolated.

4.4.1 Control Terminal Allocation (X5)

Terminal No.	Terminal identification	Description of Terminals
1	+10V	Voltage supply for reference value input
2	- 10V	
3	ISA0-	Analog reference value input 0 (differential)
4	ISA0+	+10 to -10 V / +20 to -20 mA
5	ISA1	Analog reference value input 1: 0 to +10 V / 0 to +20 mA
6	AGND	Ground for analog reference value input
7	+24V	+24 V-supply for digital
8	+24V	inputs and outputs 1)
9	IS00	Digital standard inputs
10	IS01	freely assignable using software
11	ENPO	Input power stage (Enable Power Output)
12	OS00	Standard outputs
13	OS01	OS00 can also be used as a PWM output
14	DGND	Ground for digital standard inputs and outputs 1)

1) Connections are also used for the control section when there is an external +24V supply

4.4.2 Specification of Control Connections

Auxiliary supplies:

- ±10 V DC, ±5%, short circuit proof, max. load 2 mA
- +24 V DC, internal: ±10%, short circuit proof, max. load 200 mA
- +24 V DC, with external supply (all other voltages are generated from +24 V): ±20%, current requirements: typically 0,5 A (all inputs and outputs loaded, no cards in slots 1 and 2); max. 3 A (slots 1 & 2 occupied)

Analog reference value inputs ISA0-, ISA0+, ISA1:

- for entering reference values with voltage or current (configurable using jumpers J1 and J2)

		ISA 0	ISA 1
Range	U	-10 ... +10 V	0 ... +10 V
	I	-20 ... +20 mA	0 ... 20mA
Input Impedance	U	≥ 100 kΩ	94 kΩ
	I	500 Ω	500 Ω
Resolution		11 Bit	10 Bit
Accuracy		3 % ± 1 LSB	1 % ± 1 LSB
Switching level digital	LOW=	< 4,8 V	
	HIGH=	> 8 V	

- with protection against external voltage spikes
- cascading of several drives possible using voltage reference value and current reference value
- can also be used as fully programmable +24V digital inputs
- sampling time 1 ms
- offset matching factory-set (hardware)

Control inputs IS00, IS01:

- fully programmable
- sampling time 1 ms
- delay time input filter 10 ms
- PLC compatible, +24 V logic to DGND
- Switching level HIGH = 19,2 to 26,8 V DC
  LOW = 0 to 4,8 V DC
  (other voltages not permissible)
- contact current 6,4 mA (24 V), 8 mA (30 V)
- input impedance 3,9 kΩ

Power stage enable ENPO:

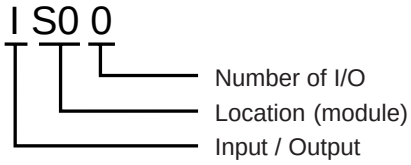
- hardware enabling of power stage
- delay time input filter 10 ms
- PLC compatible, +24 V- logic to DGND
- high level = power stage enabled

Outputs OS00, OS01:

- digital +24V outputs, high active
- short circuit proof
- fully programmable
- sampling time: 1 ms
- max. load per output: 65 mA
- internal freewheeling diode
- OS00 can also be used as PWM output:
  - * pulse width modulated output signal
  - * PWM frequency: 200 Hz
  - * minimum load: 1 kΩ
  - * can be used as quasi analog signal (0 to+24V) for pointer instruments

4.4.3 Identification of Input and Output Codes

The codes for inputs and outputs are made up as follows:



Code Input/Output	Device(module)		Description
IS00, IS01	Servocontroller	S	Standard inputs
OS00, OS01		S	Standard outputs
ISA0, ISA1		SA	Analog inputs
IP1x	PosMod1	P1	x= 0 to 7
OP1x			x= 0 to 3
ICyx	CAN-Module 1)	C	x= 0 to 7, y= 0 to 7
OCyx			x= 0 to 7, y= 0 to 7
IExx	I/O Module 1	E	xx= 00 to 07
OExx			xx= 00 to 03

1) only in connection with PosMod1, 12 I/8 0 per module.

4.4.4 Wiring of Control Terminals

The diagrams show the switching arrangements of the control terminals.

Differential analog input ISA0

1. Input of voltage reference value
   ISA0 = - 10 to + 10 V;

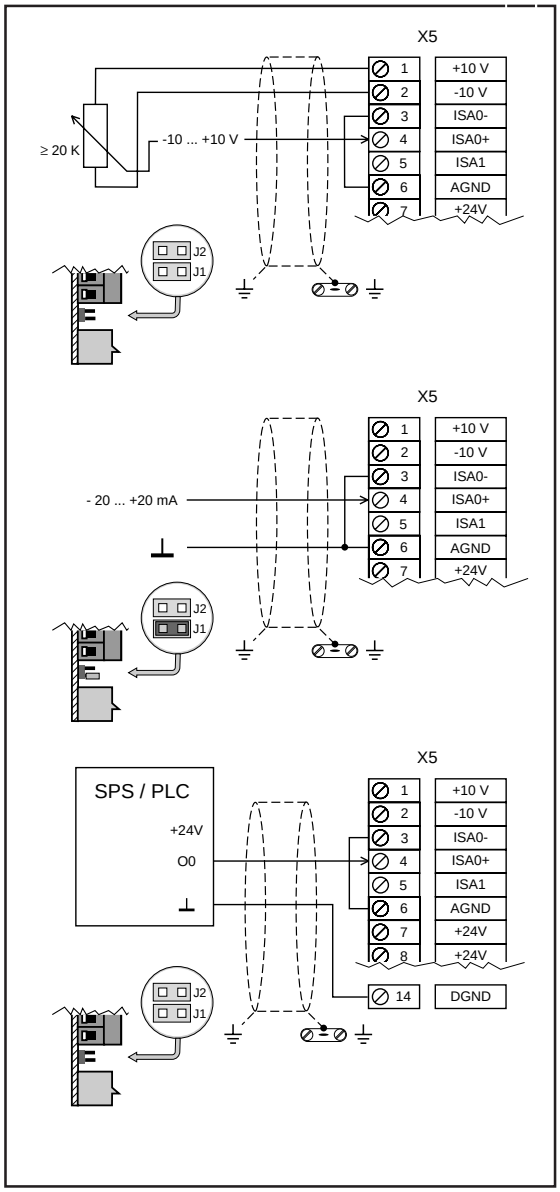
   Resolution 11 Bit
   (10 Bit per direction of rotation);

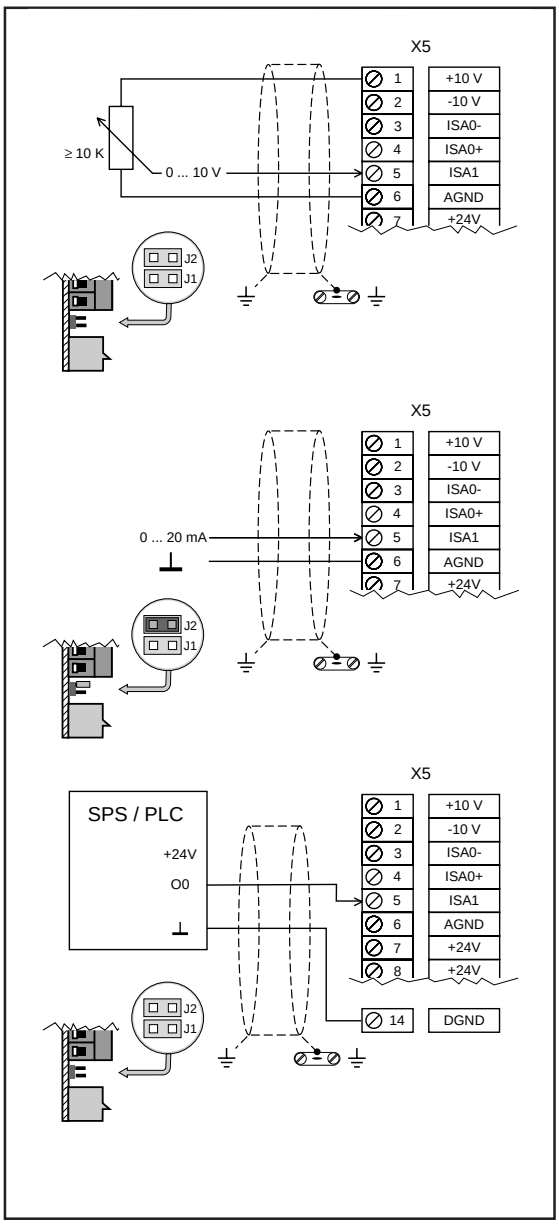
2. Input of current reference value
   ISA0 = - 20 to +20 mA;

   Resolution 11 Bit
   (10 Bit per direction of roation);

   Jumper J1 must be set

3. Use as digital input





Analog input ISA1

1. Input of voltage reference value
   ISA1 = 0 to + 10 V;

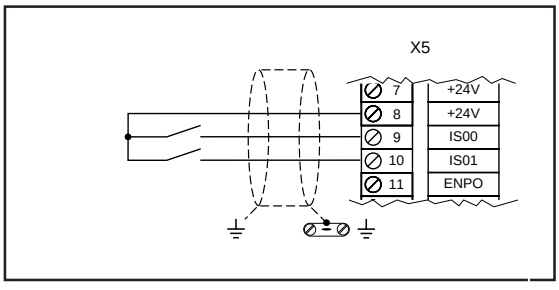
   Resolution 10 Bit

2. Input of current reference value
   ISA1 = 0 to +20 mA;

   Resolution 10 Bit;

   Jumper J2 must be set

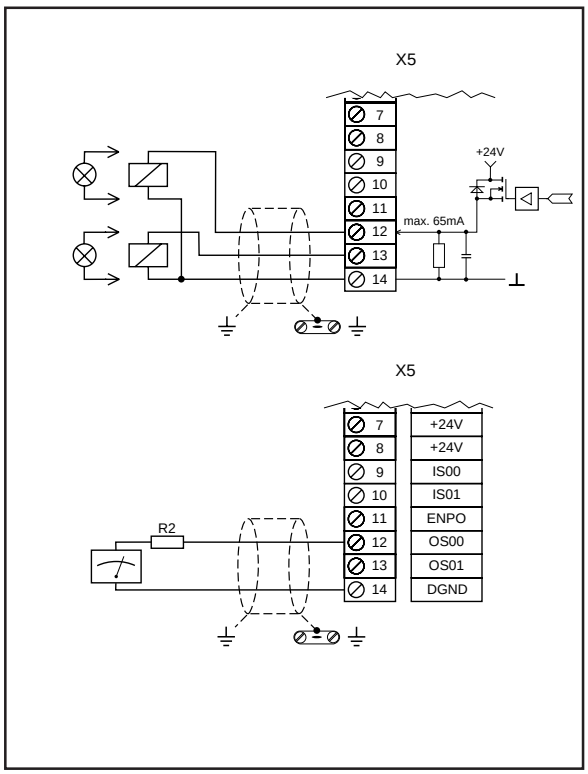
3. Use as digital input



Digital Standard Inputs IS00, IS01

Outputs OS00, OS01

1. Use as digital output

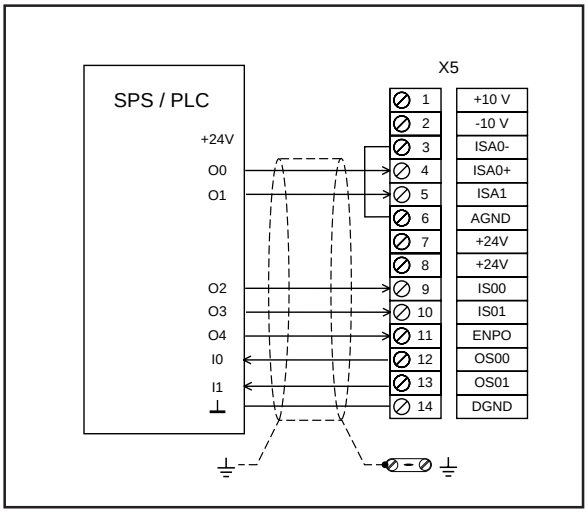


2. Use as PWM output

   Output voltage range: 0 - 24V
   minimum load: R2 ≥ 1 kΩ

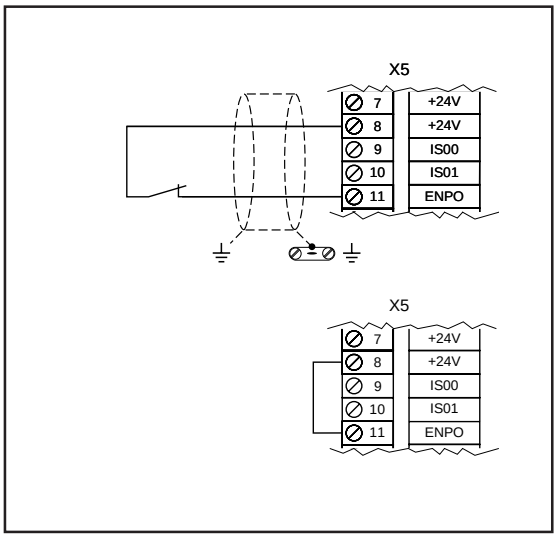
Wired in parallel with a PLC

(e.g. use of 5 digital inputs
and 2 digital outputs)



4.4.5 ENPO Input (Enable power stage)

ENPO input (Enable Power Output) enables or disables the power stage transistors of the Servocontroller. The input is directly hard wired in the hardware. Apply +24 V to the input to enable the power stage.



ENPO Digital Input Enable Power Stage

1. Facility for blocking power stage is used

2. If not used +24V should be applied to the input

The ENPO input can be used for an emergency function (*see Section 4.3.6*). If the input is set to LOW the power stage is locked and the power to the motor is cut off.

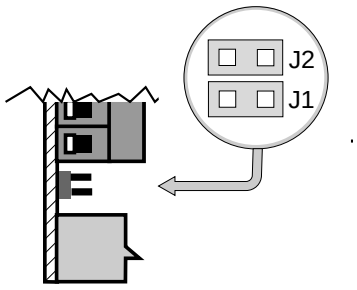
This input can also be used to reset faults. To reset an error message the HIGH level is cancelled at input ENPO and then reapplied. Errors can also be reset using the KEYPAD multifunction control unit.

4.4.6 Input of Current Reference Values

Both Jumpers J1 and J2 can be used to select input reference at analog input ISA0 and ISA1 as voltage or current reference signal. The jumpers are immediately under the control terminals.

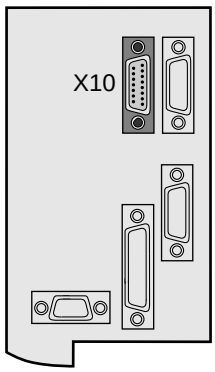
Internal resistance: 500 Ω (with current reference values)

Use as	ISA0 J1	ISA1 J2
Input for voltage reference value		
Input for current reference values		
Digital input		



4.5 Encoder Connection

The encoder cable is supplied ready for use. This cable connects the round connector on the motor casing to the 15 way Sub-D socket in the device lid as shown in the system connection plan.



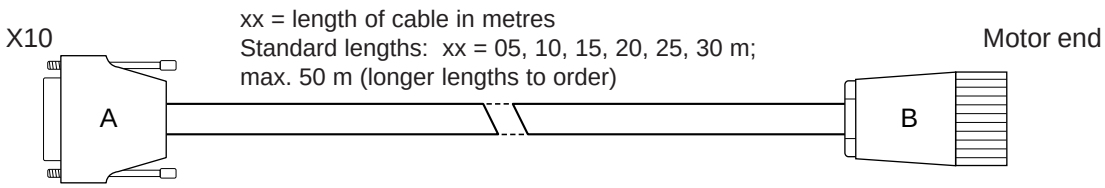
The encoder cable must **not** be separated, for example to feed signals via terminals in the cabinet. Ensure that the knurled screws on the Sub-D connector case are screwed home tight!

The MASTERCONTROL Servocontroller recognises which encoder is connected by reading in the SMARTCARD so no manual adjustment is necessary.

Warning!
It is absolutely essential to ensure that the encoder interface, encoder type and encoder cable are compatible (*see Section 3.1 "Instructions for Installation"*) otherwise correct functioning cannot be guaranteed.

Warning - Danger of Death!
Under no circumstances must the encoder cable ever be withdrawn during operation because the Servocontroller would lose all control of the motor. This could lead to damage to the motor and the equipment and also be a source of danger to people because of the uncontrolled rotation of the drive.

4.5.1 Resolver Cable KRX-Nxx, KRX-KSxx



A	B	Function	Color
1		inner screen	
2		inner screen	
3		n. c.	
4	5	REF+	yellow
5	7	REF-	green
6		n. c.	
7	2	COS+	pink
8		n. c.	
9		inner screen	
10		n. c.	
11		n. c.	
12	10	SIN+	white
13	1	SIN-	brown
14	11	COS-	gray
15		n. c.	
outer screen to casing			

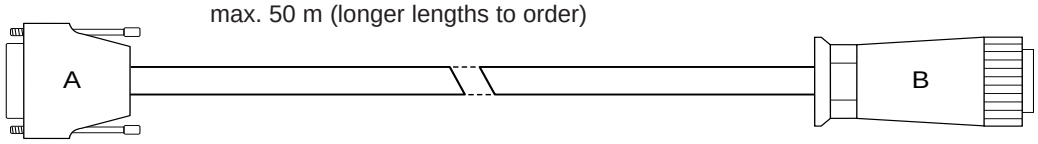
KRX-Nxx	Cable not festoonable Lapp Unitronic CY Pi CY 3x2x0,25
KRX-KSxx	Cable festoonable Lapp Ölflex Servo-FD 760 P
Connector X1	Sub-D 15-pin metal housing
Connector X2	Signal connector 12-pin socket Interconnectron SPNA12B NNNN 169 (for KRX-Nxx) PLD121 NV 171187 (for KRX-KSxx)

4.5.2 Encoder Cables: KG1-KSxx and KG2/3-KSxx

X10

xx = length of cable in metres
Standard Lengths: xx = 05, 10, 15, 20, 25, 30 m;
max. 50 m (longer lengths to order)

Motor end



KG1-KSxx

A	B	Function	Color
1		bridge pin	
2		1 K pin 4	
3		5 V	blue
4	C	5 V, 1 K pin 2	brown/green
5	A	0 V	white/green
6		bridge pin	
7	J	B+	gray
8	H	R-	black
9		n. c.	
10		n. c.	
11		0 V	white
12	E	A+	brown
13	F	A-	green
14	K	B-	pink
15	G	R+	red
outer screen to casing			

KG1-KSxx Cable not festoonable,
Heidenhain 244 957 01

KG2/3-KSxx Cable festoonable,
Heidenhain 266 306 01

KG2/3-KSxx

A	B	Function	Color
1	T	DATA+	gray
2	U	DATA-	pink
3	D	5 V	blue
4	C	5 V	brown/green
5	A	0 V	white/green
6	V	inner screen	
7	J	B+	blue/black
8		n. c.	
9	S	CLK-	yellow
10	R	CLK+	purple
11	B	0 V	white
12	E	A+	green/black
13	F	A-	yellow/black
14	K	B-	red/black
15		n. c.	
outer screen to casing			

Connector X1 Sub-D 15-pin metal housing

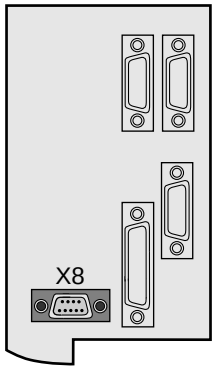
Connector X2 Connector19-pin socket
Schaltbau Munchen T1

Encoder Cable Technical Specifications

	Unit	KRX-Nxx	KRX-KSxx	KG1-KSxx	KG2/3-KSxx
for encoder types		R1, R2, R8		G1	G2, G3
festoonable		no	yes	yes	
minimum radius					
fixed routed cable	mm	60	k. A.	40	
loose routed cable	mm	–	120	100	
temperature range:					
fixed routed cable	°C	- 30 ... + 70	k. A.	- 35 ... + 80	
loose routed cable	°C	–	- 30 ... + 70	- 10 ... + 80	
cable diameter, approx.	mm	9,9	9,4	8,0	
outer sheath material		PVC	PUR	PUR	
chemical resistance		flame retardant	flame retardant, resists moisture and microbes	Resistant to oil, moisture & microbes (VDE0472)	

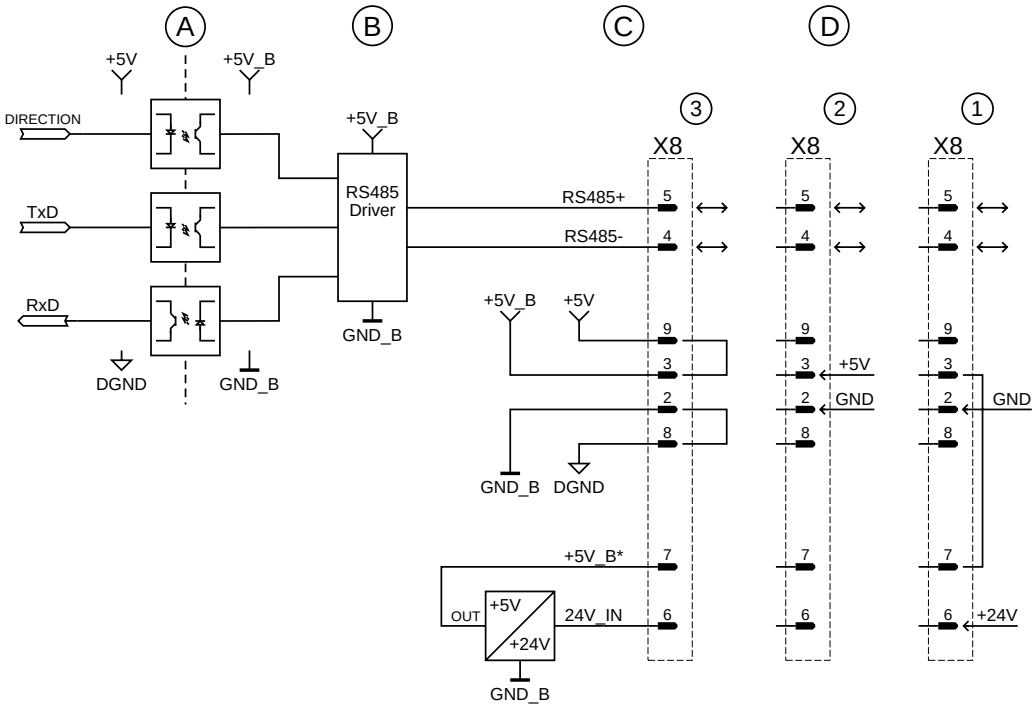
4.6 Serial Interface RS485

The MASTERCONTROL RS485 Serial Interface is available at the 9-pin Sub-D connector X8. The Serial Interface is potential-isolated via optocoupler to improve resistance to interference and an external voltage supply is required for that purpose



There are three ways of connecting & using the RS485 interface:
1. potential-free, + 24 V supply.
2. potential-free, + 5 V supply.
3. not potential-free, use of internal + 5 V supply.

The block diagram below shows the serial interface and connection options:



No.	Function
A	isolated by optocoupler
B	conversion to RS485 level
C	RS485 connection via X8
D	connection versions for supply voltage
1, 2, 3	wiring for versions 1, 2, 3

The following table shows the allocation of the RS485 interface and the version-specific connections required. The connections listed are made within the cable connector.

Pin no. X8	Assignment (RS485)	Version 1 (external + 24 V)	Version 2 (external + 5 V)	Version 3 (internal + 5 V)
1	n.c.	n.c.	n.c.	n.c.
2	GND_B	GND	GND	GND, bridge pin 8
3	+5V_B	bridge pin 7		bridge pin 9
4	RS485-	RS485-	RS485-	RS485-
5	RS485+	RS485+	RS485+	RS485+
6	24V_IN	+ 24 V supply	n.c.	n.c.
7	+5V_B*	bridge pin 3	n.c.	n.c.
8	GND	n.c.	n.c.	GND, bridge pin 2
9	+5V	n.c.	n.c.	bridge pin 3

Screening:
The serial interface must be connected using screened cable and the screening must be grounded via the connector housing to grounding conductors.

If Bus operation must be ensured in case of mains power supply failure, then the +24 V voltage for the control section must be an external supply (*see Section 4.4.1*)!

PCs with RS232 interface (25-pin Sub-D socket) can be connected using the interface connector cable which is available as an accessory (LBSKK200). This cable which converts the RS485 signals to RS232 uses the internal + 5V supply of the Servocontroller.
This cable is not intended for networking but is simply used to connect a single Servocontroller to a PC.

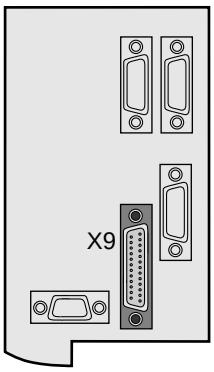
Sub-D 25pol.	PC-RS232
2	TxD
3	RxD
7	GND

The serial interface parameters (e.g. baud rate) are in area _SIO. The interface supports the LustBus data transfer protocol and up to 30 frequency inverters and Servocontrollers can be networked.

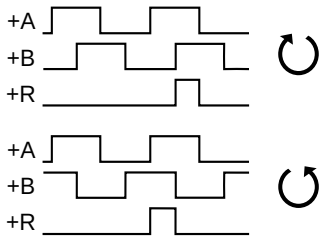
4.7 Encoder Simulation

Encoder simulation provides position information, e.g. when operating with superordinate position control in twin device technology (*see diagram Twin Device Technology below*) or in the mode position servocontrol mode (special software in preparation).

Encoder simulation is provided at connector X9 (25 pin Sub-D socket). This simulates an incremental encoder with square wave output signals using the signals from the encoder connected at X10.

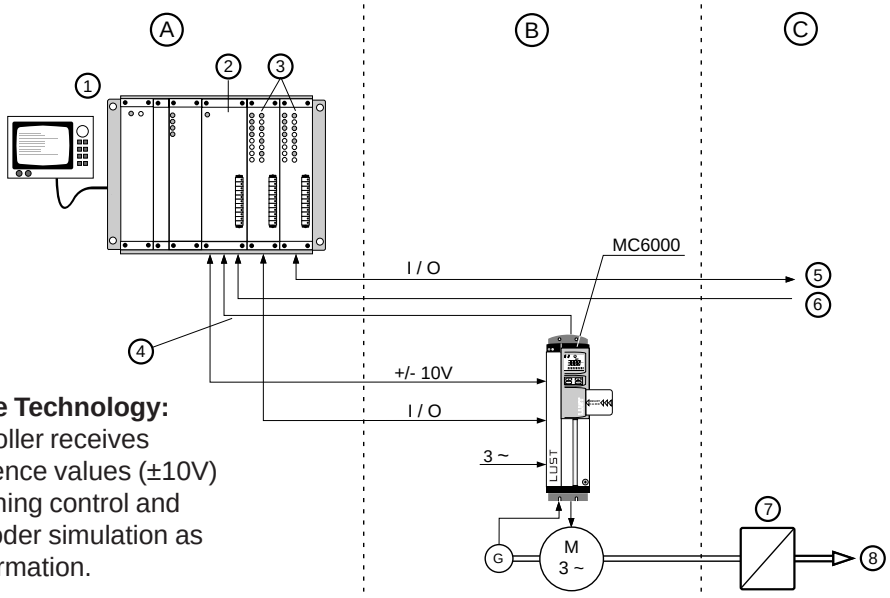


Encoder simulation is generated using hardware switching. The signals are time continuous and quasi delay free (only few gate times). Using encoder simulation does not produce a restriction on maximum speed.



Encoder simulation provides +5V level signals. In resolvers, the number of pulses per revolution is obtained by multiplying the pole pair number P of the resolver with the standard pulse count 1024. Because of the pole pair number, R2 resolvers produce 2 null pulses per revolution and R8 resolvers produce 3. If this is not desirable, the single pole pair resolver R1 can be used.

Encoder at X10	G1	G2	G3	G4	R1 (p=1)	R2 (p=2)	R8 (p=3)
Pulses per rev. at X9	2048			1024	1024	2048	3072
Null pulses per rev.	1	0	0	0	1	2	3



Twin Device Technology:
Servorcontroller receives speed reference values (±10V) from positioning control and returns encoder simulation as position information.

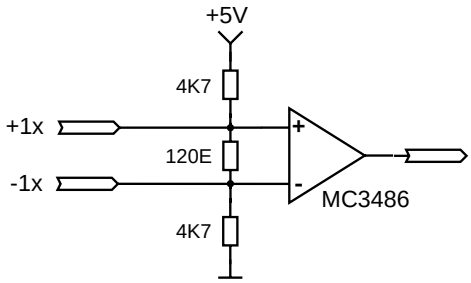
No.	**Function**	**No.**	**Function**
A	Control level	3	I/O module
B	Drive level	4	Encoder simulation
C	Process level	5	I/O signals from/to process
1	PLC with control unit	6	Reference cams, safety limit switches
2	Serial interface SIO (RS485, InterBus-S, CAN-Bus)	7	Drives
		8	Single process

Additional Input for incremental encoders

Servocontrollers which are equipped to evaluate signals from optical encoders (Version code D2) also have an additional function which can be used in future by specific software modules. In this equipment the X9 connector can also be used as an input for an additional incremental encoder with square-wave output signals. Encoder simulation and incremental encoder input both use non-inverted and inverted signals (e.g. +1A=LOW → -1A=HIGH).

Evaluation of encoder simulation signals

Line receiver MC3486 is suitable for evaluating differential signals. The line should be terminated with a 120 Ω resistor. If required, the output signals from the MC3486 can be potential-isolated via an optocoupler.



Connection Cable:
Twisted pair with complete screening, screening grounded at both ends. Max. cable length 20m.

x = A, B or R

Note:

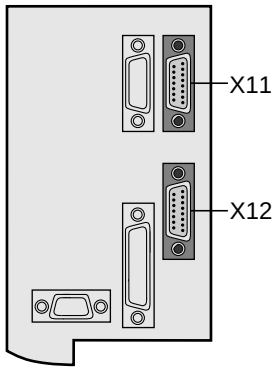
The superordinate control must be able to process the encoder simulation high output frequencies. Example: f = 3000 min^{-1} · 2048 pulses = 102 kHz. If necessary, an industry standard external frequency divider can be used.

Pin no. X9	Assignment	Function
1	+5V	output in the case of incremental encoder: input to supply encoder (load 40 mA)
2	n.c.	
3	+2R	incremental encoder input
4	n.c.	
5	+2B	incremental encoder input
6	n.c.	
7	+2A	incremental encoder input
8	n.c.	
9	n.c.	
10	n.c.	
11	n.c.	
12	GND	
13	+1R	encoder simulation output
14	+5V	
15	+1B	encoder simulation output
16	-2R	incremental encoder input
17	-1B	encoder simulation output
18	-2B	incremental encoder input
19	-2A	incremental encoder input
20	+1A	encoder simulation output
21	n.c.	
22	-1A	encoder simulation output
23	n.c.	
24	-1R	encoder simulation output
25	GND	

n.c.	not connected
1	encoder simulation output
2	incremental encoder input (only in the case of encoder interface for optical encoders (Model D2) not for encoder interface for resolver (n.c.)
R	reference signal from an incremental encoder (zero pulse)
A	track A of incremental encoder
B	track B of incremental encoder

4.8 InterBus-S Interface (C1 and C7)

Version Code C1: Local Bus Connection (IBS-L)
C7: Remote Bus Connection (IBS-F)



The Bus connection is via X11 and X12:
X11 - InterBus-S output (Sub-D connector socket)
X12 - InterBus-S input (Sub-D connector plug)

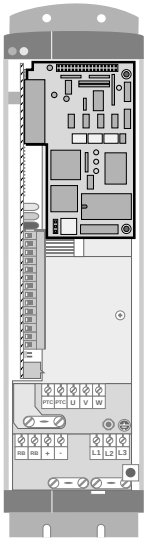
Local Bus connection (C1):
Sub-D 15-pin

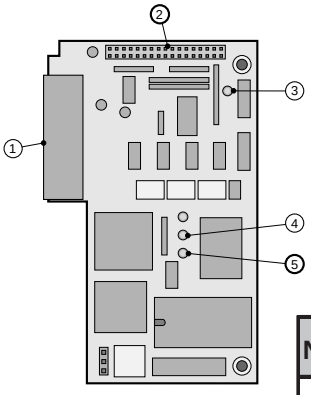
X11	Assignment	X12
1	Uv0	1
2	Uv0	2
3	+ 5 V	
4	RBST	
5	SLI	5
6	CKI	6
7	CRI	7
8	DI	8
9	COM	9
10	COM	10
11	RC	11
12	SLO	12
13	CKO	13
14	CRO	14
15	D0	15
	n.c.	3, 4

Remote Bus connection (C7):
Sub-D 9-pin

X11	Connection	X12
1	D0	1
2	DI	2
3	COM	3
5	+ 5 V	
6	/D0	6
7	/DI	7
9	RBST	
4, 8	n.c.	4, 5, 8, 9

Screening:
The Bus must be wired using a screened cable and the screening must be grounded to a grounding conductor via the connector housing.





No.	Function
1	Connection for slot 1 (X6)
2	Connection X11 and X12
3	LED "Bus supply voltage OK "
4	LED "parameter channel initialised "
5	LED "TRANSMIT / RECEIVE"

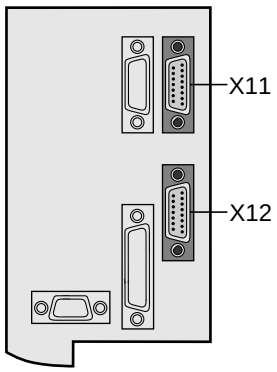
Note:
To ensure uninterruptible operation of the InterBus-S independently of the MC6000 mains power supply, the Servocontroller should be operated using an external +24V supply (*see Section 4.4.1*).

Technical Specifications	
Supply voltage:	24 V DC ± 20 % for MC6000 controller
Current:	max. 3 A (slots 1 and 2 occupied), typically 0.5 A
Interface version:	C1 - Local Bus C7 - Remote Bus (2 conductor)
Module identification:	Factory setting 211,i.d. may be changed
Data:	Processing data - control word - reference value, channel width can be set PCP-Data - channel width can be set

Note:
For further information on the installation, please consult the InterBus-S Installation Handbook by Messrs. Phoenix Contact (IBS SYSINST UM).

4.9 CAN-Bus Interface (C2)

The Bus connection is via X11 and X12:
X11 - Sub-D 9-pin connector socket
X12 - Sub-D 9-pin connector plug



X11, X12	Allocation
1	5 V
2	CAN_L
3	GND-CAN 1)
4	ADR0
5	ADR1
6	GND-CAN 1)
7	CAN_H
8	ADR2
9	24V-CAN 1)

1) External +24V supply required (24 V DC, ± 10 %, 100 mA)!

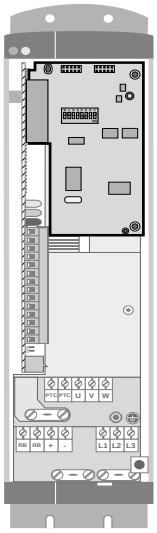
Screening:
The Bus must be wired using a screened cable and the screening must be grounded to a grounding conductor via the connector housing.

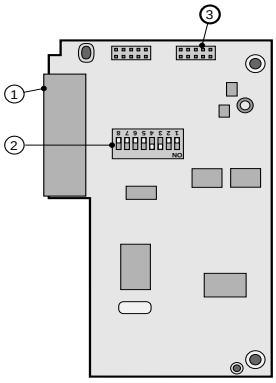
Facilities for allocating device addresses:

a) using a parameter (Addresses 0 - 29)
b) using DIP switches on the PCB (Addresses 0 - 29)
c) using a coded plug (Addresses 0 - 7) Connect address pins with pin 1 (+5V)

DIP switch/Pin No.									
ADRx	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Address**
	X	X	X	0	0	0	0	0	0
	X	X	X	0	0	0	0	1	1
	X	X	X	0	0	0	1	0	2
	X	X	X	:	:	:	:	:	:
	X	X	X	1	1	1	0	1	29

X - Setting of no significance





No.	Function
1	linking for slot 1 (X6)
2	DIP switch for device addresses
3	X11 and X12 connector

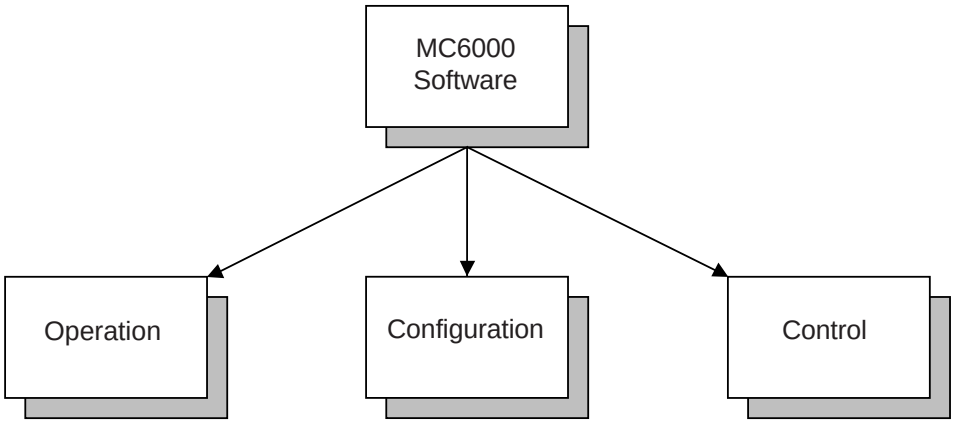
Note:
To ensure uninterruptible operation of the CAN-Bus independently of the MC6000 mains power supply, the Servocontroller should be operated using an external +24V supply (*see Section 4.4.1*).

Technical Specifications	
Supply voltage:	24 V DC ± 20 % for MC6000 controller 24 V DC ± 10 % for CAN-Bus, pin 9 (X11, X12)
Current:	max. 3 A (slots 1 and 2 occupied), typically 0,5 A
Baud rate:	can be set from 50 kBit/s (1 km line length) to 1 MBit/s (40 m line length)
Transmission:	CAN-Bus to ISO11898

5 MC6000 Software and Overview

This section provides an overview of the Servocontroller software structure. The following sections provide further detail.

The MC6000 Servocontroller software consists of 3 types:



	Operation	Configuration	Control
	Operation using KEYPAD, PC or bus systems	Configuration of Servocontroller, motor and encoder (matching to the application)	Control circuit for torque, speed and position any special matching by control technicians
important for:	Using the Servocontroller		
see	*Section 6 and separate descriptions*	*Section 7*	*Section 8*

The software is immediately much easier to use if these categories are understood since only a fraction of the MC6000 software is actually of direct significance to the user.

The **operation software** provides the user interface. It set parameters for the Servodrive, eg via the KEYPAD control unit or a PC.

Parameter setting. The **configuration software** is used for setting parameters for individual components. Some parameters depend on the drive system hardware, eg the motor and encoder specifications and data specific to that the controller, (eg device rated current, options fitted etc). The motor and encoder data are stored on the SMARTCARD and can be downloaded to the equipment for automatic compatibility matching using the KEYPAD. The hardware configuration of the Servocontroller is recognised automatically and can be displayed using the KEYPAD. Because these data do not have to be set it is actually not very important for the user to be familiar with them.

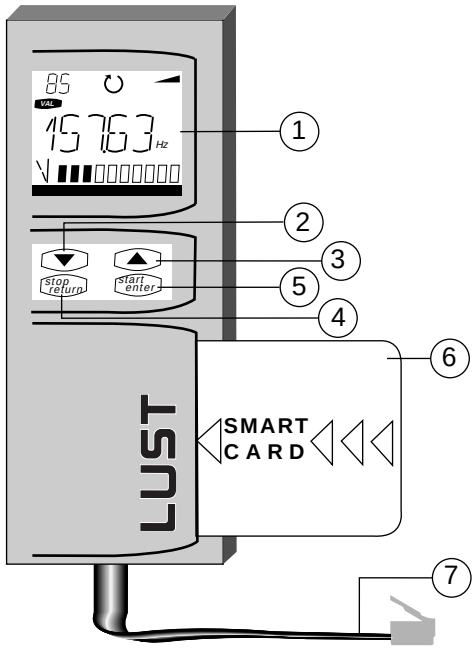
Matching the MC6000 Servocontroller to the specific application is part of the drive system configuration process. A function must be assigned to the freely assignable control input, for example, and the type of reference value input must be defined. This part of the configuration process is therefore important for the initial matching of the system to the application. Configuration is covered comprehensibly in *Section 7 "Configuration Software"*.

The **Control Software** contains the internal control structures of the Servocontroller. The parameters in these control circuits include controller application and the lag time of the torque controller. As these parameters have been factory-set for best results, they will only need modifying in exceptional cases by qualified users. The control software is described in *Section 8 "Control Software"*. In normal use there is no need to become involved in the complicated control structures.

6 System Software

It is very simple to use the Servocontroller and set the parameters using the KP100 KEYPAD which is supplied as standard.

6.1 Layout of the KEYPAD



No.	Description	Function
1	LCD display	140 segments, backlit, red/green
2	key	Scroll backw3ards in menu structure, change value
3	key	Scroll forwards in menu structure, change value
4	stop/return key	Stop (CTRL menu), exit or exit from selected menu
5	start/enter key	start (CTRL menu), confirm or select menu option
6	SmartCard	chip card data store storage of device settings
7	cable	max length 0.30 m

Dimensions and weights

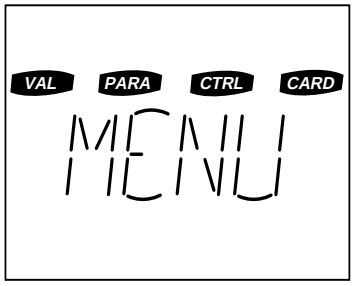
Dimensions	WxHxD	mm	62x158x21
Weight		g	100
Protection			VBG4, IP20
Ambient temperature		°C	0 - 40

6.2 Using the keys

6.2.1 General

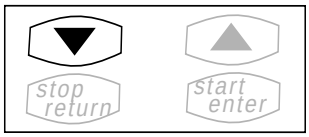
The equipment carries out a self test (display backlit in red) when the mains power supply is switched on. The instantaneous value of the control value is displayed (display backlit in green) when the test is complete.

The VAL menu option is active. Press the stop/return key twice to return to the menu and see the menu options available. The current menu is always displayed on one line of the display.



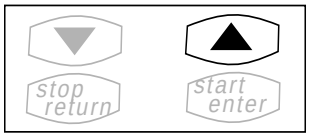
KeyPad display:	VAL	PARA	CTRL	CARD
Description	Value	Parameter	Control	Card
Function:	display values	edit parameters	control drive	read/write SmartCard

6.3 Controls

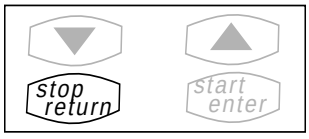


The **arrow keys** ▼ and ▲ are used for selecting menu options and specific parameters and for changing them.

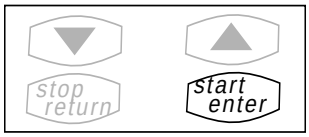
Press once to jump to the next menu branch or parameter or to increment or decrement a parameter value by the smallest step size.



If a key is held down displayed values will change until released (scroll function).

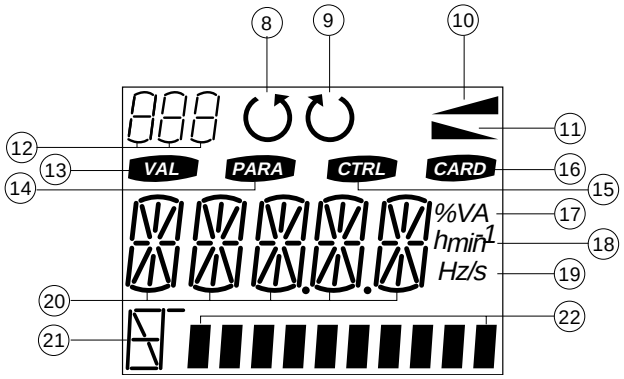


The **stop/return** key is used for exiting from a menu branch or cancelling parameter changes (old value is retained).



The **start/enter** key is used for selecting menu branches and parameters and storing changes.

6.4 LCD Display



No.	Description	Function
8	Counterclockwise	symbol for output rotating field counterclockwise enabled
9	Clockwise	symbol for output rotating field clockwise enabled
10	Acceleration ramp	symbol displayed when acceleration enabled
11	Braking ramp	symbol displayed when braking enabled
12	3 digit display	7 segment display for editing status, parameter number or exponential
13	VAL menu	display actual values, eg: speed
14	PARA menu	change parameter setting
15	CTRL menu	control drive from KeyPad
16	CARD menu	load/save device settings using SmartCard
17	Physical unit to 20	displays %, V, A, VA with automatic assignment
18	Physical unit to 20	displays h, min-1 with automatic assignment
19	Physical unit to 20	displays s with automatic assignment
20	5 digit display	15 segment display for parameter name and value
21	Barchart caption	displays formula characters/physical units for 22
22	10 column barchart	displays selected parameter values

6.5 Control Levels

The control level or mode is set using the parameter MODE (*see PARA Menü*). The number of parameters which can be edited and displayed depends on the mode selected. Modes 2 - 4 are protected from unauthorized access by passwords. The passwords allow access to all lower levels/modes.

It is always a good idea to select the lowest possible level because then only those parameters which are really necessary are displayed.
If the levels/modes are used systematically the parameters which are important for safe and reliable operation of the Servodrive are protected from unauthorised access.

MODE	Used for	Comment	Password PSWx
1	User without access authorization, for status monitoring	no parameter editable, the most important parameters displayable	
2	Users with basic knowledge, for minimum operation	the most important parameters editable, many displayable	222
3	Commissioning Users with advanced knowledge & for control using the serial interface Interbus S, CAN	all parameters necessary for standard applications can be edited, many parameters can be displayed	333
4	Users with technical control expertise and for control using the serial interface	all control parameters can be edited and displayed	444

When the user wants to change the operating level (mode) he is automatically asked for his password — PWx (x stands for the mode requested). The password to be entered is the one entered in _KPAD as a password under PSWx for the level in question.

The KEYPADS displays top left whether a parameter is just displayed independently of the current operating level or whether it can also be edited (parameter status):

Display	Meaning
-S-	Parameter can only be shown
-E-	Parameter can be edited
"-E-“	Parameter is edited

“-E-”: parameter status flashing

If a user tries to edit a parameter which in the current operating mode/level can only be displayed this fact is indicated by error ATT1 (reset using **start/end key**).

Note:
If no key is pressed for 10 minutes the operating level is reset to Level 1. This avoids the risk of unauthorized access to a higher operator level after a parameter changing session.

6.6 Examples for Setting Parameters

The procedure for editing parameters can best be understood through examples. We recommend that you make these changes during actual commissioning of the Servocontroller.

Note:
You can cancel or exit from any action by pressing **stop/return key**.

Reset to factory settings:

- single parameter: press ▲ and ▼ simultaneously
- all parameters: press ▲ and ▼ while switching mains on, KEYPAD will display RESET.
  Then download (read in) SMARTCARD (DRIVE) for matching to the motor.

Example1 - Setting user level to MODE=3:

First the user level should be changed from 1 to 3. The MODE parameter in KEYPAD (_KPAD) must be edited and then the password (— PW3 —) must be entered. The password for this level is factory set to the value 333.

We are assuming that you are starting at menu level in the PARA menu.

Display		Action	Description
	MENU	**start/enter**	Open PARA Menu
	_CONF	▲ or ▼	Search _KPAD
	_KPAD	**start/enter**	Select _KPAD
- E -	MODE	**start/enter**	Access to editing in MODE parameter
“- E -”	1	▲	To edit MODE
"- E -“	3	**start/enter**	Select user level 3
	--PW3--	**start/enter**	Password request
	0	▲	Input password 333
	333	**start/enter**	Confirm password
- E -	MODE	**stop/return**	Exit MODE parameter
	_KPAD	**stop/return**	Exit subject area
	MENU		Menu level

Symbols used:
- x - - any parameter status (-S- or -E-)
NNNNN - any parameter
"-E-" - parameter status flashing (signifies Edit mode)

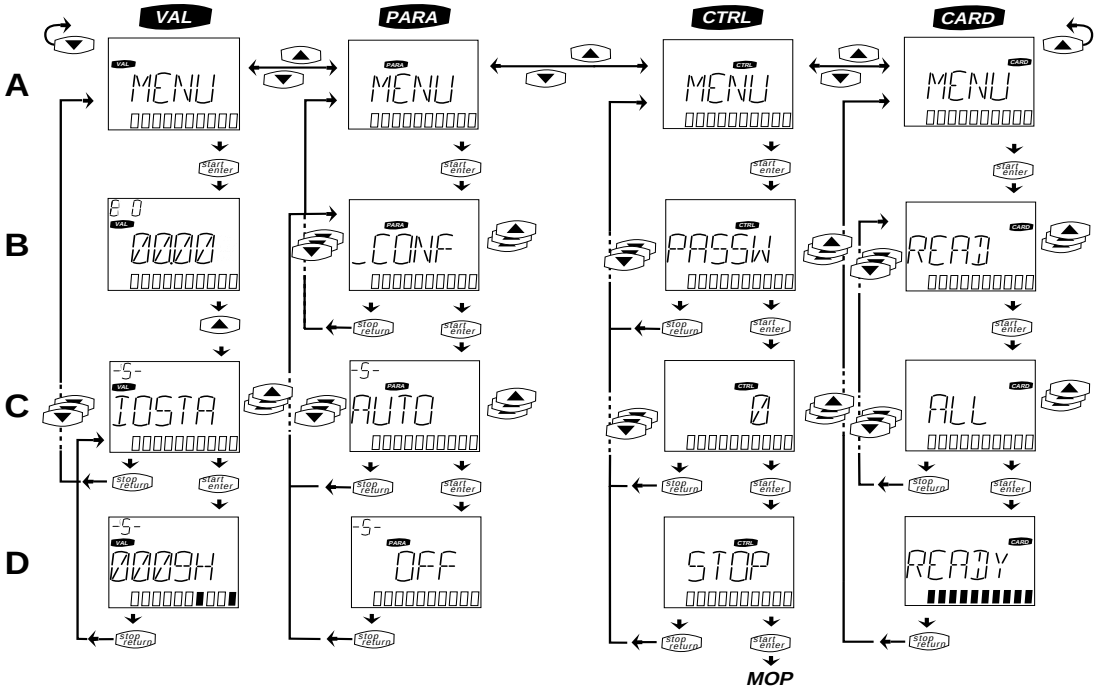
Example 2 - Setting Position Control mode

By way of an example control mode is here set to Position Control. The corresponding parameter is CFCON (CONFIGURATION CONTROL) in _CONF, which contains the system configuration. The parameter CFCON must be set to PCON mode (POSITION CONTROL). It is only possible to change the mode at user level MODE=3 (or higher). At user levels 1 and 2 it is only possible to display the current mode.

Display		Action	Description
	MENU	**start/enter**	Open PARA menu
	_KPAD	or	Search _CONF area
	_CONF	**start/enter**	Select _CONF area
- x -	NNNNN	or	Search for parameter CFCON
- E -	CFCON	**start/enter**	Enter edit mode of parameter CFCON
"- E -“	NNNNN	or	Search PCON mode
"- E -“	PCON	**start/enter**	Select PCON mode
- E -	CFCON	or	Possible search for further parameters to be edited in area _CONF
- x -	NNNNN	**stop/return**	Exit from area _CONF
	_CONF	or	Possible search for further parameters to be edited in the PARA menu
	NNNNN	**stop/return**	Exit from PARA menu
	MENU		

All Servocontroller parameters can be edited and displayed in a similar way.

6.7 Overview of Menu Structure



A	VAL Menu selected (display actual values)	PARA Menu selected (set parameters)	CTRL Menu selected (control drive from KeyPad)	CARD Menu selected (load/save using SmartCard)
B	Display parameter value. Using arrow key, change to...	Select area	Password prompt, factory setting = 465	READ= load WRITE= save LOCK= enable write protect
C	... next parameter	Select parameter	Enter password	Select parameter area Start with start/enter key
D	Display parameter value	Display parameter value, or change	Enable MOP function	Function terminated error-free

MOP = Motor operated potentiometer function in the CTRL Menu (*Section 6.6.3*).

6.7.1 The VAL Menu

The VAL menu is used exclusively for displaying actual and fixed values. Parameters cannot be edited here. The number of parameters available depends on the user level (parameter MODE).

To display the value of a parameter select the required parameter name by **pressing** ▲ or ▼ (scrolling) and then press the **start/enter key** to confirm.

When the Servocontroller starts the KEYPAD displays this menu with the value of the parameter selected shown as the continuous actual value in the PARA menu. The default is factory-set. This is the control reference value, the parameter REFV (Reference Value).

Included in the actual values which can be displayed in the VAL Menu are, for example, the effective output current or speed. In addition parameters are available which provide information on the (instantaneous) condition of the device: software version, status word, service hours, most recent error etc. There is a complete listing of the VAL Menu parameters in *Section 10.2.*

6.7.2 The PARA Menu

In the PARA menu the user can change parameters, those parameters to which the current user level affords him access. Setting parameters is described in *Section 5.7*.

The PARA menu has sub menus. The parameters are grouped by subjects which makes dealing with large numbers of parameters much easier.

The parameters are grouped by function-related subjects (not by parameter number). Grouping them by function in this way makes them fairly simple to use.

The following subject areas are defined:

Code	Term	Description
_CONF	Configuration	System configuration (controller HW/SW)
_ENCD	Encoder	Opt. encoders & resolvers
_OPT1	Option1	Slot 1 (X6)
_OPT2	Option2	Slot 2 (X7)
_MOT	Motor	Motor parameters
_TCON	Torque Control	Torque control
_SCON	Speed Control	Speed control
_PCON	Position Control	Position control
_SIO	Serial Input/Output	Configuration of serial interface
_KPAD	KeyPad	KeyPad settings
_SCTY	Security	Error responses and safety input
_USER	User	Special parameters for custom software
_REF	Reference	Parameter s for generating reference values

Note:
Not all the subjects displayed listed here can be displayed on the KEYPAD. The reason is that subjects which are dependent on device configuration and current operating mode do not contain parameters and are not displayed in the PARA menu. This makes it easier to make a selection from the relevant subjects. In the standard version of the device, subjects _OPT1, _OPT2 and _USER are not displayed as there are no corresponding parameters available.

Only parameters from 3 subject areas, namely _CONF, _KPAD and _REF have a special meaning. _CONF contains the general configuration of the Servocontroller and the whole drive system. This can be used for selecting the control mode: control of torque, speed or position. There are some settings in _KPAD which relate to the KEYPAD, eg the user level and the continuous display of the continuous actual value.

Parameters in areas _MOT and _ENCD depend on the type used and are stored on the motor-specific SMARTCARD supplied. The corresponding parameters in these areas can be viewed, but no changes can be made there. For this reason these two areas are more or less irrelevant for users.

Control circuit parameters are in _TCON, _SCON and _PCON and are factory-set for optimum results. Small adjustments may be necessary in specific cases, (eg moment of inertia of the installation). This is described in detail in *Section 8 "Control Software".*

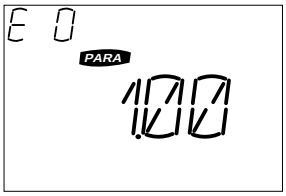
_OPT1 and _OPT2 are reserved for parameters in versions with option slot X6 and X7, (eg InterBus-S Interface). The _USER area is reserved for customer-specific custom software. In the standard version of the equipment these areas are not required and are therefore not displayed.

The groups _SIO and _SCTY are of subordinate importance. They may be used for one-off matching, eg baud rate of serial interface (_SIO) or error reactions (_SCTY).

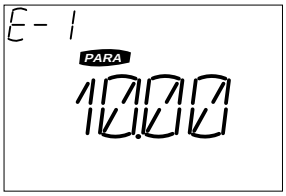
Note:

Numbers are always displayed with 2 digits before and 2 digits after the decimal point.

If, for example, you enter →



the display automatically converts to exponential representation →



This applies to the PARA and CTRL Menus.

6.7.3 The CTRL Menu

This menu is used for operating the drive with any preferred reference value using the KEYPAD. Depending on the operating mode a reference value can be entered for torque, speed or position.

In speed control, acceleration and braking ramps (parameters ACCR and DECR in the subject area _REF) can be used. The factory settings disable the ramps and accelerate and brake the drive at maximum torque.

The KEYPAD is a higher priority control location than any of the others (terminals, SIO, etc.). Consequently whenever a reference value is entered using KEYPAD, control is switched to the KEYPAD automatically. Any other reference values from other control locations are disabled.

Note:

1. The CTRL Menu is password protected. Password prompt: PASSW (factory setting = 465). The password can be changed using parameter PSWCT (_KPAD).
2. The CTRL Menu can only be accessed when the drive is stationary.
3. Whilst the CTRL Menu is selected (even if STOP is displayed), control is not possible from any other control location.

Drive control using the KEYPAD (CTRL Menu):
At menu level the CTRL Menu is accessed by pressing the **start/enter key.** If "STOP" is displayed it means that no reference value has been entered via the KEYPAD. Press **start/enter** again to edit the reference value.

The reference value is expressed as an exponential to allow a wide range of settings. Holding down the ▼ **key** changes the editing position and pressing the ▲ **key** increments each digit, cycling back to 0 after 9.

If the reference value is entered in full, it is swtiched to the drive simply by pressing **start/enter**.

Note:
The reference value is always displayed with the highest value unit in the 10 column. As it is displayed as an exponential, the number will often look different from what has been entered.

The reference value can be changed on-line by pressing the **stop/return** key once. Pressing the **stop/return key** twice allows off-line editing.

Press the **stop/return key** once more to exit from the editing mode. At the same time the reference value display on KEYPAD is replaced by the message STOP. Press the **stop/return key** to leave CTRL Menu and return to the main menu. Control has returned to the original control location.

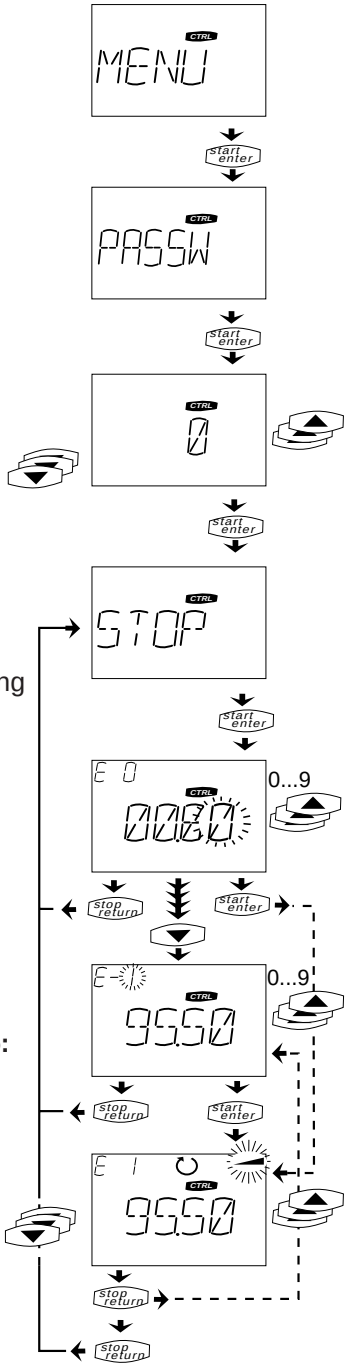
CTRL Menu Structure

CTRL Menu selected.

Press the **start/enter key** to change to password prompt.

Press the **start/enter key** to initiate password changes.

Enter the password with the arrow keys (factory setting = 465). This has to be entered every time after a mains supply reset. Press the **start/enter key** to confirm the password (control terminals are blocked automatically).



Press the **start/enter key** to start reference value input.

The last digit flashes. It can be changed with the ▲ **key.** Pressing the ▼ **key** moves to the next position.
The fifth position on the extreme left is reserved for the direction of rotation (—) = counterclockwise
and ( ) = clockwise.
The exponential can be entered as the last digit.

Pressing the **start/enter key** starts the controller and the motor is run up to the reference value.

Motor operated potentiometer (MOP) function using KEYPAD:
press ▲ **key** to increase reference value online
press ▼ **key** to reduce reference value online
The ramp symbol flickers to indicate that the value is being changed.

Pressing the **stop/return key** once causes the motor to continue running with a constant reference value. A new reference value can be entered. Pressing the **start/enter key** again causes the Servocontroller to use the new reference value.

Pressing the **stop/return key** twice stops the motor.

Note:
Online means that the motor output will follow the reference value change immediately. The reference value changes initially in small increments which gradually increase if one of the arrow keys is held down. Small increments (with smallest increments, speed = 1/655 RPM, programmable with CTLFA (_KPAD)) are sometimes not visible on the display, but the ramp symbol flickers to represent the changing value.

6.7.4 The CARD Menu

This menu is used for reading from and writing to the SmartCard for storing device settings and for automatic matching to specific motors.

The CARD Menu contains 4 functions:

Function	Description
READ	Read some or all parameters from the SmartCard
WRITE	Save all parameters on the SmartCard
LOCK	Enable SmartCard write-protected
UNLOCK	Disable SmartCard write-protection

READ and WRITE Functions

The parameters on the SmartCard have been grouped by activity. These groupings do not correspond to the subject areas in the PARA Menu. When you write to the SmartCard all parameters are saved.
After selecting READ, select the required area. It is possible to read just one section of a SmartCard which contains the complete parameter set.

Setting	Identification	Read ...
ALL	All	All parameters
OPTN1	Option 1	Parameters for model in slot 1 (X6)
OPTN2	Option 2	Parameters for model in slot 2 (X7)
APPLI	Application	Application-specific parameters
SYSTM	System	General system configuration
REFRC	Reference	Parameters for setting reference values and Function selectors
DRIVE	Drive	Drive parameters

Note:

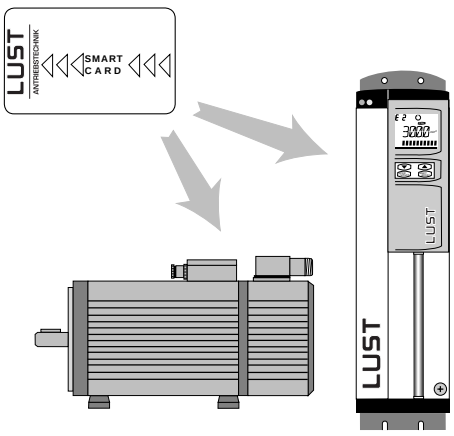
1. The CARD Menu can only be selected when control is disabled.
2. Control cannot be started whilst you are still in the CARD menu.
3. For this reason there is an automatic switch to the VAL Menu after 10 minutes.
4. Parameters which are dependent on existing hardware or which are determined by software settings are not stored on the SmartCard. These parameters are identified in Section 10 as "not stored", eg hardware and software status word (CFHSW and CFSSW in subject area _CONF).
5. Bus system operation: whilst the SmartCard is being read from or written to, the bus is disabled. If the bus watchdog is switched on it may therefore be triggered.

SmartCard for ASx and PSx Servomotors

The SmartCard is used for minor matching to Servomotors in the series ASx and PSx. All motor parameters and complete controller specifications are stored on the SmartCard under DRIVE.

The motor type is printed on the SmartCard.

It is also possible to save all parameters on this SmartCard (setting ALL).



6.8 Setting the parameters for the MC6000

Parameters for the Servocontroller are set in the PARA Menu.

When the PARA Menu is selected the first subject area is displayed. Now select the required area containing the parameters to be edited. Press the ▲ or ▼ arrow keys to scroll through the subject areas. Confirm selection by pressing the **start/enter key.**.

Now the first parameter of the selected area is displayed. As you have now selected the required subject area you can access all the parameters in this area by scrolling up and down (using ▲ or ▼ arrow keys).

Parameter status is displayed top left. An **-S-** (Show) indicates that this parameter is for display only and cannot be edited. The letter **-E-** (Edit) indicates that the parameters can be edited. Parameter status depends mainly on the operating level (MODE parameter).

Press the **start/enter key** to go into edit mode. Edit mode is indicated by the flashing parameter status "-E-". The parameter value can now be changed using ▲ and ▼ arrow keys. The new setting can be confirmed by pressing **start/enter** or cancelled by pressing **stop/return**.

PARA Menu structure

The PARA Menu has been selected.

Tap the **start/enter key** to change the subject level..

The ▲ or ▼ arrow keys are used for selecting a subject area, eg. _CONF = configuration of controller.

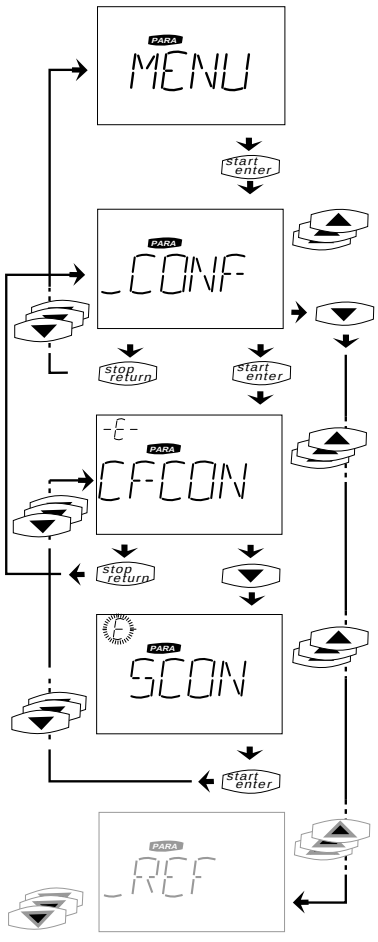
Tap the **start/enter key** to change the parameter level.

Use the ▲ or ▼ arrow keys to select parameters, eg CFCON = control mode.

Tap the **start/enter key** to edit the parameter.
Use the ▲ or ▼ arrow key to select, eg SCON = speed control.

Tap the **start/enter key** to confirm the selection.

Another area, _REF = reference value input is described on the next page.



Press the **stop/return key** to exit from any level immediately. The last stored value is retained.

PARA menu structure (parameters expressed as an exponential)

_REF = reference value input selected.

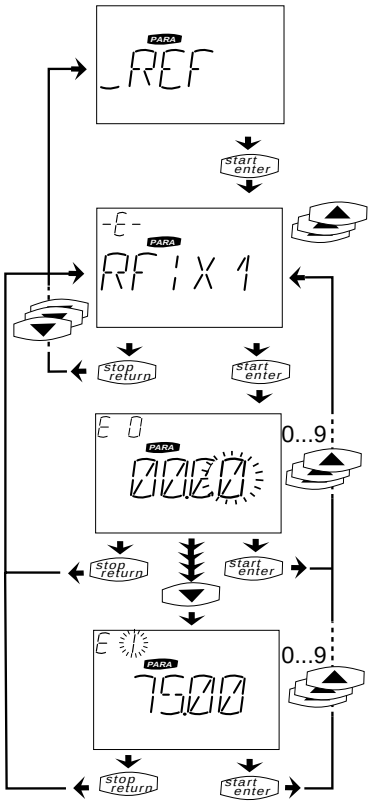
Tap the **start/enter key** to change to the parameter level.

Select the parameter level with the arrow keys ▲ or ▼ eg. RFIX1 = fixed reference value 1

Tap the **start/enter key** for parameter change (edit).

The last digit will flash. This can now be changed using the ▲ **arrow key.** The ▼ **arrow key** moves to the next position. The fifth digit on the extreme left is reserved for direction of rotation: (—) = counterclockwise and ( ) = clockwise.

The last position can be used to show the exponential. Pressing the **start/enter key** confirms the change. Value confirmation is possible at any time during the change process.



Changing parameters

Changes in parameter values usually take effect immediately, ie they become effective whilst the drive is controlled. In the case of some parameters however a **reset** is necessary because any change in these parameters could have far reaching consequences.

A reset can be triggered by:

1. Leaving the PARA Menu after setting parameters	especially suitable for setting parameters using KEYPAD
2. Reset and execute start command	universal (control via terminals, serial interface or Bus system)
3. Setting the parameter PLRDY (_KPAD)	universal, but not convenient when setting parameters using the KEYPAD

On reset the parameter list is checked for validity and dependent parameters are calculated. There is a short pause for updating the parameter list.

In order to avoid this delay when starting the drive, the reset can be triggered manually in advance (option 1 or 3 above).

7 Configuration Software

It is important to differentiate between the two types of parameters in the configuration software:

a) Parameters which relate to the actual hardware. These are recognised automatically by the Servocontroller and stored on the SMARTCARD supplied; the user can display them on the KEYPAD :

Parameter	Area	Description	
MOxxx	_MOT	Motor data (rated speed, moment of inertia, resistance, inductivity, etc.)	SmartCard
ECxxx	_ENCD	Encoder data (line count, pole pair count etc.)	SmartCard
CFMOT	_CONF	Motor type (asynchronous/synchronous)	SmartCard
CFPNM	_CONF	Device performance class (rated current)	automatic
CFCMX	_CONF	max. output current	automatic
OPTN1	_CONF	Detection of module in option slot 1 (X6)	automatic
OPTN2	_CONF	Detection of module in option slot 2 (X7)	automatic
CFHSW	_CONF	Hardware status word	automatic
TYPE	VAL menu	Device type	automatic

xxx = wildcard, any alphanumeric character

Control parameters in areas _TCON, _SCON and _PCON depend on the motor and are also stored on the SMARTCARD.

b) Parameters which relate to the specific application. These can be entered by the user as appropriate.

Configuring the Servocontroller
(Five-Point Plan):

	Parameter	Area
1. Read in the SmartCard with the motor specifications (DRIVE area)		
2. Select control mode (torque, speed or position)	CFCON	_CONF
3. Select control location (Control via terminals, serial interface,, InterBus-S, CAN-Bus, etc.) 1)	CLSEL	_CONF
4. Program function selectors (Allocate functions to inputs and outputs, see Section 7.1)	FIS0x, FISAx, FOS0x, etc	_CONF
5. Program reference values (see Section 7.2)		_REF

1) The control location identifies the source of control commands START and INV (invert reference value).

This sequence must always be observed during configuration.

Advantages of the SMARTCARD:

All parameter settings can be stored on SMARTCARDs and transferred to other servo spindles. In this way several drives can have their parameters set to identical values quickly and reliably. By reading in the SMARTCARD (READ - ALL) all settings can be copied to other drives. This eliminates the need for steps 2 to 5 in the Five-Point Plan.

If you only wish to copy the configuration (for example if there are various motors), then read in areas SYSTM and REFRC from a SMARTCARD consecutively.

The control parameters have been optimised for the motor in the factory settings and stored on the SMARTCARD. By reading in the motor data, the Servocontroller is automatically set for best results with the motor in use. In most applications it is not necessary to make any further changes.

If it should arise, however, that after configuration the drive characteristics are not satisfactory, then the control parameters should be matched (e.g. set the moment of inertia of the installation or the set-up mode for speed control, see *Section 8*).

Warning!
Not reading the SMARTCARD with motor data will usually result in inferior control characteristics. There is also the danger that the motor may accelerate uncontrollably and may even be destroyed.

7.1 Function Selector

Each input and each output (I/O) of the device has a parameter which allocates a function to the input or output. These parameters are called function selectors and are found in Configuration (_CONF).

Standard unit has two digital inputs (IS00, IS01), two analog inputs (ISA0-/+, ISA1) and two outputs (OS00,OS01). The associated function selectors are FIS00, FIS01, FISA0, FISA1, FOS00 and FOS01. Output OS00 can also be used as a PWM output.

Section 7.6 contains examples of the use of function selectors.

I/O Module 1:
If the number of inputs and outputs on the standard equipment is inadequate for an application, an additional 8 inputs and 4 outputs can be made available by using the I/O Module 1. The additional inputs and outputs have the same functionality as the inputs and outputs of the standard equipment. The associated function selectors are in _OPTN2 of the PARA-Menu. I/O Module 1 is described in *Section 11*.

7.1.1 Input Functions

Each of the inputs IS00, IS01, ISA0 and ISA1 (when using the I/O Module also IE00 to IE07) can undertake one of the following functions if the appropriate function selector has its parameter set accordingly (_CONF and _OPTN2). The described function is carried out if there is high level at the input (Exception: emergency stop and hardware position slot are low active).

Note:
Inputs which have been assigned the same function operate as an OR-Link.

Settings:	Function:
OFF	Switch off input (if not required)
START	Start control with set reference value
INV	Invert reference value ,of reference value channels 3 & 4 (see diagram, Structure of Reference Value Input
/STOP	Emergency Stop function triggered by applying a low level signal 1)
ADy-x	Switching between reference value sources (see Section 7.2)
/ENDL, /ENDR	Detecting hardware limit switches (ccw/cw) with low level If a limit switch has been triggered, the device can be turned in the other direction.
E-EXT	Signal input for error messages from an external device (e.g. from the PLC). The response of the Servocontroller is determined by parameter R-EXT (_SCTY).
MP-UP, MP-DN	Motor potentiometer function (changing reference value by push button). Input MP-UP increments and input MP-DN decrements the reference value by the value of parameter PINC (_REF) (see also Section 7.2 Reference Value Input) 1)
OPTN1, OPTN2	The input is made available to the module in option slot 1 or 2 (for function see the relevant description) No function if module not present
USER0, USER1 USER2, USER3	The input can be used by the custom software No function in the case of standard software
ANALG	The input is used as an analog reference value input Only possible for analog inputs ISA0 and ISA1
SCALE	Scaling torque limitation TCMMX from 0 - 100 %. Only for input ISA1. 1)
SPEED	Direct input for rapid speed setting (avoids reference value input) Used in conjunction with a superoridinate position controller. Scaling using RNA0. Only for input ISA0.

1) Functions /STOP, MP-UP, MP-DN and SCALE are described in Section 7.3 "Special Functions".

Warning!
When a function is changed it is enabled immediately (this applies to all input function selectors). The drive will start instantly the moment the function START is assigned to an input.

7.1.2 Functions of Outputs

Each of the outputs OS00 and OS01 (when using an I/O module, also OE00 to OE03) can undertake one of the following functions if the parameters are set for the appropriate function selector (_CONF or _OPTN2). The output produces high level when the condition is fulfilled.

Setting:	Function (the output is set if...):
OFF	Switch off output (if not required)
ERR	...there is a fault (error).
WARN	...there is a warning (error without error response).
/ERR	...there is no error.
/WARN	...there is no warning.
ACTIV	...control is active (green LED flashing).
ROT_R, ROT_L, ROT_0	...clockwise, counterclockwise, stationary; depends on parameter SPD_0 (CONF).
LIMIT	...the actual value of the control has reached a limit value; depends on parameters RLIM1, RLIM2 (_REF).
REF	...the actual value has reached the reference value (window); depends on parameters REF_R (_CONF).
ASM	...an asynchronous motor has been parametered.
SIO	The output is controlled by control word (SCTL1 (_SIO)
OPTN1, OPTN2	The output is assigned to the module in slot 1 or 2 (for function, see specific description). No function is module not present.
ERRW	...there is a warning or error.
/ERRW	...there is no warning and no error.
USER0, USER1 USER2, USER3	The output can be used by custom software No function in the case of standard software
ANALG	only for output OS00! The output provides a PWM signal. The value of the analog output is is determined by parameter FOA0 (_CONF).

1) The function ANALG is described in *Section 7.3.4 "OS00 as PWM output"*.

7.1.3 Fixed Inputs FIF0 and FIF1

The Servocontroller also provides two simulated "inputs" using selectors FIF0 and FIF1 (Function Selector Fixed Input; Area _CONF). These always have the fixed value 1 (High level) so they can be used instead of a continuously on switch.

Fixed inputs are useful if the Start signal or inverting in the reference value input is switched on continuously.

7.2 Reference Value Input

7.2.1 Short Description of Reference Inputs

The purpose of reference value input is to prepare an externally entered reference value and to transfer it to the control. Parameters for reference value input are set specific to the application when commissioning the Servo drive.

Four reference value selectors are used for selecting any number of reference value sources (e.g. analog input, serial interface etc.). Each reference value selector has a permanent link with an internal reference value channel. The channels are linked and can also be processed mathematically. This produces the overall reference value which is then fed to the control.

Irrespective of the control mode, the reference values are entered in the same way. The reference value entered always refers to the selected mode. Therefore the unit of this parameter always relates to the current mode (Nm, min^{-1} or r (=rotations)).

7.2.2 Description of Reference Inputs

The diagram "Structure of Reference Value Input" shows the detailed structure of reference inputs.

The parameters for reference value input can be edited in _REF (Reference) of the PARA-Menu and also display. The parameters which have been calculated, and therefore cannot be edited, are identified in the diagram with an asterisk (*) after the parameter number.

There are 16 reference value inputs (A):

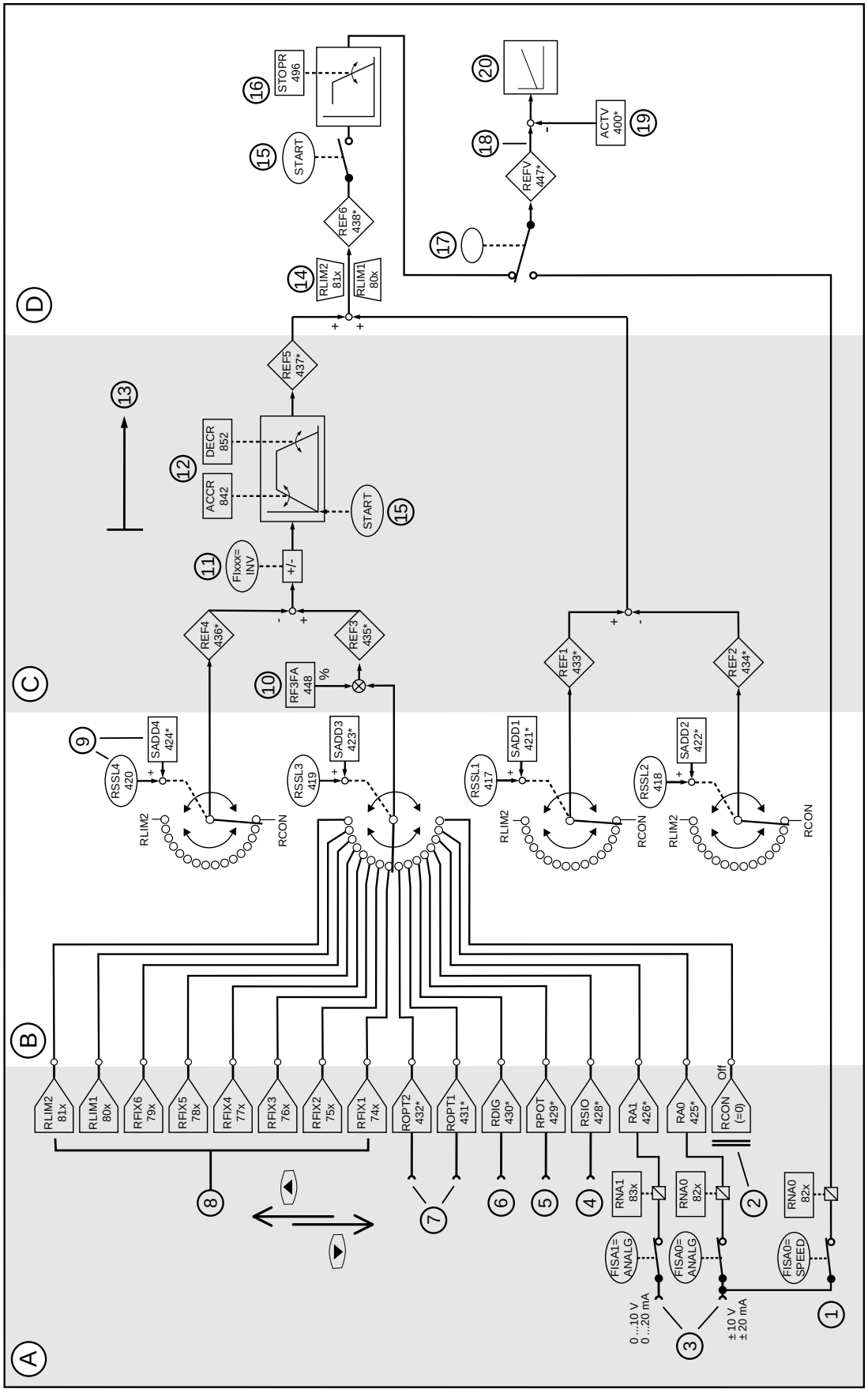
- 2 analog inputs
- RS485 serial interface
- digital reference value input (not with standard software)
- motorised potentiometer (MOP) via digital inputs
- PosMod1position controller
- Bus-Interfaces (e.g. Interbus-S-Local Bus Link)
- Application Hardware (e.g. I/O-Module 1)
- 8 fixed reference values which can be set via software

Reference Value Selectors (B):

Depending on the setting, the four reference value selectors RSSL1 to RSSL4 (Reference Source Selector) the reference channels are fed from the reference sources. Each reference source can be used as an input for several channels i.e. several selectors can point to one source.

An offset SADD1 to SADD4 (Selector Addition) can be added to the selectors. This offset consists of a 4-bit data word (= 0 -15). The offset can be changed using digital inputs if the function selectors are suitably configured (c.f. Section on Function Selectors). In this way, the settings of the reference selectors can be changed using digital inputs and switching is possible between various reference sources, e.g. between two fixed values. The use of selectors and switching via input is explained using examples in *Section 7.4*.

Structure of Reference Value Input



Key to "Structure of Reference Value Input" :

No.	Function	No.	Function
A	Reference value sources		The diagram shows the reference value selectors with factory settings
B	Ref. value selectors of 4 ref. val. channels		
C	Ref. val. channels & intermediate ref. vals.		
D	Calculation of overall reference value	11	Sign reversal possible
1	Rapid reference value channel for ±10V	12	Ramp generator 2)
2	Constants for switching off channel	13	Effective only after START
3	analog ref value inputs ISA0, ISA1	14	Reference value limit
4	Ref. value input serial interface	15	Start command closes the switch & initiates acceleration ramp 3)
5	MOP function (via digital inputs)		
6	Input of digital reference values 1)	17	Automatic switchover with FISA0-SPEED
7	Ref. values from module in slot 1 or 2	16	Stop ramp (Emergency Stop)
8	Fixed ref/. vals (parameters can be set)	18	Overall reference value
9	Ref value selector with offset facility	19	Actual value of control
10	Percentage reference value matching	20	To the control structure

1) Not available with standard software.
2) Acceleration ramp and braking ramp only available in speed control mode.
3) The drive coasts out of control if START is disabled. If this is undesirable, set drive to new reference value (e.g. speed 0 min^{-1}) or use stop ramp.

Symbols used:


Reference value source (input)


Reference value selector (switch)


Mathematical effect


Intermediate reference values, for display only


Reference value limit

* - Parameters read only cannot be edited.

In parameters whose numbers end in an "x", the last position represents the type of control selected:

x	Control mode
1	Torque control
2	Speed control
3	Position control

Explanation on Reference Value Sources (A):

- It is unusual for all four reference value channels to be required. The channels not required are switched off by setting the appropriate selector to the value RCON (Reference Constant). This is a software constant which has the value =0. The reference value channels 1, 2 and 4 are shown as switched off in the diagram (factory setting).
- Both analog inputs can be adjusted using parameters RNA0 or RNA1 (Reference Normal Analog Input). The value of these parameters indicates which reference value is to be entered if a maximum value of + 10 V or + 20 mA is applied to the input.
  e.g.: Mode speed control, RNA1 = 3000 means that a speed of 3000 rpm corresponds to a reference value of + 10 V
  When using analog inputs, the function selectors e.g. FISA0 (_CONF) should have their parameters set accordingly.
- If reference values are to be entered via the serial interface, then the appropriate sector of the required reference value channel must be switched to RSIO.
- There are six software reference value sources RFIX -RFIX6 (Reference Fixed Input) with fixed reference values; these are freely available. These fixed values can be edited here directly.

- The other software reference values RLIM1 and RLIM2 have a fixed function assigned to them. RLIM1 (Reference Limit 1) is the lower limit of the reference value, RLIM2 (Reference Limit 2) the upper limit. Both limit values, like the freely available fixed values, can be edited directly. RLIM1 and RLIM2 can also be used as reference value inputs. At the same time, both these parameters also represent the maximum and minimum values for a reference value which is entered via a different reference value source. If the reference value entered reaches the limit value RLIM1 or RLIM 2, then this is indicated by the flashing red LED and the direction of rotation symbol in the KEYPAD display flashing.

Reference Value Channels and Intermediate Reference Values (C):
The calculated intermediate reference values can be displayed using parameters REF1 to REF6. Channels REF1 and REF2 and also channels REF3 and REF4 always work together. Channel 2 is subtracted from channel 1, channel 4 is subtracted from channel 3.

The reference value of channel 3 can be matched in percentage terms using Factor RF3FA . The prefix can be changed using an input to which function INV has been assigned. Parameter ACCR (Acceleration Ramp) determines the accleration ramp and parameter DECR (Deceleration Ramp) determines the deceleration ramp. Acceleration and deceleration ramps are only available in the speed control mode. The unit used in these parameters is $min^{-1}s^{-1}$. The ramp generator can be swtiched off by setting ACCR or DECR =0. Then the drive accelerates or decelerates with maximum torque (parameter TCMMX in area _TCON) to the reference speed. The ramp generator is triggered by the START signal. The drive coasts on uncontrolled if the START signal is withdrawn (c.f. Stop ramp *Section 7.3.1*).

Calculation of the Overall Reference Value (D):
The total reference value is produced by the switching of all reference value channels together. The total reference value can be limited to one area by using the parameters RLIM1 and RLIM2.

CTRL-Menu
If the CTRL menu of the KEYPAD is used to control the drive, channel 3 is used automatically. Ramps ACCR and DECR can be used to control speed. Reference value channels 1, 2 and 4 and also inverting are switched off.

Direct Input for Superordinate Position Control

The setting FISA0= SPEED (_CONF) should be selected for ±10V speed reference values if the Servocontroller is to be driven from an external positioning control using speed reference values. This provides time-efficient monitoring and processing of speed reference values (250 µs).

For scaling use the parameter RNA0 (_REF) as described for the analog input. The reference value selectors should be switched off RSSLx= RCON (_REF) otherwise the error message E-PAR (error in parameter list) will be displayed.

If the SPEED function is selected, control is not possible via the CTRL-Menu.

POSMOD1
A separate rapid reference value channel has been arranged for the integrated positioning and sequence control POSMOD1 and arranged in the MC6000. It is used for transferring position reference values and processing profiles to the control.

If POSMOD1 is inserted in slot X7 there is automatic switching to this module (when POSMOD1 is removed, all selectors will be reset automatically to the factory setting). The reference value input must not be programmed when positioning control is used. Any previous settings in the area _REF are disabled when POSMOD1 is inserted in the slot.

7.2.3 Setting Reference Value Input

a) If reference values are to be provided continuously from one reference value source:

- Set a reference value selector, e.g. RSSL3 to the required reference value source.
- Only in the case of speed control: set parameters for the acceleration and deceleration ramp ACCR and DECR (_REF).
- If necessary set parameter for an inversion of reference value on channel 3 using the function selector of an input.
- If necessary, parameter a percentage matching of the reference value using RF3FA (_REF).

Note:
A number of reference value selectors can be used in order to superimpose reference values from a variety of sources.

b) Switching between a number of reference value sources using external signals:

- Set RSSL3 (for example) to the reference value to be selected if there are no external signals at the inputs.
- Using the diagram "Structure of reference value input" check how many reference value sources are to be handled by applying external signals.
  e.g.: If there is to be switching between RFIX1 and RFIX2 the extent of switching =1.
- Now the appropriate function has to be assigned to the input e.g. ISA0 at which you wish to feed in the external signals for switching. In the case of the example that would be FISA0 = AD3-0. The setting AD3-0 produces an offset to the basic setting of the reference value selector RSSL3. The value of the offset is derived from a binary 4-bit word.

Setting	Offset binary	Offset decimal
ADx-0	0001 b	1
ADx-1	0010 b	2
ADx-2	0100 b	4
ADx-3	1000 b	8

- If additionally the function FISA1 = AD3-2 is allocated to input ISA1, then the following switching facilities for RSSL3 = RFIX1 result:

ISA0 (Offset +1)	ISA1 (Offset +4)	RSSL3 =
0	0	RFIX1 (Default)
1	0	RFIX2
0	1	RFIX5
1	1	RFIX6

0 = Low Level
1 = High Level

- With FISA1 = AD3-3 the following transfer occurs:

ISA0 (Offset +1)	ISA1 (Offset +8)	RSSL3 =
0	0	RFIX1 (Default)
1	0	RFIX2
0	1	RCON (off)
1	1	RA0

After the reference value selectors have been set and hence the required reference value source(s) has/have been selected, other reference value input parameters can be set. Which parameters are to be set depends on the reference value selector and reference value source(s) selected. For examples, see *Section 7.4 "Examples"*.

7.3 Special Functions

7.3.1 Emergency Stop (/STOP)

The Emergency Stop function can be used as an additional protective function. Emergency Stop can be triggered from a variety of difference control locations:

Control Application	Emergency stop triggered by
Control terminals	Input configured as „/STOP“
Serial interface	Bit in control word SCNTL (_SIO)
Interbus-S	See InterBus-S data transfer protocol
CAN-Bus	See CAN-Bus data transfer protocol
E/A-Module	Input configured as„/STOP“

The ramp can be entered in units $min^{-1}s^{-1}$ at which the motor is to be braked down to Speed=0, using the Stop Ramp parameter STOPR (_CONF). With the setting STOPR= 0 (factory setting) the motor is braked at the set torque limit (TCMMX in area _TCON) as quickly as possible (Emergency Stop without ramp).

Control of the drive remains switched on and the motor is held speed controlled in this position. The Emergency Stop can be activated from any control mode.

Note
If torque limiting (SCALE Function) is activated, it also takes effect in the case of an Emergency Stop.

Resetting the Emergency Stop:
Emergency Stop condition remains until the /STOP-Signal and the Start signal have both been reset.

Warning!
The ENPO signal must not be discontinued during the Emergency Stop condition or the motor would be isolated from its control. In that case, the Servocontroller would lose control of the motor and the motor would coast on uncontrolled.

7.3.2 Auto Start

In many applications it may be necessary to enable control automatically after switching on mains power. In such cases the parameter AUTO should be set to the value "ON" in the area (_CONF). After mains power is switched on (even after a short power failure) control is automatically switched on if the Start signal is present

Note:
1. The Start Signal may be applied continuously if a fixed input FIF0 or FIF1 (_CONF) =START. The input IS00 can then have another function assigned to it.
2. There is no Start signal after a mains power supply failure when controlling from the CTRL-Menu.

7.3.3 Motor-operated Potentiometer

Motor-operated Potentiometer (MOP) function means that the reference value is increased or reduced by a specific amount via two digital inputs or via the ▲ and ▼ arrow keys of the KEYPAD.

Parameter RSSLx= RPOT (_REF):	Set MOP as reference value source
Parameter MPCNF (_CONF):	Select operating mode (MOP configuration)
Parameter RINC (_REF):	Determines step for increment/decrement
Input with MP-UP function	Increases reference value
Input with MP-DN function	Reduces reference value

Four modes can be set using the parameter MPCNF (_CONF) :

MPCNF	Mode	MP-UP input	MP-DN input	Function
0	condition controlled	0	0	-
	without reset	1	0	Increase ref. value
		0	1	Reduce ref value
		1	1	-
1	condition controlled	0	0	-
	with reset	1	0	Increase ref value
		0	1	Reduce ref value
		1	1	Reference value = 0
2	flank controlled	0	0	-
	without reset	0 > 1	0	Increase ref value
		0	0 > 1	Reduce ref value
		1	1	-
3	flank controlled	0	0	-
	with reset	0 > 1	0	Increase ref value
		0	0 > 1	Reduce ref value
		1	1	Reference value =0

7.3.4 Output OS00 as PWM Output

Output OS00 can be used as a PWM output. Note however that the output signal is only suitable for display instruments with slow response but not for processing in controls. An external filter can be used however to smooth the signal if necessary and produce an analog signal.

PWM Frequency	200	Hz
Transition Frequency (internal low pass filter)	1	kHz
Output voltage range	0 to +24	V

The following parameters in the _CONF area are used to configure the PWM output:

FOA0 Function selector which determines what value shall be outputted at output OS00

Setting	Output
TORQE	instantaneous torque
SPEED	instantaneous speed
POS	instantaneous position
CURNT	instantaneous effective output current
IA0	input differential at input ISAO
IA1	input value at input ISA1

Factory setting: SPEED

Other parameters for output OS00 as PWM output:

OA0MN minimum output value; value of output at 0V; factory setting= 0

OA0MX maximum output value; value of output at +24V;
factory setting= 0

Example:
The instantaneous speed is outputted via OS00 with factory setting of these parameters and selection of the PWM function by setting FOS00=ANALG (_CONF). The parameters OA0MN and OA0MX determine the speed window:

speed:	0	...	3000	U/min
output voltage:	0	...	24	V

corresponds to

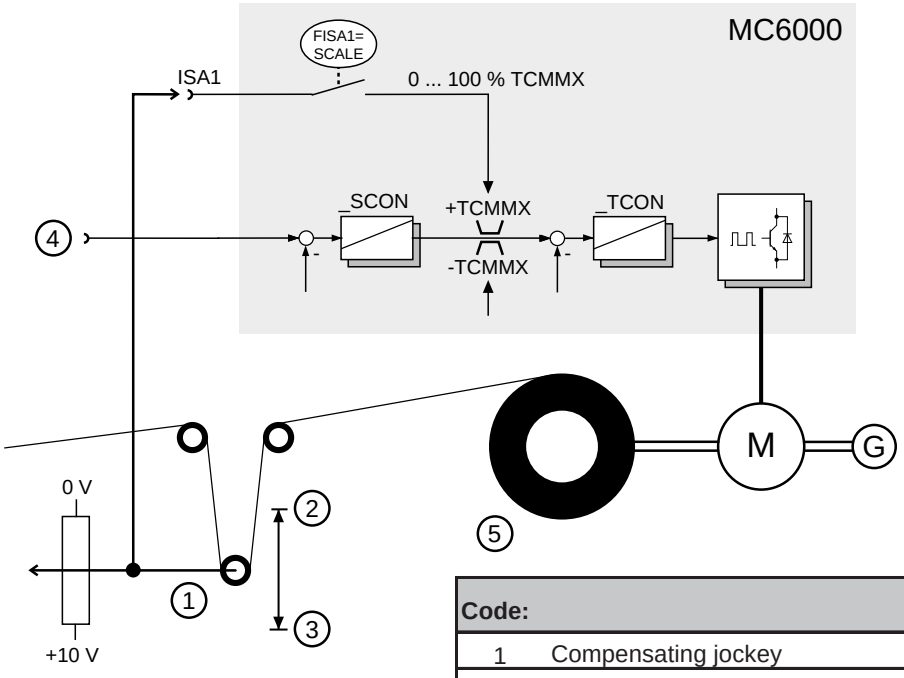
7.3.5 Torque Limitation (SCALE)

In many applications there is a requirement for the torque limitation to be adjusted continuously. The SCALE function can be used to adjust the torque limitation via the analog input ISA1. When the SCALE function is enabled it also affects Emergency Stop.

FISA1= SCALE 0 ... +10 V
0 ... 20 mA → 0 .. 100 % TCMMX

Note:
The SCALE Function limits the reference value for torque, i.e. the torque generated by the Servocontroller (see diagram). Additional dynamic forces from the moment of inertia of the load may also act on the motor shaft.

Example: Winding Drive
To avoid the wound material breaking, a certain torque must not be exceeded. The tension value is captured by the compensating jockey and the torque is corrected accordingly.



Code:	
1	Compensating jockey
2	Upper jockey stop (M=0, n=0)
3	Lower jockey stop (M=max., n=max.)
4	Speed reference value
5	Bobbin with wound material

7.4 Examples of Applications

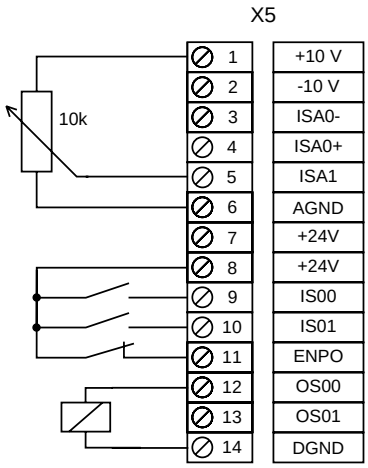
This section explains the control terminal arrangements, programming the function selectors and the reference value input by way of examples.

7.4.1 Example: Analog Reference Value Input

A synchronous machine is to be driven with speed control using an analog reference value (0 - 10V) in the range -3000 to +3000min-1. In an emergency the motor is to coast on independently of the control. In case of error a 24 volt relay is to be operated.

a) How should the control terminals be connected?
b) What parameter settings should be made?
c) What parameters should be set if an asymetrical speed range of -1000 to +3000 min-1 is required?

Solution:
a) Control terminal connections:



b) Setting configuration parameters using the Five-Point plan:

	Parameter	Setting	Area
1.Read in the SmartCard with the motor specifications			
2.Select control mode	CFCON	SCON	CONF
3.Select control location	CLSEL	TERM	_CONF
4.Set function selectors:			_CONF
IS00 =Start control	FIS00	START	
IS01 =Reverse (change direction)	FIS01	INV	
ISA0 =No function	FISA0	OFF	
ISA1 = Reference values (0 to 10 V)	FISA1	ANALG	
OS00 =Error message display	FOS00	ERR	
OS01 =No function	FOS01	OFF	
5.Program reference values:			_REF
Use reference value channel 3,	RSSL1	RCON	
switch off other channels	RSSL2	RCON	
	RSSL3	RA1	
	RSSL4	RCON	
Scaling: 10 V = 3000rpm	RNA1	3000 1)	

1) Displayed as 30.00 *E2

Result:

Ref. Value	IS01	Speed
0 to + 10 V	0	0 to + 3000 rpm
0 to + 10 V	1	0 to - 3000 rpm

Note:
The Servocontroller parameter settings are factory-set so that the acceleration and deceleration ramps (ACCR and DECR) are switched off and the matching factor RF3FA = 100 %.

The parameters of the drive are already set to meet the requirements of the operation. The control circuits have been set to suit the motor by reading in the SMARTCARD and do not require any further matching in standard applications.

c) Setting parameters for asymmetrical speed range

Solution 1: with prefix switching
A fixed reference value channel 1 is switched on which continuously adds 1000 min^{-1} to the reference value of the analog input. The following changes should be made:

RSSL1 = RFIX1
RFIX1 = 1000
RNA1 = 2000

Result:

Ref. Value	IS01	Speed
0 to + 10 V	0	+1000 to +3000 rpm
0 to + 10 V	1	+1000 to +3000 rpm

Solution 2: without prefix switching
Using a fixed reference value 1000 min^{-1} are continuously subtracted from the reference value of the analog input. The following changes should be made:

RSSL1 = RFIX1
RFIX1 = -1000
RNA1 = 4000
FIS01 = OFF

Result:

Ref value	Speed
0 to 10 V	-1000 to 3000 rpm
2.5 V	0 rpm

7.4.2 Example: Reference Value Input using Serial Interface

Torque values are to be transferred to a drive via the Serial Interface. How should the parameters be set?

Solution:

Use the Five-Point Plan for the configuration.

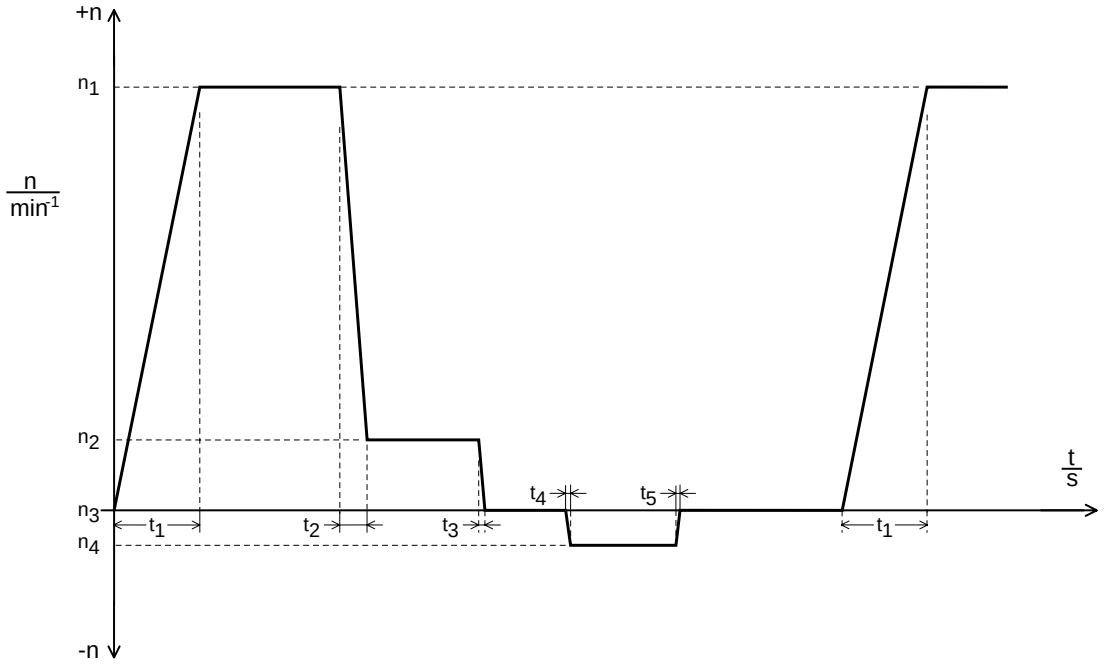
	Parameter	Setting	Area
1. Read in SmartCard with motor data			
2. Select control mode	CFCON	TCON	_CONF
3. Select control location	CLSEL	SIO	_CONF
4. Do not set function selectors as no inputs or outputs are required			_CONF
5. Program reference value input:			_REF
Use reference value channel 1,	RSSL1	RSIO	
switch off other channels	RSSL2	RCON	
	RSSL3	RCON	
	RSSL4	RCON	

The parameters in area _SIO should be checked and matched up if necessary. This may be necessary particularly for the baud rate (SBAUD) and the device address (SADDR). The drive will then be controlled using control word SCTL1.

Do not forget to bridge signal ENPO to + 24 V!

7.4.3 Example: Switching Fixed Reference Values

The Servo drive is to operate to the speed profile as in the diagram below. A PLC provides the reference values in the required time frame. An Emergency Stop will provide protection. How should the parameters be set?



n_1 = 6000 min^{-1} t_1 = 3 s
n_2 = 1000 min^{-1} t_2 = 1 s
n_3 = 0 min^{-1} t_3, t_4 and t_5 are non-critical and are derived from t_1 und t_2
n_4 = - 500 min^{-1}

Solution:
The reference value channel 3 is used (RSSL3) so that the ramp generator can be used. Speeds n1 to n4 are programmed as fixed reference values RFIX1 to RFIX4. The reference value selector RSSL3 is set to the first reference value RFIX1. Switching between the reference values is on a bit-coded basis via inputs IS01 and ISA0.

Both inputs change the value of the offset for reference value channel 3 (parameter SADD3) by means of using its binary value. So that Bit 0 of ISO1 and Bit 1 of ISA0 are affected, the function selector should be set as follows:

FIS01 = AD3-0 Bit 0 of offset for RSSL3
FISA0 = AD3-1 Bit 1 of offset for RSSL3.

The following arrangement shows the value of the offset parameter and the selected reference value in relation to the two inputs. The superordinate PLC sets the inputs IS01 and ISA0 to suit the speed profile.

Bit 1 (ISA0)	Bit 0 (IS01)	Value of SADD3	Resultant reference value
0	0	0	RFIX1
0	1	1	RFIX2
1	0	2	RFIX3
1	1	3	RFIX4

Acceleration and braking ramp are determined from:

ACCR: $$\frac{6000\,\mathrm{min}^{-1}}{3\,\mathrm{s}} = 2000\,\mathrm{min}^{-1}\mathrm{s}^{-1}$$

DECR: $$\frac{6000-1000\,\mathrm{min}^{-1}}{1\mathrm{s}} = 5000\,\mathrm{min}^{-1}\mathrm{s}^{-1}$$

Times t_3 bis t_5 can be calculated:

$$t_3 = \frac{1000\,\mathrm{min}^{-1}}{5000\,\mathrm{min}^{-1}\mathrm{s}^{-1}} = 0{,}2\,\mathrm{s}$$

$$t_4 = \frac{500\,\mathrm{min}^{-1}}{2000\,\mathrm{min}^{-1}\mathrm{s}^{-1}} = 0{,}25\,\mathrm{s}$$

$$t_5 = \frac{500\,\mathrm{min}^{-1}}{5000\,\mathrm{min}^{-1}\mathrm{s}^{-1}} = 0{,}1\mathrm{s}$$

Please note that under certain circumstances and especially in field weakening the available torque may not be sufficient to accelerate as required at specific moments of inertia.

Setting parameters:

	Parameter	Setting	Area
1. Read in SmartCard with motor data			
2. Choose control mode	CFCON	SCON	_CONF
3. Choose control location	CLSEL	TERM	_CONF
4. Set function selectors:			_CONF
IS00 = Start control	FIS00	START	
IS01 = Switch bit	FIS01	AD3-0	
ISA0 = Switch bit 1	FISA0	AD3-1	
ISA1 = Emergency Stop	FISA1	/STOP	
5. Program reference value input:			_REF
Use reference value channel 3,	RSSL1	RCON	
switch off other channels	RSSL2	RCON	
	RSSL3	RFIX1	
	RSSL4	RCON	
enter fixed reference values	RFIX1	6000	
	RFIX2	1000	
	RFIX3	0	
	RFIX4	-500	
Enter limit values	RLIM1	-500	
	RLIM2	6000	
Enter ramps	ACCR	2000	
	DECR	5000	

When these settings have been entered, the drive parameters are fully customized to meet your requirements.

7.4.4 Example: Analog reference value input with switching

A drive is to be driven with an analog reference value

a) 0 to + 10 V
b) - 10 V to + 10 V

Using a switch the drive will be ramp controlled to 0 rpm or to a different speed.
What parameters should be set?

a) 0 to + 10 V:

	Parameter	Setting	Area
4. Set function selectors			_CONF
IS00 = Start control	FIS00	START	
IS01 = not allocated	FIS01	OFF	
ISA0 = Switching to bit 3	FISA0	AD3-3	
ISA1 = Reference value (0...10 V)	FISA1	ANALG	
5. Program reference value input	RSSL1	RCON	_REF
	RSSL2	RCON	
Use reference value channel 3	RSSL3	RA1	
switch off others	RSSL4	RCON	
Fixed reference value, e.g. 0 rpm	RFIX1	0	
Scaling: 10 V = 3000 rpm	RNA1	3000	

Result:

Ref value	ISA0	speed
0...+10 V	0	0 to +3000 rpm
0...+10 V	1	0 rpm

b) - 10 V ... + 10 V:

	Parameter	Setting	Area
4. Set function selectors			_CONF
IS00 = Start control	FIS00	START	
IS01 = ohne Funktion	FIS01	OFF	
ISA0 = Switching bit 3	FISA0	ANALG	
ISA1 = Ref value (0...10 V)	FISA1	AD3-3	
5. Program reference value input	RSSL1	RCON	_REF
	RSSL2	RCON	
Use channel 3,	RSSL3	RA0	
switch off others	RSSL4	RCON	
Fixed ref value, e.g. 0 rpm	RFIX2	0	
Scaling: 10 V = 3000 rpm	RNA0	3000	

Result:

Ref value	ISA1	speed
10 V to+10 V	0	3000 to +3000 U/min
10 V to +10 V	1	0 rpm

8 Control Software

The MASTERCONTROL MC6000 servocontroller works on the principle of **flux vector control.** Flux vector control means that current is introduced into the part of the motor where the field is strongest. In this way the current is converted most efficiently into torque. The result is maximum utilization of the motor with the best possible dynamic performance and with minimum losses. This produces a very high level of efficiency.

Traditionally DC servo-motors have been used for dynamic drive applications because they can be regulated very simply as analog units. Nowadays because of the tremendous increase in the capacity of electronics these drives are being replaced by dynamic digitally-controlled AC induction servomotors. These have considerable advantages over DC servos:

- Reproducibility: Digital control produces excellent reproducibility because there is no drift caused by temperature or over time. This is especially important in positioning applications.
- Precision: Resolution and precision are inherently higher when using a digital version than with analog control.
- The price: Because they are simpler, three phase motors are also cheaper.
- Space requirements: The AC motor is considerably more compact than the DC motor.
- Service Life: AC servo motors are virtually non-wearing, whereas DC motors are expensive to maintain and repair (e.g. brushes).
- Speed: The speed range is wider and ranges from 1 rpm up to maximum of 12,000 rpm, (asynchronous machines with field weakening).

A digital drive controlled by MASTERCONTROL is suitable for all applications in which one or more of the following characteristics are important:

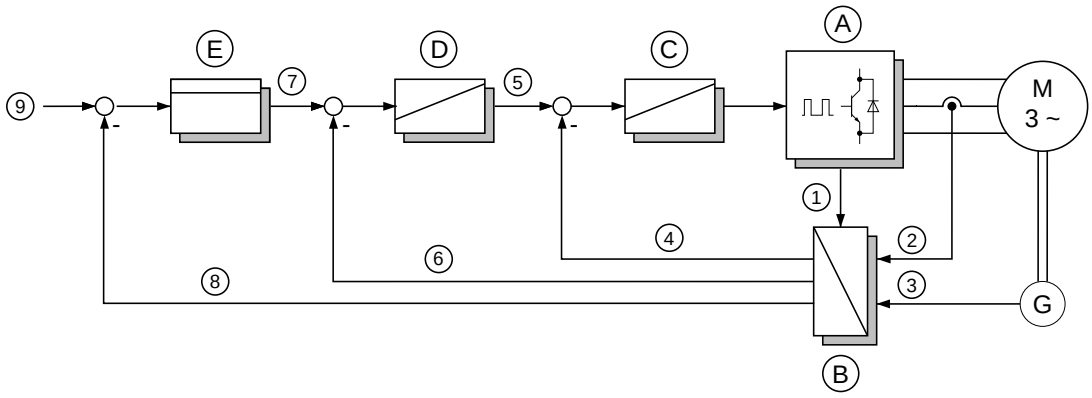
- Constant speed (concentricity)
- Positioning accuracy
- Dynamics
- Constant torque
- Disturbance suppression (varying load)

MASTERCONTROL can be used for controlling both synchronous and asynchronous motors. Asynchronous motors are extremely robust and permit high maximum rpm in field weakening and are required for example for the main spindle drive in machine tools. The advantages of synchronous motors with permanent magnet excitation may be seen in their minimum size and dynamic response.

The MC6000 servocontroller can be operated in three modes:

- Torque Control (TCON)
- Speed Control (SCON)
- Position Control (PCON)

The servocontroller has three control circuits which are superimposed on each other *(see diagram).* Depending on the mode, the subordinate control circuits are enabled e.g. in speed control only the speed controller and torque controller are enabled. The speed reference value (7) is then supplied directly by the reference value, the position controller (E) is disconnected and does nothing.



No.	Function	No.	Function
A	Modulator and power stage	D	Speed control
B	Processing of actual values	E	Position control
C	Torque control		
1	Voltage capture	6	Speed actual value
2	Current capture	7	Speed reference value
3	Speed and position signal	8	Position actual value
4	Torque actual value	9	Position reference value
5	Torque reference value		

The parameters of the control loops are classified in the PARA menu in three areas _TCON, _SCON and _PCON. Torque and speed controls are in the form of PI controllers, the position controller is in the form of a P controller. The gain (P proportion) and the adjustment time (I proportion) of the individual controllers may be set as parameters in the specific area.

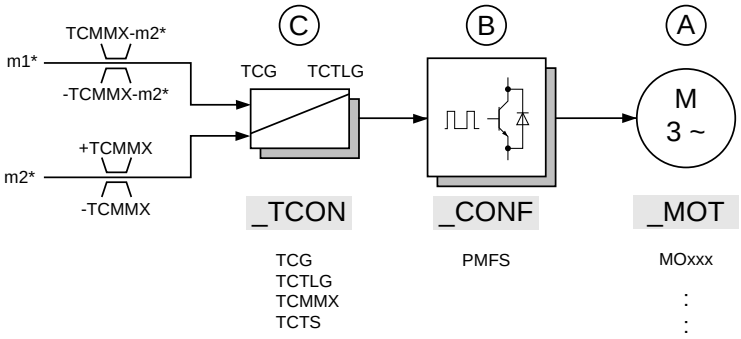
The control circuits are matched automatically to the motor data by downloading the SMARTCARD which produces excellent results with the specific motor. Tedious fine tuning of controller settings is a thing of the past. Depending on the application it may be necessary, however, to match one or two specific parameters, if, for example, the system has a high moment of inertia (*see Section 8.3, item 3 and Section 8.3.1).*

Control circuit cycling times:

Torque controller:	125 µs	
Speed controller:	250 µs	(with optical encoders G1, G2, G3, G4)
	500 µs	(with resolvers R1, R2, R8)
Position controller and pre-controller:	500 µs	

8.1 General Control Structure

The basic structure shown here applies to all types of control. Additional structure diagrams build on this.



No.	Function
A	Asynchronous or synchronous motors
B	Modulator and power stage
C	Torque controller
m1* and m2* are torque controller inputs	

Note:
The formation of the differential from the reference value minus actual value occurs in the controller block and is not shown separately for the sake of simplicity. This applies also to the other block diagrams.

Motor data such as rated speed (MOSNM), rated current (MOCNM), rated torque (MOMNM), moment of inertia (MOJNM) etc. are stored in _MOT. The ASM has a number of other parameters: rotor resistance (MOR_R), magnetizing inductance (MOL_M). In addition there are also maximum speed (MOSMX) and motor constants (MOMC0...MOMC4) in the field weakening area.

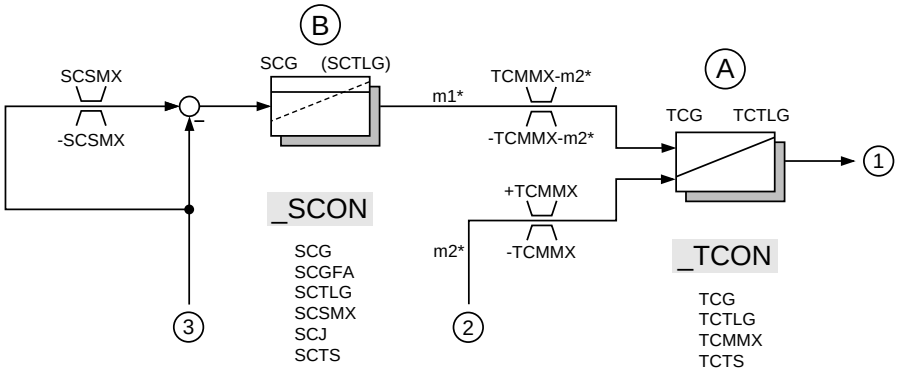
The switching frequency of the modulator can be controlled using parameter PMFS (_CONF).

The torque controller parameters which can be set in _TCON are: gain (TCG), reset time (TCTLG) and torque limitation (TCMMX). The scanning time of the TCTS controller is fixed at 125 µs. The torque controller has two inputs m1* and m2* which can be summated internally. The second input is necessary for inputting initial control values in position control and also for torque control. This is explained in the following sections. Each of the torque controller inputs has limits. The aim of limits is to ensure that the permitted limit values are not exceeded. The limits of input m1* are dynamic and depend on input value m2*.

8.2 Torque Control Mode

As shown in the diagram, the speed controller is also enabled in torque control mode. This special feature offers the following advantages:

- The speed controller limits the speed to the maximum value set in parameter SCSMX. The controller works as a P controller. Reset time SCTLG is inactive.
- If an Emergency Stop is triggered, the speed controller brakes the drive at the maximum torque configured using TCMMX down to rpm n=0. This is an error condition which can be reset by canceling and enabling the power stage ENPO by resetting. The I proportion SCTLG of the speed controller is switched for the execution of Emergency Stop



No.	Function
A	Torque controller
B	Speed controller
1	To modulator and power stage
2	Torque reference value
3	Speed reference value

Relevant parameters:

1. Torque maximum value TCMMX (_TCON)
   Generally the torque limit should be determined by the servocontroller, as the maximum torque of the motor can be approximately five times the nominal torque, but the device can only take double the rated current for ten seconds.

   If the application requires limitation of torque then TCMMX should have its parameters set accordingly.

   Note:
   TCMMX limits the reference value of the torque. Only when the shaft is stationary does this correspond to torque limitation on the motor shaft. In the case of extreme external moments of inertia it may also apply in the dynamic context.

   Torque limitation can also be set from 0 - 100% on-line using the function SCALE via analog input ISA1 (see *Section 7.3.5*).

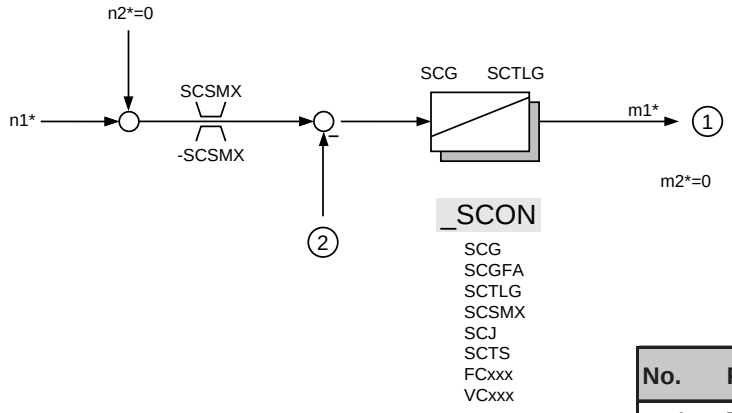
2. Speed Maximum Value SCSMX (_SCON)
   This parameter limits the maximum rpm of the motor, also when it is in torque control mode. The maximum value of the parameter is determined by the rated speed MOSNM of the motor in use. The maximum speed should be limited to suit the application as appropriate.

3. Lag time of torque controller TCTLG (_TCON)
   the lag time is optimized for the motor and no adjustment is necessary.

4. P gain of torque controller TCG (_TCON)
   The gain is optimized for the motor and no adjustment is necessary.

8.3 Speed Control Mode

The speed controller obtains its reference value from the inputs n1* and n2*. Input n2 is only required for precontrol in position control and is otherwise disabled. The speed controller generates a torque reference value which is transmitted to the torque controller.



No.	Function
1	To torque controller
2	Speed actual value
n1*=	Speed reference value
m1*=	Torque reference value

Relevant Parameters:

1. Torque limit TCMMX is the only parameter from the _TCON area which is set to suit the requirements of specific applications *(see "Torque Control Mode").*

2. Maximum Values of Speed

SCSMX	(_SCON)	Limit of speed controller
MOSNM	(_MOT)	Rated speed of motor (SM and ASM)
MOSMX	(_MOT)	Maximum speed of motor (only in the case of ASM, only for speed limitation)

   The parameter SCSMX limits the maximum speed of the motor. The maximum value for this parameter is obtained from the data of the motor in use. In the case of synchronous motors this is the rated speed MOSNM and in the case of asynchronous motors the maximum speed MOSMX (in the field weakening area).

   The parameters for SCSMX speed limitation are always set to be application-specific.

Note when using positioning and sequencing control PosMod1 (AH2):

1. Asynchronous motors can only be operated up to the rated motor speed MOSNM (_MOT) and field weakening cannot be used.
2. Motor parameter K14 must be used to limit operating speed (not SCSMX).

3. P gain of speed controller
   The total P gain results from the following parameters.

SCG	(_SCON)	Parameter for P gain of speed controller
SCGFA	(_SCON)	For scaling and fine adjustment of SCG (0 - 999%, factory setting 100%)
SCJ	(_SCON)	Moment of inertia of installation
MOJNM	(_MOT)	Moment of inertia of motor. This is set to suit the motor by loading the motor specification from the SMARTCARD

   SCG is factory set on the assumption that the moment of inertia of the installation = 0. The moment of inertia of the installation should be set using the parameter SCJ.

   This results in proportional matching of the resulting controller gain. Using parameter SCGFA it is possible to fine tune the gain on-line. The gain of the controller is calculated as follows:

$$\frac{SCG*(SCJ+MOJNM)}{2*MOJNM}*\frac{SCGFA}{100\%}.$$

   If the moment of inertia of the installation is not known, the function of the Servocontroller should be used for setting speed control, as described in *Section 8.3.1*.

   Permissible maximum values for SCG, SCGFA and SCJ are each calculated such that the total controller gain is in the permitted area of $0 - 10^8$.

4. Reset time of speed controller SCTLG (_SCON)
   The lag time should be calculated in advance for the basic setting of the Servocontroller and does not normally need to be changed again.

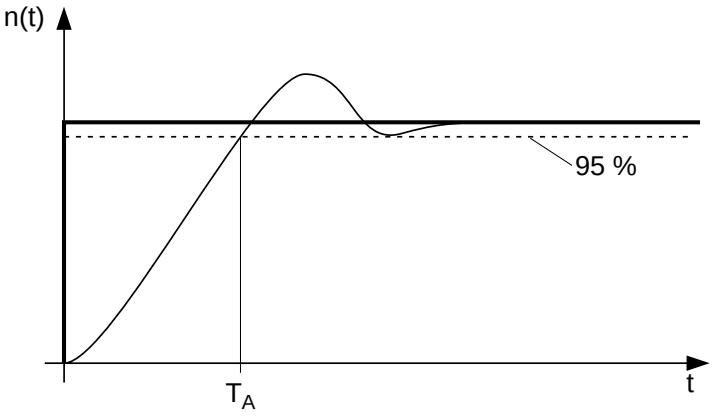
8.3.1 Setting speed control

The MC6000 speed controller has a function for setting the speed control step. When a speed step is applied the step response from the drive is captured. From this response the quality of the control circuit can be judged and the P proportion of the speed controller can be set. This function should be used especially in cases where the moment of inertia of the installation is not known exactly.

The step response provides the following Servocontroller values automatically:

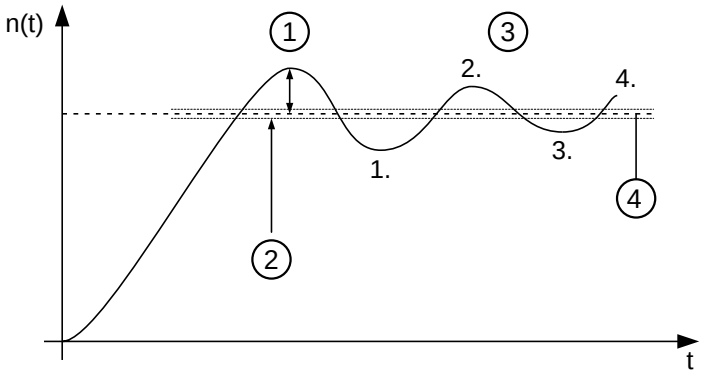
a) Rise time T_A
b) First overshoot
c) Number of overshoots which are grater than 10% of the first overshoot

a) Rise time T_A



b) First overshoot

c) Number of overshoots which are greater than 10% of the first overshoot



No.	Function
1	First overshoot distance
2	10 % of first overshoot distance
3	Overshoots counted (excluding 1st overshoot)
4	Reference value

Definition: overshoot = maximum value (1) - reference value (4)

Using setup mode (Setup mode)

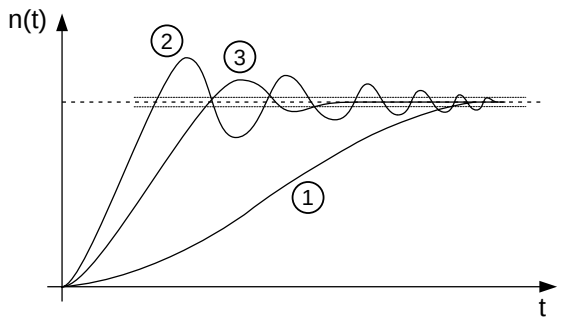
Setup mode is used for setting up the speed control circuit, taking into account the moment of inertia of the installation. The motor must therefore be connected to the installation.

Setup mode cannot be used in conjunction with the SCOPE function of MCWORK.

Safety waring:
Remember that the connected motor will rotate in setup mode. You as user are responsible for ensuring safety.

1. Select MODE = 4 (_KPAD)
2. Enable speed control CFCON = SCON (_CONF) (otherwise the error message E-PAR will be displayed with the error location number 118)
3. Switch off ramps: set parameters ACCR and DECR =0 (_REF)
4. Activate setup mode with SETUP = ON (_CONF)
5. Re-initialize (which returns to the main ***MENU***)
6. Operate the speed control with reference value 0 rpm (e.g. using the CTRL menu) then apply a positive or negative step of approximately 50 to 100 rpm. When the motor reaches the reference speed the control can be switched off again.
7. The values of the speed step response of the system (Servocontroller and link) can be read in _SCON of the PARA-Menu:
   - STIME Setup Time — Rise time
   - 1OVER First Overshoot — First overshoot
   - 10PC Ten Percent — Number of overshoots until the amplitude has reduced to less than 10% of the first overshoot

   The values of the rise time and the first overshoot are only valid if the torque limitation of the motor was not reached (otherwise control behaves in non-linear fashion). If the limit case occurs because too high a reference value step has been set STIME and 1OVER will be preceded by a negative prefix. In this case the step response must be obtained again with a step to a lower speed.
8. Optimizing the step response by matching SCGFA (_SCON).
   In most applications a step response is required which has the minimum first overshoot. After the first or, at the very latest, the second overshoot, the overshoot distances should be less than 10 % of the first overshoot (Parameter 10PC < 1).



In general it is true to say that the rise time is shorter when SCGFA is increased (and vice versa) but this can also render the control loop unstable.

Main Sequences:	
1	slow increase to final speed without overshoot (aperiodic sequence)
2	very short rise time but strong overshoot
3	short rise time with minimum overshoot (usually preferable)

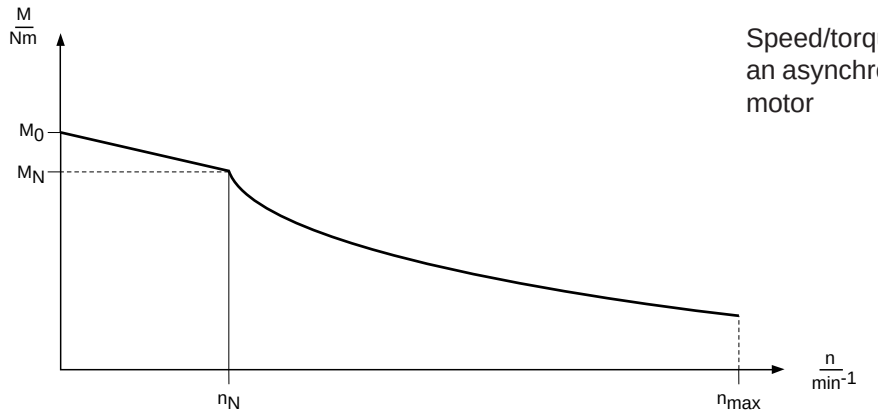
9. If a new reference value step is entered, the parameters of the SETUP mode are updated automatically.
10. The SETUP mode is switched off when SETUP = OFF (_CONF).

The speed controller is factory set to the symmetrical optimum with control filter: The first overshoot is 15%.
The speed controller uses speed steps larger than approximately 50 to 100 rpm (depending on the drive) for speed limitation. The torque controller executes the speed change. The 15% overshoot only applies to the range within which the speed controller is active (small signal).

Example:	Speed step	$0 \rightarrow 3000$	min^{-1}
	Speed controller limitation	from 50 to 100	min^{-1}
	15% of above overshoot	= 7.5 - 15	min^{-1}

8.3.2 Speed in field weakening

Asynchronous motors can be run at high speed with reduced torque in the field weakening range. The graph shows the main features of torque relative to speed in the field weakening range.



Speed/torque graph for an asynchronous motor

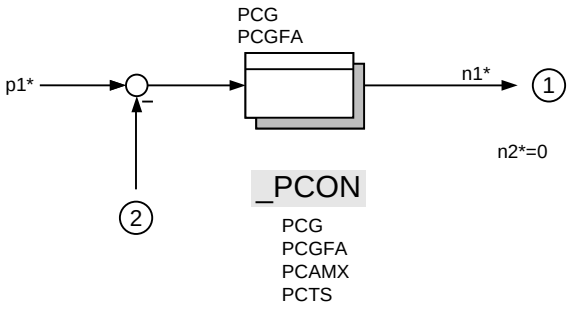
Relevant Parameters
The MC6000 Servocontroller has additional parameters for operating in the field weakening area (speed control _SCON, FCxxx, VCxxx). The parameters have already been optimized for the specific machine using the SMARTCARD at the factory and no further adjustment is necessary.

8.4 Position Control

The position control circuit is integral in the Servocontroller and is used in conjunction with the positioning and sequence control POSMOD1 (option). POSMOD1 provides the position reference value for the internal position controller, prepares the functions necessary for positioning and also includes an operating and programming interface.

8.4.1 Position control without pre-control

This is actually only a theoretical control as the MASTERCONTROL Servocontroller uses an integral pre-control which is described in the next section. Operation without pre-control is described here for the sake of simplicity.



No.	Function
1	To position controller
2	Position actual value
p1*=	Position ref value

8.4.2 Position control mode

In position control an additional pre-control and reference value smoothing is executed. Pre-control means that speed reference values and torque reference values are generated from the position reference value and fed to the specific controller. This results in very short control reaction times and the position controller hardly has to intervene.

The motor is simulated in the MASTERCONTROL Servocontroller. From a technical point of view the motor and installation count as onesystem. The system cannot be overloaded because the Servocontroller does not demand more than the system can deliver. The position reference value is also smoothed so that it is possible to home in on set target positions virtually without overshoot.

Relevant Parameters:

1. Torque limit TCMMX (in the _TCON area) is the only parameter which has to be set to suit the specific the application (*see "Torque Control Mode*").

2. The _SCON parameters are also important in position control (*see „Speed Control Mode"*).

3. P-Amplification of Position Controller
   The total P gain results from the parameters:

PCG	(_PCON)	parameter for P-amplification of position controller
PCGFA	(_PCON)	for scaling and fine setting of PCG (0 - 999%)

   The total P-gain is calculated as follows:

   $$PCG * \frac{PCGFA}{100\%}.$$

   The maximum value of the product is 16383, and the limits of PCG and PCGFA are matched dynamically to it.

   For pre-control to work reliably it is necessary for the value of parameter SCJ to correspond approximately to the actual moment of inertia of the installation. Otherwise position control may produce unsatisfactory results. The response may be too dynamic (with a tendency to overshoot) or too unresponsive. In such cases it may be necessary to match the gain of the position controller. Fine adjustment of the gain on a percentage basis can be carried out on-line using parameter PCGFA.

4. Acceleration of the position controller can be limited by parameter PCAMX (_PCON). The unit of acceleration of the acceleration limit value is rpm/s.

5. Maximum values for position control are provided by software and hardware limit switches.

9 Displays and Error Messages

9.1 Operating Display

The MC6000 Servocontroller has three LEDs which provide current status information. The location of the LEDs is visible above the control terminals when the front panel of the cabinet is open. The two main LEDs (red and green) are also visible from the front through the cover.

LED green (H1)			LED red (H2)			LED yellow (H3)			Status
off	on	flash	off	on	flash	off	on	flash	
X			X			X			device is switched off
	X		X			X			Servocontroller ready
	X			X		X			Servocontroller ready & warning
		X	X			X			control enabled
		X		X		X			control enabled & warning
		X	X				X		flux build-up phase
		X		X			X		flux build-up phase and warning
	X		X					X	control must be initialized or is being initialized
	X			X				X	control must be initialized or is being initialized and warning
		X			X	X			reference value limit enabled (RLIM1, RLIM2) 1)
X				X		X			error
X				X			X		error response
X					X			X	charging relay not driven

1) In addition KEYPAD flashes the symbol the indicate direction of rotation (↻ or ↺)

9.2 Error Messages

Errors are indicated by:

KeyPad display: red

red LED (H2): LED on

KeyPad displays:		**Section**
E-xxx	Warning or fault on Servocontroller	*9.2.1*
ATTx	KeyPad operating error	*9.2.2*
ERRxx	SmartCard error	*9.2.3*

x, xx, xxx - wild card characters: represent any alpha numeric character

Resetting of warnings and Servocontroller errors (after correcting the cause):

- rising flank on ENPO input of control terminals
  warning:
  This disconnects the Servocontroller from the motor. The motor coasts on/rotates freely
- Press the KEYPAD **stop/return key** for approximately 3 seconds
- Set the 'Reset Error' bit in the SIO controller
  (only when controlling using RS485 serial interface; CLSEL = SIO)
- Set the 'Reset Error' bit in InterBus-S/CAN-Bus
  (only when controlling using InterBus-S/CAN-Bus; CLSEL = OPTN1)

9.2.1 Warning and errors in the Servocontroller

Warnings: safe operation not affected, no further reaction (display only)

Errors: safe operation is affected, programmable reaction

Six defined error reactions can be programmed. These range from a warning to an error reaction in which the drive is stopped by Emergency Stop and locked. The standard setting and programming of error reactions is described in detail in the Description of Parameters in *Section 10.2.11*.

In case of error, an error message and a location number (top left on the screen display) are displayed. Accurate diagnosis is assisted by the error location number. If an error occurs which you cannot correct without the assistant of LUST, please give our service engineer the error location number.

Error	Error locat. no.	Cause	Solution
OFF	1	undervoltage, d.c. link voltage <425 V (also displayed on normal power off)	connect increased voltage supply or restore power
E-CPU	---	processor defective	1)
E-OC	1	overvoltage caused by incorrectly set parameters or short circuit, ground f or insulation fault or internal defect in device	check control circuit parameters, check installation; 1)
E-OV	1	over-voltage from brake chopper overload (braking too long or too hard or mains power supply over-voltage	1) set DECR ramp to slower (_REF), set external braking resistor or chopper; adjust mains voltage
E-OLI	1	Servocontroller I*t switch off (exceeding permitted I*t)	reduce load, reduce maximum torque TCMMX (_TCON)
E-OTI	1	Servocontroller overtemperature: ambient temperature too high or; load too high (power stage or brake chopper)	improve ventilation; 1) install higher capacity Servocontroller or external braking resistor or braking chopper
E-OTM	1	motor overtemperature (PTC in the motor triggered): PTC not connected; or motor overload	let motor cool off connect PTC or bridge terminals; 1) install more powerful motor
E-OLM		I^2-t motor monitoring (currently no function)	reduce load
E-FLW		drag error	accelerate or reduce load
E-WDG	11	Watchdog for RS485 triggered	check busmaster or increase SWDGT (_SIO)

Error	Error locat. no.	Cause	Solution
E-EEP	3	error in EEPROM	1) EEPROM defective
	6	error in automatic parameter setting of PosMod1	1)
	12	error in EEPROM	1) EEPROM defective
	100 - 118	error in accessing parameter	1)
E-PLS	xxx	Validity check has invalid parameters or has recognized illegal program sequence	1)
E-PAR	2	limits of reference value input incorrect (RLIM1 > RLIM2)	set RLIM1 < RLIM2 (_REF)
	7	incorrect parameter when checking after device switch on. The number of the incorrect parameter is displayed before the error message	search for incorrect parameter using number in parameter list and correct it
	8	initialization error	1)
	13	function and reference value selector settings incompatible	check selectors and correct setting (_CONF, _REF)
	101	pole pair of resolver illegal (different from the motor pole pair and not 1)	set parameter ECNPP (_ENCD)
	102	invalid switching frequency	1) EEPROM error
	103	initialization of current control	1)
	107	probably incorrect motor type	correct CFMOT (_CONF)
	118	incorrect set-up mode selected	set CFCON =SCON (_CONF) in advance
E-FLT	0	floating point general error	1)
	119	processing error in checking SCJ, SCG, SCGFA	check and modify values of parameters SCJ, SCG, SCGFA
E-PWR	6	power supply unit not recognized correctly	1) return to manufacturer
E-EXT	1	error in external device	correct the error in the external device
E-ENC	6	encoder analysis printed card defective not correctly identified, or not present	1)
	105	encoder invaliding	1)
E-TIM	2, 4, 8, 16	run time monitor triggered	1)
	101	encoder could not be initialized	encoder not connected or defective
E-OP1	xxx	error on option module 1 (X6)	1)
E-OP2	xxx	error on option module 2 (X7)	1)

1): There is a hardware or software error which should not occur during normal operation. Please contact the LUST service department:

Lust Antriebstechnik GmbH
Abt. Service
Tel: +49 6441 966 -157 or
+49 6441 966 -187
Fax: +49 6441 966 -177

Acknowledge error by pressing **stop/return key** for at least 3 seconds.

9.2.2 KEYPAD operator errors

The following operator errors may occur when using the KP100 KEYPAD:

Error	Cause	Solution
ATT1	parameter cannot be changed in current level mode or cannot be edited	select higher MODE 1)
ATT2	motor must not be controlled on-line from the CTRL menu	cancel start signal from another control location
ATT3	motor must not be controlled from CTRL menu because of error condition	reset error
ATT4	new parameter value illegal	change value of parameter
ATT5	new parameter value too high	select lower parameter value
ATT6	new parameter too small	select higher parameter value
ATT7	card must not be read in its present condition	stop control (cancel start signal)
ATT8	permissible speed limit value for SCSMX too high for selected control type or motor	Reduce SCSMX (_SCON) to permissible values
ATT9	CTRL menu cannot be used with PosMod1	select different menu or remove PosMod1
ERROR	invalid password	enter correct password for operating level 1)

1) A higher operating level is only accessible to users familiar with the device and who have the appropriate authorization including the password for access to the operating level.

Acknowledge error by pressing **start/enter key**.

9.2.3 Errors when using SMARTCARD

Error	Meaning
ERR91	SmartCard is write protected
ERR92	error in validity checking
ERR93	SmartCard not reading, incorrect servo or inverter type
ERR94	SmartCard not readable, parameters incompatible
ERR96	link to SmartCard distrupted
ERR97	SmartCard data invalid (CS test)
ERR98	insufficient memory on SmartCard
ERR99	selected area not on SmartCard, no parameters transferred from SmartCard

These errors occur when illegal - and generally unintentional - operations are being carried out, eg an attempt to write to a back-up copy of parameter data or use of a SMARTCARD to operate the VF1000 range of inverters. The use of another SMARTCARD is recommended.

Acknowledge error by pressing **stop/return key.**

9.2.4 Troubleshooting

Possible causes of a function not working as as expected:

Symptom	Solution
Reference value present, but drive does not turn	- ENPO = High level - select correct control location CLSEL (_CONF) - use START command - check function selectors for analog inputs
Drive turns but reference value cannot be inverted (eg change of direction of rotation not possible)	- use reference value 3 or 4 RSSL3, RSSL4 (_REF)
Drive does not turn with required reference value	- switch off reference value channels not in use RSSLx= RCON (_REF) - switch off Offset for selectors FIxxx not = ADx-y (_CONF)
Ramps inactive	- set parameters for ramps ACCR and DECR (_REF) - use reference value channel 3 or 4 RSSL3, RSSL4 (_REF)

10 Description of Parameters

10.1 System for Parameter Names

The KEYPAD has five upper case characters for representing parameter names. All parameter names are English as is customary in this area of technology. The five characters as abbreviations of the parameter name indicate the function of the parameter. As there is a meaningful link between the name and the meaning of the parameter, these parameter names are considerably easier to remember than parameter numbers.

There are physical parameters (control parameters such as controller gain) and non-physical parameters (such as control mode, for example). This has implications for the names of the parameters, as described below.

10.1.1 Areas _ENCD, _MOT, _TCON, _SCON, _PCON

In the areas which relate to control structures and configuration of the encoder and configuration of the motor, it is possible to deduce the function of the parameter from its parameter name. The parameter names in these groups are strictly based on a three stage scheme. This scheme is possible and meaningful because it consists almost exclusively of physical values. This system avoids ambiguities. The three stages in the system relate to:

1. the particular module
2. the physical unit
3. an alphanumeric index

Some parameters are exceptions and do not fit into this strict system. These have a suitable name described under 4 below which replaces stages 2 and 3.

1. The first two characters show the module:

Abbreviation	English
CF	Configuration
EC	Encoder
FC	FluxController
MO	Motor
PC	PositionController
SC	SpeedController
SF	SmoothingFilter
TC	TorqueController
VC	VoltageController

2. In the case of physical values and parameters, the next character provides the meaning:

Formula Code	English
A	Acceleration
C	Current
D	Deceleration
F	Flux
G	Gain
J	Inertia
L	Inductance
M	Torque
P	Power
R	Resistance
S	Speed
T	Time
V	Voltage

3. These values are detailed with a one or two character alphanumeric index:

Index	English
_R	Rotor
_S	Stator
1..99	Index (Numerical)
DC	DC-Link
F	Filter(time)
FA	Factor
LG	Lag
MN	minimum (value)
MX	maximum (value)
NM	nominal (value)
RF	Reference (value)
S	Sample(time)

4. In the case of values which do not fit neatly into this system, three characters are used for identification:

Abbreviation	English
ENA	Enable
LIM	Limitation
LNC	Line Count
MCn (n {1...5})	Magnetizing Curve Parameters
NPP	Number of Pole Pairs
OFF	Offset
QA, QB	1/n-curve

10.1.2 Other areas and Val Menu

This sort of system is not possible in the other areas _CONF, _OPTN1, _OPTN2, _SIO, _KPAD, _SCTY, _USER and _REF and in the VAL Menu. The reason is that these are parameters from many different areas and with various functions, not just physical values. Consequently it is not possible to deduce the meaning of the parameter unambiguously from the parameter name.

However the clear connection between the name and the meaning of thre parameter is maintained by the parameter names being easy to remember. This is further assisted by the use of uniform abbreviations form the same functions in parameter identification.

Abbreviations used widely in these areas:

Abbreviation	English
A	Analog
C (order CON)	Control
CF	Configuration
D	Digital
ERR	Error
F	Function (Selector)
F (order FIX)	Fix(ed Input)
FA	Factor
I	Input
IB (order IBS)	Interbus
MN	Minimum (Value)
MX	Maximum (Value)
N	Normal
NM	Nominal (Value)
O	Output
R	Error Reaction
R (order RF, REF)	Reference
S	Serial
S	Source
SEL (order SL)	Selector

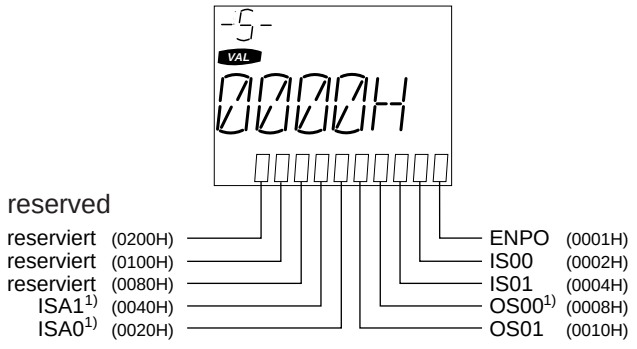
10.2 The VAL Menu Parameters

This list displays all actual values and fixed values which can be accessed in the VAL menu. AEach parameter is assigned a number which is required for control of the system via the serial interface or InterBus-S. The MODE column shows the minimum user level from which there is access to the display.

No.	Name	MODE	Unit	Title	Description
75	CURNT	1	A	Current	Instantaneous effective output current
76	TORQE	1	Nm	Torque	Instantaneous torque
77	SPEED	1	rpm	Speed	Speed instantaneous rpm
78	POS	1	U	Position	Instantaneous position
86	TSYS	1	min	System Time	System time (time since switch-on)
87	TOP	1	h	Time of Operation	Time of operation
90	SREV	1		Standard Revision	A reference to standard software in customer software
91	TYPE	1		Type	Type of equipment
92	REV	1		Revision	Software version
94	TERR	1	min	Time Error	Time between switch-on and the last error
95	ERR1	1		Error 1	Last error 1)
339	OP1RV	1		Option 1 Revision	Software version of Module in slot X6 (if present)
340	OP2RV	1		Option 2 Revision	Software version of Module in slot X7 (if present)
347	DCV	1	V	DC (Link) Voltage	DC link voltage
400	ACTV	1	Nm, rpm, U	Actual Value	Actual value of control value
427	TEMP	1	°C	Temperature	Temperature des MC6000
447	REFV	1	Nm, rpm, U	Reference Value	Reference value of control value
495	IOSTA	1		I/O Status	Status of inputs and outputs 2)
9	TAX	3	%	Controller Tax	Instantaneous load on controller
10	MAXTX	3	%	Maximum Tax	Maximum load on controller
12	MIDTX	3	%	Mid Tax	Mid load on controller
96	ERR2	3		Error 2	Second to last error 1)
97	ERR3	3		Error 3	Third from last error 1)
98	ERR4	3		Error 4	Fourth from last error 1)

1) The error E-OFF is only stored if the mains voltage is restored within one minute.

2) Parameter IOSTA - status of inputs and outputs (hexadecimal).



For bar chart display: parameter BARG= IOSTA (_KPAD).

1) Only in case of digital function of input/output

10.3 Para Menu Parameters

Sequence of Parameters:
The parameters in the KEYPAD are sorted by parameter number - depending on the set user level.

In this description the parameters within each area are listed alphabetically for ease of access.

"Display Level" and "Editing Level":
These levels provide the minimum user level (MODE) required for displaying and editing these parameters.
Examples:

- Display level = 2 means that a parameter will not be displayed at user level MODE = 1 but only from level 2 upwards.
- Editing level = 3 means that this parameter can only be modified from user level MODE = 3 and upwards.

"Effective Changes":
All parameter changes can also be made on line, ie whilst the control is in operation. In most cases the changed parameter becomes effective immediately. Changes in control specific parameters (such as control mode, control gain etc) only take effect after the parameter list has been re-initialized (see Se*ction 6.7*). The line "effect of changes" shows whether or not it is a parameter in which changes only become effective after the control has been re-initialized.

Parameter numbers with "x":
Some parameters are available separately with various control modes, eg fixed reference values RFIX1 to RFIX6. Depending on the control mode the parameter may operate with a reference value in Nm, rpm or U.
These parameters can be recognized by the “x” as the last character in the parameter number, (eg 74x). The last position in the parameter number is determined by the table (right)

x	Control mode
1	Torque control
2	Speed control
3	Position control

Reset to factory setting:

- individual parameter: press ▲ and ▼ arrows simultaneously
- all parameters: hold down ▲ and ▼ arrows whilst switching on the mains, KEYPAD displays RESET.
  Then load SMARTCARD (DRIVE) for matching to the motor.

Parameter setting range:
The setting range for parameters is only a theorectical range which cannot be used by every drive. For example ramp parameters ACCR and DECR can be set =65536 min^{-1} s^{-1}. In practice however, depending on moments of inertia and the torque available, the maximum acceleration or deceleration is likely to be in the range 20,000 to 30,000 min^{-1} s^{-1}. If higher parameter levels are set the drive will run at maximum torque until reaching the reference speed.

Setting parameters using serial interface (RS485, InterBus-S, CAN-Bus):
Possible parameter settings are listed under "Value range" in { } and in tables under "No." .

Allocation of user levels and SmartCard areas:

MODE	Reference Value Input & Function Selectors	Motor & Control Setting	Application Specific Settings	Options	System
1	Display parameter				
	-	-	-	-	
2	Programming of I/O and reference value input	-	-	I/O Module 1	Password, Bar chart, Continous actual value
3	- " -	Control mode, Auto start	System	InterBus-S, CAN-Bus	Serial interface
4	- " -	Improving control Parameters	- " -	- " -	- " -
SmartCard area	**REFRC**	**DRIVE**	**APPLI**	**OPTN1, OPTN2**	**SYSTM**

Note:
Parameters which depend on the hardware present or which are derived from software settings are not stored on the SmartCard. These parameters are identified with "no data storage", eg Hardware- and Software Status word (CFHSW and CFSSW in area _CONF).

10.3.1 Configuration Area (_CONF)

ANFIL

Analog Filter Constant — Time constant of analog filter for the analog reference value inputs ISA0, ISA1

Parameter number: 410
Physical unit: ms
Value range: see table below
Factory setting: 4
Customer setting:
Display level: 3
Editing level: 4
SmartCard area: REFRC

Setting	Function
0	0 ms
1	1 ms
2	2 ms
3	4 ms
4	8 ms
5	16 ms

To correct error increase time constant. To be used if the reference value is affected adversely by errors in the analog signal.

AUTO

Auto Start — Auto-Start:
If a start command has been wired at the terminals the control will be enabled immediately at power on

Parameter number: 7
Physical unit: -
Value range: OFF {0} / ON {1}
Factory setting: OFF
Customer setting:
Display level: 1
Editing level: 3
SmartCard area: SYSTM

CFCMX

Configuration Current Maximum	Maximum permissible effective value of current (100% overload for 10s); the value depends on the device type and is derived automatically from the final stage identification.
Parameter number:	304
Physical unit:	A
Value range:	see table below
Factory setting:	dependent on device type
Customer setting:	
Display level:	1
Editing level:	cannot be edited
SmartCard area:	no data storage

Setting	Device Type
8A	MC6404
16 A	MC6408
24 A	MC6412
32 A	MC6416
64A	MC6432
96A	MC6464

CFCON

Configuration Control	Control mode (control of torque, speed or position)
Parameter number:	300
Physical unit:	-
Value range:	see table below
Factory setting:	SCON
Customer setting:	
Display level:	1
Editing level:	3
SmartCard area	SYSTM:
Change effective:	only after re-initialization (*see Section* 6.7)

Explanations:

- If in torque control mode the torque (reference value) is greater than the load, the drive will accelerate up to the speed or voltage limit. The speed limit can be set using parameter SCSMX (_SCON).
- In the case position control, position is entered in rotations (r). A reference value of 1.00 represents a position which is displaced by 360 °clockwise..

CFHSW

Configuration Hardware State Word — Hardware status word (set after mains power on and manual changes)

Parameter number: 305
Physical unit: hexadecimal
Value range: see table below
Factory setting: 0000h
Customer setting:
Display level: 4
Editing level: cannot be edited
SmartCard area: No data storage

Bit Position	Value of Position	Meaning of Bit
0	0000 H	No encoder connection
1	0001 H	Resolver is connected (R1, R2, R8)
2	0002 H	Encoder with sign wave output is connected (G1) or no encoder recognized
3	0004 H	Encoder with square wave output is connected
4	0008 H	Single turn absolute encoder with SSI interface (G2)
5	0010 H	Multi turn absolute encoder with SSI-Schnittstelle (G3)
6	0020 H	Slot 1 (X6) in use
7	0040 H	Slot 2 (X7) in use
8	0080 H	Asynchronous motor connected
9	0100 H	Synchronous motor connected
10	0200 H	Reluctance motor connected

Example:
00C1 H - Asynchronous motor with resolver connected, option slot 2 in use.

CFMOT

Configuration Motor — Motor type (synchronous/asynchronous)

Parameter number: 301
Physical unit: -
Value range: see table below
Factory setting: AS
Customer setting:
Display level: 1
Editing level: cannot be edited
SmartCard area: DRIVE
Changes effective: only after re-initialization (*see Section* 6.7)

No.	Setting	Motor Type
0	AS	Asynchronous Servomotor
1	PS	Synchronous Servomotor

CFPNM

Configuration Power Class Nominal — Identification of power class of final stage (effective rated output current in amps)

Parameter number: 302
Physical unit: A
Value range: 4, 8, 12, 16 A
Factory setting: device-dependent
Customer setting:
Display level: 1
Editing level: cannot be edited
SmartCard area: no data storage

CFSSW

Configuration Software State Word — Software status word
Parameter number: 306
Physical unit: hexadecimal
Value range: see table below
Factory setting: 0000h
Customer setting:
Display level: 4
Editing level: cannot be edited
SmartCard area: no data storage

Bit Position	Value of Position	Meaning of Bits
0	0001 H	Torque control
1	0002 H	Speed control
2	0004 H	Position control
4	0010 H	Electrical drive (master)
5	0020 H	Electrical drive (slave)

CLSEL

Control LocationSelector — Control location selector (terminals, KeyPad, ...) source for START and INV, control commands reference values in accordance with reference value input, also from other locations.

Parameter number: 402
Physical unit: -
Value range: see table below
Factory setting: TERM
Customer setting:
Display level: 1
Editing level: 2

No.	Setting	Identification	Function
1	TERM	Terminal	Control drive from terminals (Input configured as Start)
2	KPAD	KeyPad	Control drive from KeyPad
3	SIO	Serial Input/Output	Control drive from serial interface (LustBus control word)
4	OPTN1	Option 1	Control drive from module in slot 1 (eg InterBus-S, CAN-Bus Interface)
5	OPTN2	Option 2	Control drive from module in slot 2 (eg I/S-Module 1, PosMod 1)

FIF0, FIF1

Function Selector Input Fixed 0, 1 — Function selector for fixed input 0 or 1; input simulated by software. Use:eg for START and INV

Parameter number:	443,444
Physical unit:	-
Value range:	see table below
Factory setting:	OFF
Customer setting:	
Display level:	2
Editing level:	2
SmartCard area:	REFRC

No.	Setting	Function
0	OFF	None
1	START	Start with preset reference value
2	INV	Reference value of reference value channels 3 and 4 is inverted (see Section 7.4 "Examples of Applications)
4	AD1-0	Offset for RSSL1 (SADD1-Bit 0), switching: +1
5	AD1-1	Offset for RSSL1 (SADD1-Bit 1), switching: +2
6	AD1-2	Offset for RSSL1 (SADD1-Bit 2), switching: +4
7	AD1-3	Offset for RSSL1 (SADD1-Bit 3), switching: +8
8	AD2-0	Offset for RSSL2 (SADD2-Bit 0), switching: +1
9	AD2-1	Offset for RSSL2 (SADD2-Bit 1), switching: +2
10	AD2-2	Offset for RSSL2 (SADD2-Bit 2), switching: +4
11	AD2-3	Offset for RSSL2 (SADD2-Bit 3), switching: +8
12	AD3-0	Offset for RSSL3 (SADD3-Bit 0), switching: +1
13	AD3-1	Offset for RSSL3 (SADD3-Bit 1), switching: +2
14	AD3-2	Offset for RSSL3 (SADD3-Bit 2), switching: +4
15	AD3-3	Offset for RSSL3 (SADD3-Bit 3), switching: +8
16	AD4-0	Offset for RSSL4 (SADD4-Bit 0), switching: +1
17	AD4-1	Offset for RSSL4 (SADD4-Bit 1), switching: +2
18	AD4-2	Offset for RSSL4 (SADD4-Bit 2), switching: +4
19	AD4-3	Offset for RSSL4 (SADD4-Bit 3), switching: +8

Warning!
A changed function is enabled immediately (this applies to all input functions selected). That means that the drive will start immediately if the function START is allocated to an input.

Note:
Inputs with the same function work as an OR link (this applies to all input function selectors).

FIS00, FIS01

Function Selector Input Standard 00, 01 — Function selector for input IS00 and IS01

Parameter number: 439, 440
Physical unit: -
Value range: see table below
Factory setting FIS00: START
Factory setting FIS01: INV
Customer setting:
Display level: 2
Editing level: 2
SmartCard area: REFRC

No.	Setting	Function of input
0	OFF	none
1	START	Start with preset reference value
2	INV	Reference value of reference value channels 3 and 4 is inverted (see Section 7.4 "Reference Input"
3	/STOP	Enable Emergency Stop with stop ramp STOPR (low active)
4	AD1-0	Offset for RSSL1 (SADD1-Bit 0), switching: +1
5	AD1-1	Offset for RSSL1 (SADD1-Bit 1), switching: +2
6	AD1-2	Offset for RSSL1 (SADD1-Bit 2), switching: +4
7	AD1-3	Offset for RSSL1 (SADD1-Bit 3), switching: +8
8	AD2-0	Offset for RSSL2 (SADD2-Bit 0), switching: +1
9	AD2-1	Offset for RSSL2 (SADD2-Bit 1), switching: +2
10	AD2-2	Offset for RSSL2 (SADD2-Bit 2), switching: +4
11	AD2-3	Offset for RSSL2 (SADD2-Bit 3), switching: +8
12	AD3-0	Offset for RSSL3 (SADD3-Bit 0), switching: +1
13	AD3-1	Offset for RSSL3 (SADD3-Bit 1), switching: +2
14	AD3-2	Offset for RSSL3 (SADD3-Bit 2), switching: +4
15	AD3-3	Offset for RSSL3 (SADD3-Bit 3), switching: +8
16	AD4-0	Offset for RSSL4 (SADD4-Bit 0), switching: +1
17	AD4-1	Offset for RSSL4 (SADD4-Bit 1), switching: +2
18	AD4-2	Offset for RSSL4 (SADD4-Bit 2), switching: +4
19	AD4-3	Offset for RSSL4 (SADD4-Bit 3), switching: +8
20	/ENDL	Limit switch left (counterclockwise) (low active) 1)
21	/ENDR	Limit swicth right (clockwise) (low active) 1)
22	E-EXT	External error (power supply)
23	MP-UP	Motor operated potentiometer „UP“ (increase reference val)
24	MP-DN	Motor operated potentiometer „DOWN“ (reduce ref val)
25	OPTN1	Is module in slot 1 (X6) available? 2)
26	OPTN2	Is module in slot 2 (X7) available? 2)
27	USER0	Input can be used by custom software
28	USER1	(See accompanying documentation)
29	USER2	No function in the case of standard software
30	USER3	

1) Emergency Stop is triggered with stop ramp, to release open and close START (also in the case of Auto Start).
2) No function if option not available.

FISA0, FISA1

Function Selector Input Standard Analog 0, 1 — Function selector for input ISA0 and ISA1

Parameter number: 441, 442
Physical unit: -
Value range: see table below
Factory setting: OFF
Customer setting:
Display level: 2
Editing level: 2
SmartCard area: REFRC
Changes effective: only after re-initializing (*see Section* 6.7)

No.	Setting	Function
0	OFF	None
1	START	Start with preset reference value
2	INV	Reference value of reference value channels 3 and 4 is inverted (siehe Kapitel 7.4 Sollwertvorgabe")
3	/STOP	Enable Emergency Stop with STOPR (low-active)
4	AD1-0	Offset for RSSL1 (SADD1-Bit 0), switching: +1
5	AD1-1	Offset for RSSL1 (SADD1-Bit 1), switching: +2
6	AD1-2	Offset for RSSL1 (SADD1-Bit 2), switching: +4
7	AD1-3	Offset for RSSL1 (SADD1-Bit 3), switching: +8
8	AD2-0	Offset for RSSL2 (SADD2-Bit 0), switching: +1
9	AD2-1	Offset for RSSL2 (SADD2-Bit 1), switching: +2
10	AD2-2	Offset for RSSL2 (SADD2-Bit 2), switching: +4
11	AD2-3	Offset for RSSL2 (SADD2-Bit 3), switching: +8
12	AD3-0	Offset for RSSL3 (SADD3-Bit 0), switching: +1
13	AD3-1	Offset for RSSL3 (SADD3-Bit 1), switching: +2
14	AD3-2	Offset for RSSL3 (SADD3-Bit 2), switching: +4
15	AD3-3	Offset for RSSL3 (SADD3-Bit 3), switching: +8
16	AD4-0	Offset for RSSL4 (SADD4-Bit 0), switching: +1
17	AD4-1	Offset for RSSL4 (SADD4-Bit 1), switching: +2
18	AD4-2	Offset for RSSL4 (SADD4-Bit 2), switching: +4
19	AD4-3	Offset for RSSL4 (SADD4-Bit 3), switching: +8
20	/ENDL	Limit switch left (counter-clockwise) (low active) 1)
21	/ENDR	Limit switch right (clockwise) (low active) 1)
22	E-EXT	External error
23	MP-UP	Motor operated potentiometer „UP“ (increase reference val)
24	MP-DN	Motor operated potentiometer „DOWN“ (reduce ref val)
25	OPTN1	Is a module available in slot 1 (X6)? 2)
26	OPTN2	Is a module available in slot 2 (X7)? 2)
27	USER0	Input can be used by custom software
28	USER1	(See accompanying documentation),
29	USER2	No function in case of standard software
30	USER3	
31	ANALG	Analog reference value input
32	SCALE	Scaling of torque limit in TCMMX (_TCON) of 0 - 100 % (only for FISA1)
33	SPEED	Direct input for speed ref values +/- 10V (only for FISA0), for use with superordinate position in positioning control. 3)

1) Emergency Stop when stop ramp is triggered, open and close START to release, (also in the case of Auto-Start).
2) No function if option not present.
3) Switch off reference value selectors (RSSLx= RCON), otherwise error message E-PAR. If the SPEED function has been selected control is no longer possible from the CTRL menu.

FOA0

Function Selector Output Analog 0 — Function selector, determines what value is provided at OS00 as PWM or analog output, scaling by OA0MN, OA0MX (_CONF), for example see parameter OA0MX

Parameter number: 449
Physical unit: -
Value range: see table below
Factory setting: SPEED
Customer setting:
Display level: 3
Editing level: 3
SmartCard area: REFRC

No.	Setting	Function
0	TORQE	Instantaneous torque
1	SPEED	Instantaneous speed
2	POS	instantaneous position
3	CURNT	Instantaneous effective output current
4	IA0	Input difference at input ISA0 1) 1)
5	IA1	Input value at input ISA1 1) 1)

1) Parameters set to reflect the value of the input directly
for input ISA0: OA0MN= -1023, OA0MX= 1023
for input ISA1: OA0MN= 0, OA0MX= 1023

FOS00, FOS01

Function Selector Output Standard 00, 01 — Function selector for output OS00 and OS01

Parameter number: 445, 446
Physical unit: -
Value range: see table below
Factory setting: OFF
Customer setting:
Display level: 2
Editing level: 2
SmartCard area: REFRC

No.	Setting	Function
0	OFF	None
1	ERR	Error
2	WARN	Warning
3	/ERR	No error
4	/WARN	No warning
5	ACTIV	Control operating (green LED flashing)
6	ROT_R	Rotate Right / rotate clockwise 1)
7	ROT_L	Rotate Left / rotate counterclockwise 1)
8	ROT_0	No Rotation / Stationary (excited) 1)
9	LIMIT	Limit value reached, dependent on parameters RL1M, RL1M2 (_REF)
10	REF	Reference value reached, dependent on parameters REF_R
11	ASM	Asynchronous motor parametered
12	SIO	Output assigned to serial interface and can be set using SCTL1 (_SIO)

FOS00, FOS01 (continued)

No.	Setting	Function
13	OPTN1	Output is assigned to module in slot 1 and function assigned 2)
14	OPTN2	Output is assigned to module in slot 2 and function assigned 2)
15	ERRW	Warning or error
16	/ERRW	No warning and no error
17	USER0	Output can be used by custom software
18	USER1	(see accompanying documentation)
19	USER2	No function with standard software
20	USER3	
21	ANALG	Output delivers analog (PMW) output signal, 3) Function is allocated by FOA0 (only FOS00)

1) Dependant upon parameter SPD_0 (_CONF)
2) No function if module card not present
3) PWM Signal 24 V, 200 Hz eg for slow response pointer instruments

MPCNF

Motor Potentiometer Configuration — Configuration of motor operated potentiometer (mode)

Parameter number: 415
Physical unit: -
Value range: 0 - 3
Customer setting:
Display level: 2
Editing level: 2
SmartCard area: REFRC

The reference value can be increased or decreased using 2 inputs to which functions MP-UP and MP-DN are assigned.

Setting	Function
0	Status control, no reset
1	Status control, with reset
2	Flank control, no reset
3	Flank control, with reset

OA0MN

Output Analog 0 Minimum Value — Minimum output value with analog function of output OS00 (value of output at 0V)

Parameter number:	481
Physical unit:	-
Value range:	-32764 - + 32764
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	2
SmartCard area:	REFRC

OA0MX

Output Analog 0 Maximum Value — Maximum output value with analog function of output OS00 (value of output at 24V)

Parameter number:	482
Physical unit:	-
Value range:	-32764 - + 32764
Factory setting:	3000
Customer setting:	
Display level:	2
Editing level:	2
SmartCard area:	REFRC

Example for use of output OS00:
With FOA0, OA0MN, OA0MX and PWM function selected by FOS00=ANALG (_CONF) the current speed will be outputted via OS00. The parameters OA0MN and OA0MX determine the speed window.

Speed:	0	...	3000	rpm	corresponds to
Output voltage:	0	...	24	V	

OPTN1

Option1 — Identification of module card in slot 1 (X6)

Parameter number:	307
Physical unit:	hexadecimal
Value range:	see table below
Factory setting:	dependant on device configuration
Customer setting:	
Display level:	1
Editing level:	cannot be edited
SmartCard area	No data storage
Changed effected:	only after re-initializing (*see Section* 6.7)

Setting	Function
0000 H	Slot unoccupied
0001 H	CAN-Bus Interface
01FF H	Interbus-S Interface

Other identifications can be seen from the related descriptions.

OPTN2

Option2 — Identification of module card slot 2 (X7)

Parameter number: 308
Physical unit: hexadecimal
Value range: see table below
Factory setting: dependant on device type
Customer setting:
Display level: 1
Editing level: cannot be edited
SmartCard area: No data storage
Changed effective: only after re-initializing (*see Section* 6.7)

Setting	Function
0000 H	Slot empty
0001 H	I/O module 1 present
01FF H	PosMod1present

Other identifications can be seen from the related descriptions.

PMFS

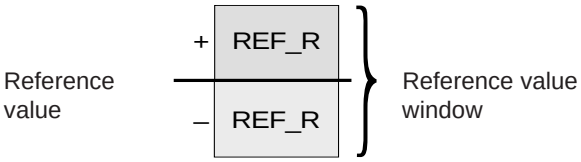
Pulse Modulation Frequency (Switching) — Switching frequency of final stage (PWM frequency). This is also the frequency at which the analog function of ouputs OS00, OS01 is driven.

Parameter number: 341
Physical unit: kHz
Value range: 4, 8, 16 kHz
Factory setting: 8 kHz
Customer setting:
Display level: 2
Editing level: 2
SmartCard area: SYSTM
Change effective: only after re-initializing (*see Section* 6.7)

REF_R

Reference Reached Value — Reference value window for the message "Reference Reached". An output to which the function “REF” is assigned shows whether the actual value is within this reference value window.

Parameter number: 86x
Physical unit: Nm, min^{-1}, r
Value range: 0 - 100, depending on control type, restricted
Factory setting: 1, dependent on control type
Customer setting:
Display level: 2
Editing level: 2
SmartCard area: REFRC



SETUP

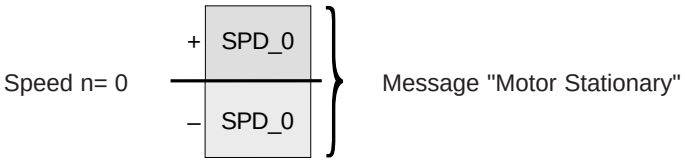
Setup Mode	Switch on/switch off set up mode for setting speed controller Other parameters: 10PC, 1OVER, STIME (_SCON)
Parameter number:	451
Physical unit:	-
Value range:	OFF {0} / ON {1}
Factory setting:	OFF
Customer setting:	
Display level:	4
Editing level:	4
SmartCard area:	ALL

SPD_0

Speed = 0	Window for the message "Motor stationary"
Parameter number:	401
Physical unit:	min^{-1}
Value range:	0,02 - 20
Factory setting:	0,2
Customer setting:	
Display level:	2
Editing level:	2
SmartCard area:	REFRC

If the speed of the motor is larger than this window, the direction of rotation is indicated by the sybols ↻ and ↺ on KeyPad. This parameter also determines from what speed ouputs will be set, to which functions “ROT_R”, “ROT_L” or “ROT_0” have been assigned.

A value of 0,2 min^{-1} is useful for resolvers as the smallest setting for the reference value window; in the case of high resolution optical encoders the value van be reduced to 0,02 min^{-1} .



10.3.2 Encoder Area (_ENCD)

Changes to parameters in this area only become effective after reinitialization (*see Section 6.7*)

ECLNC

Encoder Line Count	Line count of the encoder (only for G1, G2, G3)
Parameter number:	331
Physical unit:	-
Value range:	512 - 4096
Factory setting:	2048
Customer setting:	
Display level:	4
Editing level:	4
SmartCard area:	DRIVE

ECNPP

Encoder Number of Pole Pairs	Pole pair number of encoder (only for R1, R2, R8 resolves)
Parameter number:	334
Physical unit:	-
Value range:	see table below
Factory setting:	depending on resolver
Customer setting:	
Display level:	4
Editing level:	4
SmartCard area:	DRIVE

Setting	Pole pair no.	Resolver type	Motor type
1	1	R1	AS, PS
2	2	R2	AS
3	3	R8	PS
4	reserved		

AS = asynchronous motor
PS = synchronous motor

Note:
The number of pole pairs of the motor must be equivalent to that of the motor or simply one (*see table above*).

ECOFF

Encoder Offset	Offset of encoder (correction value for physical installation)
Parameter number:	333
Physical unit:	hexadecimal
Value range:	0000h - FFFFh
Factory setting:	je nach Einbaulage
Customer setting:	
Display level:	4
Editing level:	cannot be edited
SmartCard area:	DRIVE

ECTF

Encoder Time Filter	Filter time constant of encoder
Parameter number:	336
Physical unit:	ms
Value range:	see table below
Factory setting:	0,36 ms (ECTS = 4 kHz)
Customer setting:	
Display level:	2
Editing level:	3
SmartCard area:	DRIVE

The following filter time constants are dependent on the scanning frequency of the ECTS encoder:

Time constant [ms] (ECTS = 2 kHz)	Time constant [ms] (ECTS = 4 kHz)
0,00 ms	0,00 ms
0,72 ms	0,36 ms
1,74 ms	0,87 ms
3,74 ms	1,87 ms
7,73 ms	3,87 ms
15,72 ms	7,86 ms
31,70 ms	15,85 ms
-	31,82 ms

Values entered are approximated to these values.

Note:
The parameter value matched to the motor is transferred to the SmartCard. In the case of large moments of inertia it may be necessary to increase the time filter constant. ECTF should only be changed by one step however as control can become unstable if this setting is incorrect. This may become apparent when the motor is stationary and hums loudly. Requirements for higher value settings should be discussed with LUST.

ECTS

Encoder Time Sampling	Encoder time sampling
Parameter number:	330
Physical unit:	kHz
Value range:	2 oder 4 kHz
Factory setting:	4 kHz
Customer setting:	
Display level:	2
Editing level:	4
SmartCard area:	DRIVE

10.3.3 Option Slot 1 (_OPTN1)

_OPTN1 can only be selected from the PARA menu if there is a module card in Option Slot 1 (X6). The parameters are then available, e.g. for the Interbus-S interface. These parameters are explained in the appropriate section.

10.3.4 Option Slot 2 (_OPTN2)

_OPTN2 can only be selected from the PARA menu if there is a module card in Option Slot 2 (X7). Then the specific parameters are displayed in this area. These parameters are explained in the appropriate section.

I/O Module 1
The parameters for the I/O expansion module are explained in Section 11.

PosMod1
The positioning and sequence control is parametered using the user-friendly PC interface LuPos, so _OPTN2 is not required.

10.3.5 Motor area (_MOT)

Changes in parameters in this area only take effect after re-initialization (*see Section 6.7*). Read in motor data from the SmartCard (DRIVE area). The Servocontroller is factory-set for the type ASM22 motor.

MOCNM

Motor Current Nominal	Motor rated current
Parameter number:	317
Physical unit:	A
Value range:	0.0 - 64
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOFNM

Motor Flux Nominal	Rated flux of motor
Parameter number:	310
Physical unit:	Vs
Value range:	0032 - 09999
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	3
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOJNM

Motor Inertia Nominal	Moment of inertia of the motor (rated)
Parameter number:	319
Physical unit:	kg*m²
Value range:	0,0 - 0,12
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOL_M

Motor Inductivity [L] Mutual	Magnetizing inductance of motor
Parameter number:	312
Physical unit:	H
Value range:	0,001 - 0,9999
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	3
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOL_S

Motor Inductivity [L] Stator — Stator inductance of motor

Parameter number:	311
Physical unit:	H
Value range:	0,001 - 0,9999
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	3
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOMMX

Motor Torque [M] Maximum — Maximum motor torque

Parameter number:	327
Physical unit:	Nm
Value range:	0,0 - 256
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOMNM

Motor Torque [M] Nominal — Rated torque of motor

Parameter number:	318
Physical unit:	Nm
Value range:	0,0 - 256
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SmartCard area:	DRIVE

MONPP

Motor Number of Pole Pairs — Number of pole pairs in motor

Parameter number:	320
Physical unit:	-
Value range:	1 - 4
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOR_R

Motor Resistance Rotor	Motor rotor resistance
Parameter number:	314
Physical unit:	Ω
Value range:	0,001 - 150
Factory setting:	motor-dependent
Customer setting:	
Display level:	3
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOR_S

Motor Resistance Stator	Motor stator resistance
Parameter number:	313
Physical unit:	Ω
Value range:	0,001 - 150
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	3
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOSMX

Motor Speed Maximum	Maximum motor speed (only for asynchronous motors)
Parameter number:	316
Physical unit:	min^{-1}
Value range:	500 / 1000 / 1500 / 2000 / 3000 / 4000 / 6000 / 8000 / 10000 / 12000
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SmartCard area:	DRIVE

MOSNM

Motor Speed Nominal	Rated speed of motor
Parameter number:	315
Physical unit:	min^{-1}
Value range:	500 / 1000 / 1500 / 2000 / 3000 / 4000 / 6000
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SmartCard area:	DRIVE

10.3.6 Torque control area (_TCON)

Note: Changes to these parameters only take effect after re-initialization (*see Section 6.7*)
SMARTCARD area for these parameters: **DRIVE**.

TCG

Torque Controller Gain	Gain of torque controller (P proportion)
Parameter number:	351
Physical unit:	-
Value range:	0 - 426,0
Factory setting:	motor-dependent, read in from SMARTCARD
Customer setting:	
Display level:	4
Editing level:	cannot be edited

TCMMX

Torque Controller Torque [M] Maximum	Torque limit of torque controller
Parameter number:	353
Physical unit:	Nm
Value range:	0 - MOMMX or device limit
Factory setting:	dependent on servo type and motor type
Customer setting:	
Display level:	2
Editing level:	3

Torque limitation is enabled in all control modes. The value should be set to be application-specific. It is possible to scale the parameter from 0% - 100% using analog input. (*see FISAx under _CONF*).

TCTLG

Torque Controller Time Lag	Lag time of torque controller (I proportion)
Parameter number:	352
Physical unit:	s
Value range:	125 µs - 50ms
Factory setting:	motor-dependent, read in from SMARTCARD
Customer setting:	
Display level:	4
Editing level:	cannot be edited

TCTS

Torque Controller Time Sampling	Sampling time of torque controller (125 µs)
Parameter number:	350
Physical unit:	s
Value range:	124,8 µs
Factory setting:	124,8 µs
Customer setting:	
Display level:	3
Editing level:	cannot be edited

10.3.7 Speed control area (_SCON)

Changes to parameters in this area only take effect after re-initialization (*see Section 6.7*) There is only one exception: parameter SCGFA for on-line matching of controller gain.

Factory settings of parameters in this area depend on motor type and are set to be read in motor data from the SMARTCARD.

10PC

10 Percent	for set-up mode: number of overshoots with an amplitude greater than 10% of the first overshoot.
Parameter number:	452
Physical unit:	-
Value range:	0 - 255
Factory setting:	0
Customer setting:	
Display level:	3
Editing level:	cannot be edited
SMARTCARD area:	No data storage

1OVER

First Overshoot	First overshoot (Set-up mode for speed control)
Parameter number:	454
Physical unit:	min^{-1}
Value range:	-16384 - +16384
Factory setting:	0
Customer setting:	
Display level:	4
Editing level:	cannot be edited
SMARTCARD area:	No data storage

SCG

Speed Controller Gain	Gain of speed controller (P proportion)
Parameter number:	362
Physical unit:	-
Value range:	0 - 10^8
Factory setting:	motor-dependent, read in from SMARTCARD
Customer setting:	
Display level:	2
Editing level:	4
SMARTCARD area:	DRIVE

Note: SCG is ideally matched to the motor by reading in from the SMARTCARD and should only be changed in exceptional cases if gain matching using parameter SCGFA= 0 - 1000 % is not adequate.

SCGFA

Speed Controller Gain Factor	Matching factor for gain of speed control (P proportion) from 0% - 1000%
Parameter number:	375
Physical unit:	%
Value range:	0,05 - 999,95
Factory setting:	100,00
Customer setting:	
Display level:	2
Editing level:	3
Changes effective:	immediate
SmartCard area:	APPLI

SCJ

Speed Controller Inertia	moment of inertia of the installation, reduced to the motor shaft
Parameter number:	363
Physical unit:	$kg*m^2$
Value range:	0 - 1000
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	3
SmartCard area:	APPLI

SCSMX

Speed Controller Speed Maximum	Speed limitation of speed controller
Parameter number:	384
Physical unit:	min^{-1}
Value range:	≤ MOSMX (Maximum rpm of motor)
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	2
Editing level:	3
SmartCard area:	APPLI

Notes for use of positioning and sequence control PosMod1 (AH2):

1. Asynchronous motors can only be driven up to the motor rated speed MOSNM.
2. Motor parameter K14 must be used to limit operating speed (not SCSMX).

SCTLG

Speed Controller Time Lag	Lag time of speed controller (I proportion)
Parameter number:	360
Physical unit:	s
Value range:	0,001 - 2s
Factory setting:	motor-dependent, read in from SmartCard
Customer setting:	
Display level:	2
Editing level:	4
SmartCard area:	DRIVE

SCTS

Speed Controller Time Sampling	Sampling time of speed controller (250 or 500 ms)
Parameter number:	361
Physical unit:	s
Value range:	249,6 or 499,2 µs
Factory setting:	249,6 µs
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SmartCard area:	no data storage

STIME

Setup Time	Set-up time (Set-up mode for speed control)
Parameter number:	453
Physical unit:	s
Value range:	-25 - +25
Factory setting:	0
Customer setting:	
Display level:	4
Editing level:	cannot be edited
SmartCard area:	no data storage

10.3.8 Position control area (_PCON)

Changes to parameters in this area take effect only after re-initialization (*see Section 6.7*). There is one exception only: parameter PCGFA for on-line matching of controller gain - any changes take effect immediately.

PCAMX

Position Controller Acceleration Maximum	Acceleration limit value of position controller (ramp) Overshoots if PCAMX set too high
Parameter number:	382
Physical unit:	min^{-1} s^{-1}
Value range:	0,1 - 10^6
Factory setting:	18000,0
Customer setting:	
Display level:	2
Editing level:	3
SMARTCARD area:	APPLI

PCG

Position Controller Gain	Gain of position controller (P proportion)
Parameter number:	381
Physical unit:	-
Value range:	0 - 16383
Factory setting:	4000
Customer setting:	
Display level:	2
Editing level:	4
SMARTCARD area:	DRIVE

PCGFA

Position Controller Gain Factor	Matching factor for gain of position controller (P proportion) from 0% - 1000%
Parameter number:	386
Physical unit:	%
Value range:	0,05 - 999 % (16384/PCG) · 100 %
Factory setting:	100,00
Customer setting:	
Display level:	2
Editing level:	3
Auswirkung von Änderungen:	immediate
SMARTCARD area:	APPLI

PCTS

Position Controller Time Sampling	Time sampling of position controller (500 µs)
Parameter number:	380
Physical unit:	s
Value range:	499,2 µs
Factory setting:	499,2 µs
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SMARTCARD area:	DRIVE

10.3.9 Serial Interface area (_SIO)

Note:
Further informnation on Servocontroller operation using the serial interface will be found in the description of the LUSTBUS data transfer protocol (available from June 1996).

SADDR

Serial Address	Serial address of device
Parameter number:	82
Physical unit:	-
Value range:	0 - 30
Factory setting:	1
Customer setting:	
Display level:	3
Editing level:	3
SMARTCARD area:	no data storage

No.	Function
0	Only for non-networked operation
1...30	Addresses 1 - 30
31	Broadcast: transmission to all devices, no response

SBAUD

Serial Baud Rate	Baud rate of serial interface (data transfer rate)
Parameter number:	81
Physical unit:	Bit / s
Value range:	see table below
Factory setting:	0
Customer setting:	
Display level:	3
Editing level:	3
SMARTCARD area:	SYSTM

No.	Function
0	9600 Bit/s
1	4800 Bit/s
2	2400 Bit/s
3	1200 Bit/s
4	19200 Bit/s
5	28800 Bit/s
6	57600 Bit/s

Note:
When the baud rate is changed, the change is not normally implemented immediately, but the serial interface is set to the new baud rate next time it is switched on.
The changed baud rate *can* be enabled during operation by setting PROG = 111 in _KPAD.

SCTL1

Serial Control Word 1 — Control word 1 of serial interface

Parameter number:	416
Physical unit:	hexadecimal
Value range:	see table below
Factory setting:	0000h
Customer setting:	
Display level:	3
Editing level:	3
SMARTCARD area:	no data storage

Bit posit	Position value	Title	Meaning of bit
0	0000 H	START	Start control (1=Start, 0=Stop)
1	0001 H	INV	Invert reference value
2	0002 H	STOP	Emergency Stop / stop ramp
3	0004 H		reserved
4	0008 H		reserved
5	0010 H		reserved
6	0020 H		reserved
7	0040 H		Reset error (withg rising flank)
8	0080 H		Set/reset output OS00 1)
9	0100 H		Set/reset output OS01 1)
10 ... 15			reserved

1) Assign output with function selector of serial interface: FOS00 or FOS01= SIO.

SDMMY

Serial Dummy — Dummy parameter of serial interface

Parameter number:	83
Physical unit:	-
Value range:	0 - 255
Factory setting:	0
Customer setting:	
Display level:	3
Editing level:	3
SMARTCARD area:	no data storage

Explanation:
This is a dummy parameter which can be used for maintaining the SIO access times when the Watchdog is switched on. Write access to this parameter has no effect on the device. The value of the parameter is not lost however but is stored in the RAM area of the MC6000.

SERR

Serial Error State — Serial interface error status

Parameter number: 85
Physical unit: hexadecimal
Value range: see table below
Factory setting: 00h
Customer setting:
Display level: 3
Editing level: cannot be edited
SMARTCARD area: no data storage

Bit position	Hex	Title	Meaning
0	01 H	Power on	Bit is set each time power is switched on
1	02 H	Watchdog	Watchdog has detected timeout
2	04 H	EEPROM busy	The EEPROM is currently busy saving
3	08 H	Checksum error	Data transfer error Checksum invalid
5	20 H	No parameter	There is no parameter in the device with the parameter number transmitted
6	40 H	No change	Changes to parameters not permitted
7	80 H	Invalid value	The parameter value transmitted is invalid

SWDGT

Serial Watchdog Time — Serial interface watchdog cycle time.
This is the time within which the Bus master must have sent at least 1 telegram to the Servocontroller. If the Servocontroller does not receive the telegram, error E-WDG (Watchdog) with error location 11 will be displayed.

Parameter number: 84
Physical unit: s
Value range: 0.00 - 20.00
Factory setting: 0.00
Customer setting:
Display level: 3
Editing level: 3
SMARTCARD area: SYSTM

Note:
The setting SWDGT= 0.00 switches the Watchdog off.

10.3.10 KEYPAD area(_KPAD)

BARG

Bargraph (Displayed Parameter) — Continuous actual value of barchart display (this determines which parameter is displayed continuously on the barchart)

Parameter number: 3
Physical unit: -
Value range: see table below
Factory setting: SPEED
Customer setting:
Display level: 2
Editing level: 2
SMARTCARD area: SYSTM

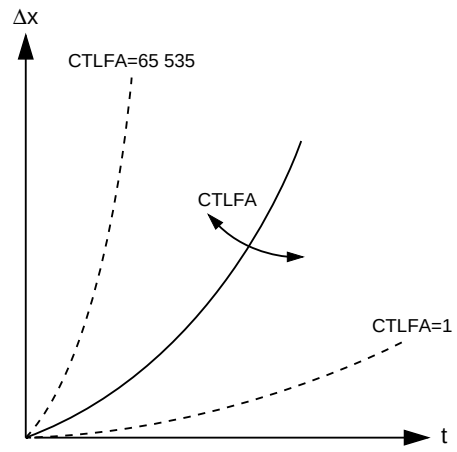
No.	Setting	Function
9	TAX	instantaneous load of controller
12	MIDTX	average load of controller
10	MAXTX	max load of controller
427	TEMP	device temperature
77	SPEED	speed (rpm)
76	TORQUE	torque
75	CURNT	effective output current
347	DCV	DC link voltage
495	IOSTA	Status of inputs and outputs 1)

1) For description see Se*ction 10.2 "Parameters of the VAL Menu"*.

CTLFA

CTRL-Menu Factor — Factor for scaling the motor operated potentiometer (MOP) function in the Control menu.

Parameter number: 5
Physical unit: -
Value range: 1 - 65535
Factory setting: 10000
Customer setting:
Display level: 3
Editing level: 3
SMARTCARD area: SYSTM



Explanation:
The value of this parameter determines the sensitivity of the MOP function when the ▲ or ▼ keys are presssed. The graph explains the function of this parameter..

t: Duration of key depression (▲ or ▼)
Δx: Change in reference value

DISP

Displayed Parameter	Continuous actual value of display (determines the parameter for continuous display or on entering the VAL menu)
Parameter number:	2
Physical unit:	-
Value range:	all the parameters available in the VAL menu (depends on the current user level)
Factory setting:	REFV (reference value)
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	SYSTM

MODE

Mode	User level The password protection (PSWX) prevents unauthorised access to safety-critical parameters.
Parameter number:	1
Physical unit:	-
Value range:	see table below
Factory setting:	1
Customer setting:	
Display level:	1
Editing level:	1
SMARTCARD area:	no data storage

Setting	Used for	Comment
1	User without access permission	no parameters can be edited, most important are displayed
2	User with basic knowledge	most important parameters can be edited, many displayed
3	User with advanced knowledge and when controlling using SIO, Interbus-S	all parameters necessary for standard applications editable, many can be displayed
4	User with control technology expertise and when controlling via SIO	all control parameters can be edited and displayed

PLRDY

Parameter List Ready — manual update of the parameter list and re-initialisation

Parameter number:	15
Physical unit:	-
Value range:	0, 1
Factory setting:	0
Customer setting:	
Display level:	4
Editing level:	4
SMARTCARD area:	no data storage

Explanation:
The control can be initialised using this parameter. The paramter list is checked for validity and the dependent paramaters are calculated (see section 6.7). Manual update of the parameter list is started by setting the parameter **PLRDY=1**. The parameter is then reset automatically =0. When the start command (controller enabled) is cancelled, re-initialisation of the control starts immediately. In the subsequent controller enable, the new parameter values are active immediately without delay.

PNUM

Parameter Number — Switch parameter on/off

Parameter number:	6
Physical unit:	-
Value range:	OFF {0} / ON {1}
Factory setting:	OFF
Customer setting:	
Display level:	4
Editing level:	4
SMARTCARD area:	SYSTM

Note:
When parameter number display is switched off the display indicates whether the parameter can only be displayed or also edited (-S- or. -E-).

PROG

Program Functions — Select special program functions

Parameter number:	4
Physical unit:	-
Value range:	see table below
Factory setting:	2
Customer setting:	
Display level:	3
Editing level:	3
SMARTCARD area:	SYSTM

Setting	Function
1	Reset all parameters to factory setting
2	Normal setting no funtion
111	Re-initialisation of serial interface with the current value of parameter SBAUD

PSW2, PSW3, PSW4

Password Mode 2, 3, 4	Password for user levels 2, 3, 4 (--PWx-- request when changing user level MODE)
Parameter number:	100, 101, 102
Physical unit:	-
Value range:	0 - 65535
Factory setting:	222, 333, 444
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	SYSTM

PSWCT

Password CTRL-Menu	Password for the control menu (PASSW prompt)
Parameter number:	105
Physical unit:	-
Value range:	0 - 65535
Factory setting:	465
Customer setting:	
Display level:	3
Editing level:	3
SMARTCARD area:	SYSTM

10.3.11 Safety and error reaction parameter area (_SCTY)

The parameters in this area can be programmed to define the reaction of servo controllers to errors occurring.

The range of error responses is defined in the error reaction table. These responses can be assigned to specific errors with the parameters as described below. Some parameters require a minimum response so the possible actions from this table are restricted in the case of these errors.

The higher the response the number of the error, the higher the priority. Errors with a higher priority will be triggered even if an error with a lower priority is already present. Errors with the same or a lower priority are ignored.

Acknowledging errors
Errors can be acknowledged in the following ways:

- rising flank at input ENPO of control terminals
- hold down **stop/return key** of KEYPAD for approximately 3 seconds
- set the RESET-Bit in the SIO control word SCTL1 (control via serial interface) (only in the case of control via serial interface; CLSEL = SIO)
- Set the bit "Reset error" in the interbus control word (control via InterBus-S) (only when controlling via Interbus-S; CLSEL = OPTN1)

Reaction table:

Response No.	Title	Function
0	No Reaction	Error message only (warning)
1	Servo Halt	Display error message and block power stage
2	Servo Stop	Display error message, emergency stop and await cancellation of start command
3	Servo Halt and Lock	Display error message, block power stage and secure against automatic restart
4	Servo Stop and Lock	Display error message, emergency stop, await cancellation of start command and secure against automatic restart
5	Wait on Error-Reset and Reset	Display error message, block power stage and await reset of error; then software reset

The following applies to all parameters in this area :
Display level: 2
Editing level: 3
SMARTCARD area: SYSTM

R-CPU

Reaction on Error CPU	Reaction to error in CPU
Parameter number:	41
Value range:	5
Factory setting:	5
Customer setting:	

R-EEP

Reaction on Error EEPROM	Reaction to error in EEPROM
Parameter number:	48
Value range:	0 - 5
Factory setting:	5
Customer setting:	

R-ENC

Reaction on Error Encoder	Reaction to encoder error (incorrect type or not present)
Parameter number:	55
Value range:	5
Factory setting:	5
Customer setting:	

R-EXT

Reaction on Error External	Reaction to error message from external control (via input control terminal)
Parameter number:	54
Value range:	0 - 5
Factory setting:	0
Customer setting:	

R-FLT

Reaction on Error Floating Point	Reaction to error in floating-point calculation
Parameter number:	52
Value range:	3 - 5
Factory setting:	3
Customer setting:	

R-FLW

Reaction on Following Error	Reaction to following error
Parameter number:	59
Value range:	2 - 5
Factory setting:	2
Customer setting:	

R-OC

Reaction on Error Over Current	Reaction to overcurrent error
Parameter number:	43
Value range:	1 - 5
Factory setting:	1
Customer setting:	

R-OFF

Reaction on Error Off	Reaction to undervoltage or power off
Parameter number:	42
Value range:	1 - 5
Factory setting:	1
Customer setting:	

R-OLI

Reaction on Error Over Limitation Inverter	Reaction to I*t switch off of servo controller The I*t monitoring switches the controller off (E-OLI), if the permitted pulse flow is operated for more than 10 s.
Parameter number:	45
Value range:	1 - 5
Factory setting:	1
Customer setting:	

R-OLM

Reaction on Error Over Limitation Motor	Reaction to I^2*t motor switch off (motor protection arrangement, not actually a device error) **currently not implemented!**
Parameter number:	49
Value range:	1 - 5
Factory setting:	1
Customer setting:	

R-OP1

Reaction on Error Option 1	Reaction to error in module in slot 1 (X6)
Parameter number:	56
Value range:	0 - 5
Factory setting:	1
Customer setting:	

R-OP2

Reaction on Error Option 2	Reaction to error in module in slot 2 (X7)
Parameter number:	57
Value range:	0 - 5
Factory setting:	0
Customer setting:	

R-OTI

Reaction on Error Over Temperature Inverter	Reaction to Servocontroller overtemperature
Parameter number:	47
Value range:	1 - 5
Factory setting:	1
Customer setting:	

R-OTM

Reaction on Error Over Temperature Motor	Reaction to motor overtemperature
Parameter number:	46
Value range:	0 - 5
Factory setting:	1
Customer setting:	

R-OV

Reaction on Error Over Voltage	Reaction to overvoltage error
Parameter number:	44
Value range:	1 - 5
Factory setting:	3
Customer setting:	

R-PAR

Reaction on Error Parameter List	Reaction to invalid data in parameter list
Parameter number:	51
Value range:	3 - 5
Factory setting:	3
Customer setting:	

R-PLS

Reaction on Error Plausibility Check	Reaction to errors in plausibility check
Parameter number:	50
Value range:	3 - 5
Factory setting:	5
Customer setting:	

R-PWR

Reaction on Error Power	Reaction to unrecognised power stage error
Parameter number:	53
Value range:	5
Factory setting:	5
Customer setting:	

R-TIM

Reaction on Error Time	Reaction to run time error
Parameter number:	58
Value range:	0 - 5
Factory setting:	3
Customer setting:	

R-WDG

Reaction on Error Watchdog	Reaction to error: watchdog triggered
Parameter number:	40
Value range:	0 - 5
Factory setting:	0
Customer setting:	

10.3.12 Custom software area (_USER)

This area is used for access to the appropriate special parameters in the MC6000 Servocontroller which have customised software installed.

This area has no parameters in standard software, so it is not listed in the PARA menu.

10.3.13 Reference Value Input Area (_REF)

Notes:
The paramaters in this area are described in detail in *Section 7.2*.

[1]) can be selected as reference value source using reference value selector
[2]) parameter only for display of reference value

ACCR

Acceleration Ramp	Acceleration Ramp (only used in speed control)
Parameter number:	842
Physical unit:	min^{-1} s^{-1}
Value range:	0 - 65535
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	REFRC
Changes effective:	only after re-initializing (see Section 6.7)

Notes:
The acceleration ramp can be switched off by setting ACCR very high (> 30.000 min^{-1} s^{-1}). Then the drive will accelerate at maximum torque to the referenced speed. The ramp generator can be switched off entirely using ACCR=0 or DECR=0 (acceleration and braking ramps disabled!).

DECR

Deceleration Ramp	Braking ramp (only for speed control)
Parameter number:	852
Physical unit:	min^{-1} s^{-1}
Value range:	0 - 65535
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	REFRC

Notes:
Speed is changed by parameter DECR, if the reference value is set to a lower value. the braking rate can be switched off by setting DECR very high (> 30.000 min^{-1} s^{-1}).Then the drive will brake at maximum torque. The ramp generator can be switched off entirely by setting ACCR=0 or DECR=0 (acceleration and braking ramps disabled!).

If the START signal is disabled the drive will coast on to a stop. If this is undesirable use the stop ramp STOPR.

RA0, RA1

Reference from Analog Input 0, 1	Analog input 0 (ISA0) and 1 (ISA1), [1]) Parameter only for display of digitized value
Parameter number:	425, 426
Physical unit:	Nm, $Umin^{-1}$ or r (depending on control mode)
Value range:	-32764 - 32764
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SMARTCARD area:	ALL

RDIG

Reference from Digital Input	Digital reference input
Parameter number:	430
Physical unit:	Nm, min^{-1} or r (depending on control mode)
Value range:	-32764 - 32764
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SMARTCARD area:	ALL

REF1, REF2, REF3, REF4, REF5, REF6

Reference Value 1 - 6	Intermediate values of the reference value input, parameters to display the reference value on the reference channels
Parameter number:	433, 434, 435, 436, 437, 438
Physical unit:	Nm, min^{-1} or r (depending on control mode)
Value range:	-32764 - 32764
Factory setting:	0
Customer setting:	
Display level:	3
Editing level:	cannot be edited
SMARTCARD area:	ALL

RF3FA

Reference Channel 3 Factor	Factor for scaling the reference value on channel 3
Parameter number:	448
Physical unit:	%
Value range:	0 - 100
Factory setting:	100
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	REFRC
Changes effective:	only after re-initializing (see Section 6.7)

RFIX1, RFIX2, RFIX3, RFIX4, RFIX5, RFIX6

Reference Fixed Value 1 - 6	Fixed reference values 1 to 6, [1])
Parameter number:	74x, 75x, 76x, 77x, 78x, 79x
Physical unit:	Nm, min^{-1} or r (depending on control mode)
Value range:	theoretically: -32764 - 32764 in practice: this depends on the motor and the control mode
Factory setting:	0 (RFIX2= 3000 min^{-1}, =0,25 r depending on control mode)
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	REFRC

RINC

Reference Increment	Increment step for MOP function using digital inputs
Parameter number:	87x
Physical unit:	Nm, min^{-1} or r (depending on control mode)
Value range:	- 32764 - + 32764
Factory setting:	1 (depending on control mode)
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	REFRC

RLIM1, RLIM2

Reference Limitation 1, 2	RLIM1= lower limit of reference value, RLIM2= upper limit of reference value (can also be selected directly as reference value source)
Parameter number:	80x, 81x
Physical unit:	Nm, min^{-1} , r (depending on control mode)
Value range:	theoretically: -32764 - +32764 in practice: depends on motor and control mode
Factory setting:	RLIM1= -3000 Nm, =-12000 min^{-1}, =-3000 r RLIM2= 3000 Nm, = 12000 min^{-1}, = 3000 r
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	REFRC
Changes effective:	only after re-initializing (see Section 6.7)

Note:
If RLIM1 is selected to be > RLIM2 then the error E-PAR will be displayed (invalid parameter list).

Explanations:
r= rotations
[1]) can be selected as reference value source using reference value selector
[2]) parameter only for displaying the reference value

RNA0, RNA1

Reference Norm Analog Input 0, 1	Scaling for analog reference value 0 and 1; example speed control: RNA0=3000 means that a reference speed of 3000 min^{-1} corresponds to an ana log reference value of +10 V
Parameter number:	82x, 83x
Physical unit:	Nm /10V, min^{-1} /10V, r /10V (depending on control mode)
Value range:	-32764 - +32764
Factory setting:	10 Nm /10V, 3000min^{-1} /10V, 100 r /10V
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	REFRC
Changes effective:	only after re-initializing (see Section 6.7)

ROPT1, ROPT2

Reference from Option 1, 2	Module in slot 1 or 2, [1]) [2])
Parameter number:	431, 432
Physical unit:	Nm, min^{-1} or r (depending on control mode)
Value range:	-32764 - +32764
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SMARTCARD area:	ALL

RPOT

Reference Potentiometer	Motor operated potentiometer function (MOP) using di gital inputs, [1]) [2])
Parameter number:	429
Physical unit:	Nm, min^{-1} or r (depending on control mode)
Value range:	-32764 - +32764
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SMARTCARD area:	ALL

RSIO

Reference from Serial Input/Output	Serial interface, can be selected as reference value source using reference value selector
Parameter number:	428
Physical unit:	Nm, min^{-1} or r (depending on control mode)
Value range:	-32764 - 32764
Factory setting:	0
Customer setting:	
Display level:	3
Editing level:	3
SMARTCARD area:	ALL

RSSL1, RSSL2, RSSL3, RSSL4

Reference Source Selector 1 - 4	Reference value selectors for channels 1 to 4, used for selecting a reference value source
Parameter number:	417, 418, 419, 420
Physical unit:	-
Value range:	see table below
Factory setting:	RCON, RSSL3= RFIX1
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	REFRC

No.	Setting	Reference value source
0	RCON	None (reference value source switched off [constant =0])
1	RA0	Analog input ISA0
2	RA1	Analog input ISA1
3	RSIO	Serial interface
4	RPOT	Motor operated potentiometer at digital inputs
5	RDIG	Digital reference value input (PWM)
6	ROPT1	Module in Slot 1 (X6)
7	ROPT2	Module in Slot 2 (X7)
8	RFIX1	Fixed reference value 1
9	RFIX2	Fixed reference value 2
10	RFIX3	Fixed reference value 3
11	RFIX4	Fixed reference value 4
12	RFIX5	Fixed reference value 5
13	RFIX6	Fixed reference value 6
14	RLIM1	Lower limit of reference value
15	RLIM2	Upper limit of reference value

SADD1, SADD2, SADD3, SADD4

Selector Addition Value for RSSL1 - 4	Offset for reference value selectors 1 to 4 (RSSL1 - RSSL4), Offset is entered via digital inputs. Parameters only for the display of the current value.
Parameter number:	421, 422, 423, 424
Physical unit:	decimal
Value range:	0 - 15
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	cannot be edited
SMARTCARD area:	ALL

STOPR

Stop Ramp	Stop ramp (for emergency stop)
Parameter number:	496
Physical unit:	min^{-1} s^{-1}
Value range:	0 - 65536
Factory setting:	0
Customer setting:	
Display level:	2
Editing level:	2
SMARTCARD area:	REFRC

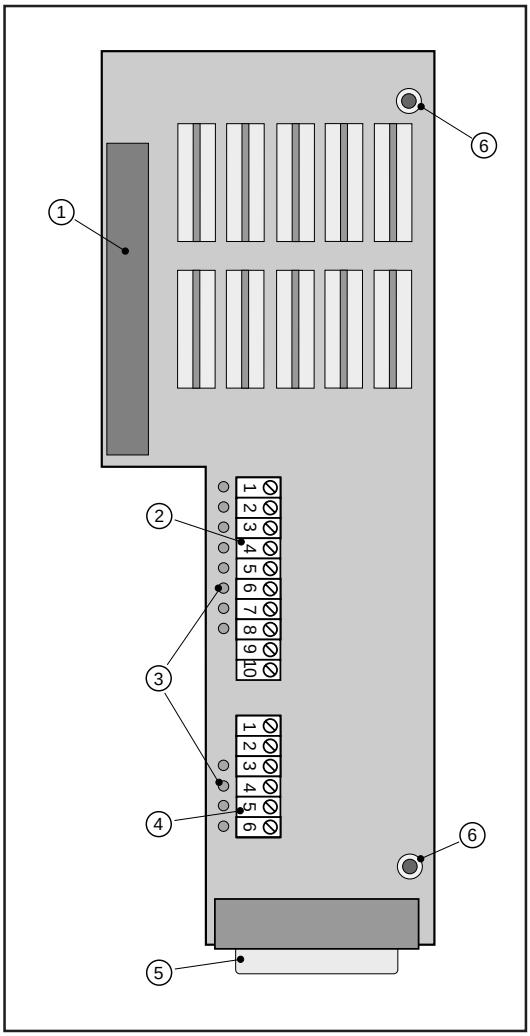
11 Description of I/O Module 1 (AH1) and EKL300

11.1 I/O Module 1 (AH1)

The number of Servocontroller inputs and outputs can be extended using I/O Module 1 (AH1). The module can be plugged into slot 2 (X7) which is accessible from the front and in this way it can be integrated into the casing of the device.

The input and output Module 1 has 8 inputs and 4 outputs and is identified by version code AH1. The inputs and outputs are PLC compatible and potential-isolated via an opto-coupler. The outputs will take 50 mA. The inputs and outputs are fully programmable and are functionally identical to the digital inputs and outputs of the standard equipment (with the exception of the PLC function of the outputs).

The inputs and outputs of the module are available on 2 separate plug-in terminal blocks and also on the 25 way sub-D connector. The external terminal module EKL300 is also available as an accessory and can be linked to this connector.



Features of I/O Module 1:

- 50 mA outputs
- PLC compatible
- potential isolation via opto-coupler
- fully programmable
- external wiring possible using EKL300
- maximum connection cross section 2.5 mm²

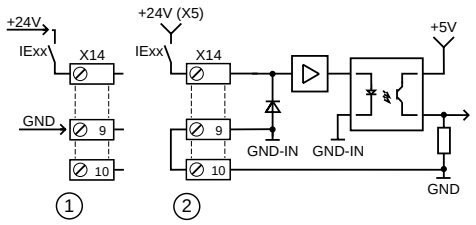
No.	Function
1	Connection to slot 2 (X7)
2	Input terminals (X14)
3	LED's for inputs and outputs
4	Output terminal (X13)
5	Sub D connector for EKL300 (X15)
6	Mechanical anchorage

Warning!
When the I/O Module1 is used, the installation separation spacing of 20 mm between Servocontrollers must be observed.

11.2 Terminal Allocation I/O Module1

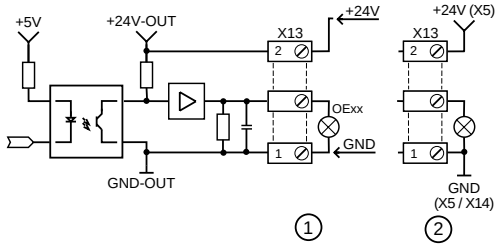
Input terminals (X14)

Terminal No.	Terminal Allocation	Description
1	IE00	Inputs (Input External 00 - 07)
2	IE01	
3	IE02	
4	IE03	
5	IE04	
6	IE05	
7	IE06	
8	IE07	
9	GND-IN	Ground for inputs
10	GND	Ground for Servo



Output terminals (X13)

Terminal No.	Terminal Allocation	Description
1	GND-OUT	Ground for outputs
2	+24V-OUT	+ 24 V supply for outputs
3	OE00	Outputs (Output External 00 - 03)
4	OE01	
5	OE02	
6	OE03	



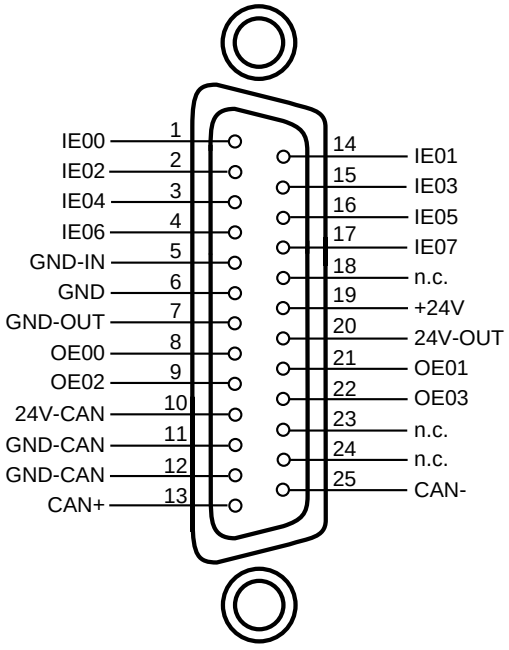
Versions for voltage supply

① - potential-isolated, external + 24 V supply required

② - not potential-isolated, using internal + 24 V from Servocontroller (200 mA) via a bridge from control terminal X5

Sub D connector (X15)

The connector plug can be used for connecting the external EKL300 Terminal Module via a screened 1:1 connector cable (KSS252) or for direct wiring of the installation.



Note:
The housing is at same potential as the cable screening.

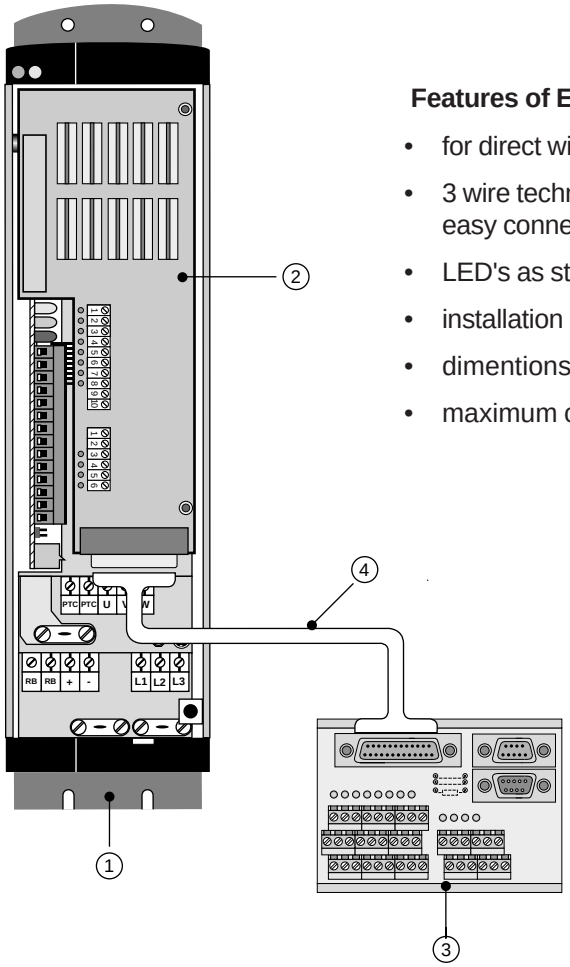
11.3 EKL300

The inputs and outputs of I/O Module 1 can be wired directly in the cabinet using the external terminal module EKL300. LED's indicate the status of inputs and outputs.

The EKL300 is three wire. Connecting initiators is a simple task using the +24V signal and ground. The terminal module is simply mounted on a Z rail.

In the Servocontroller the I/O Module 1 is connected via a 25 way connecting cable. The KSS252 (1.8m long) is connected to connector X5 on the EKL300. 8 inputs can be wired on the X1 terminals, and 4 outputs on the X2 terminals.

The EKL300 can also be used in conjunction with the positioning and sequence control PosMod1. The terminals are then allocated differently and the range of functions is extended, (see description of PosMod1).



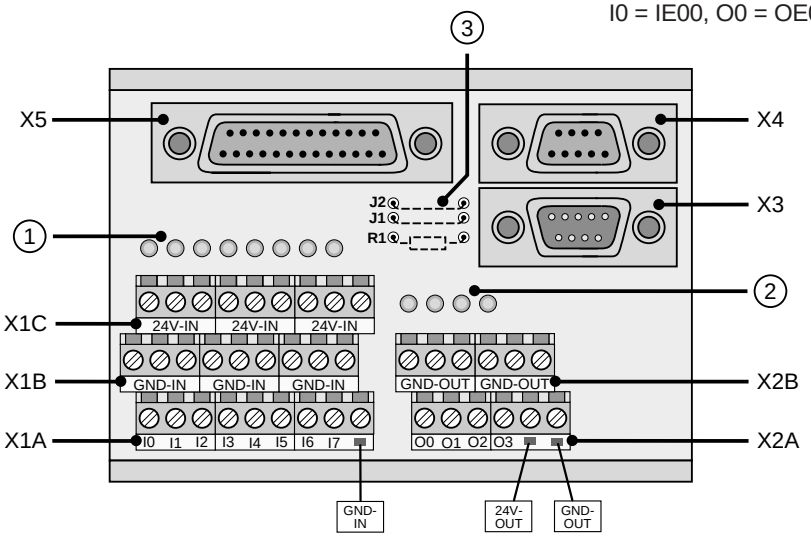
Features of EKL300:

- for direct wiring of inputs and outputs in the casing
- 3 wire technology (signal, +24V and ground) for easy connection of initiators
- LED's as status indicators for inputs and outputs
- installation of terminal module on Z rail
- dimentions W x H x D: 113 x 78 x 72mm
- maximum connection cross section 2,5mm²

No.	Function
1	MC6000 Servocontroller
2	I/O Module 1 (model code AH1)
3	EKL300 terminal module
4	Connecting cable KSS252 (25 way, 1.8m long)

EKL300 Layout

Note:
Abbreviated terminal indentification
I0 = IE00, O0 = OE00, etc.

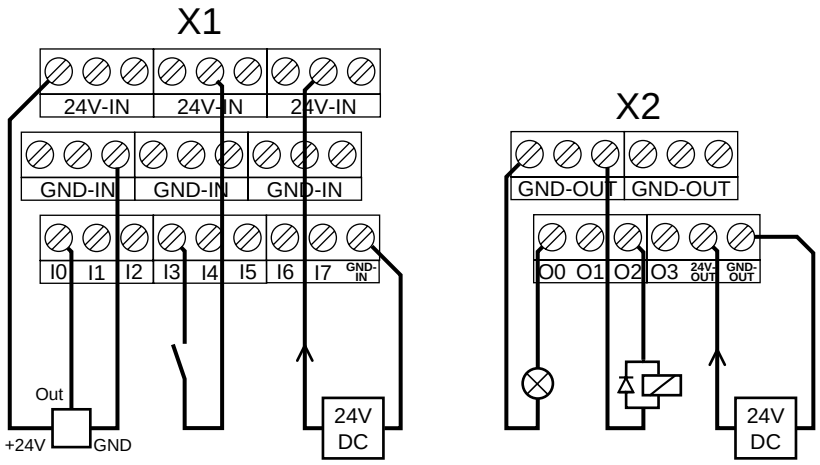


No.	Function	No.	Function
1	LEDs for inputs	X2A	output terminals
2	LEDs for outputs	X2B	ground for output terminals (GND-OUT)
3	variations for CAN-Bus	X3	CAN-Bus input 1)
X1A	input terminals	X4	CAN-Bus output 1)
X1B	ground for input terminals (GND-IN)	X5	connection to I/O Module
X1C	+24V for input terminals (+24V-IN)		

1) CAN-Bus only in conjunction with PosMod1
2) X5 connection corresponds to X15 in I/O Module 1 (25 way Sub-D connector)

Wiring diagram

A +24V external supply is required (for potential-free operation). Inputs and outputs can be supplied separately.



11.4 Software description I/O Module 1

The inputs and outputs of the I/O Module have the same functionality as the digital I/O of the standard equipment. The ouputs however cannot be used as pulse width modulated outputs.

If an I/O Module is inserted in option slot 2, it is automatically recognised by the Servocontroller and the appropriate parameters are enabled in the software. Parameter OPTN2 (_CONF) can be used to ascertain whether the module is present and has been correctly recognized.

FIE00, FIE01 - FIE07

Function Selector Input External 0 - 7 Function Selectors for External Inputs 0 - 7

Parameter number:	see 1st table
Physical unit:	-
Value range:	see 2nd table
Factory setting:	OFF
Customer setting:	
Display level:	2
Editing level:	2
SmartCard area :	OPTN2

Parameter	No.	Parameter	No.
FIE00	455	FIE04	459
FIE01	456	FIE05	460
FIE02	457	FIE06	461
FIE03	458	FIE07	462

Each input can be parametered using the appropriate function selector to execute one of the functions listed in the table below.

No.	Setting	Function
0	OFF	switch off input (if not required)
1	START	start control with pre-set reference value
2	INV	invert reference value of reference value channels 3 and 4 (see diagram ("Structure of Reference Value Input" Section 7.4)
3	/STOP	trigger Emergency Stop function by applying a low level
4 – 19	ADy-x	switching between ref value sources (see Section: Reference Value Input)
20 21	/ENDL, /ENDR	evaluation of hardware limit switches (ccw/cw) with low level if a limit switch has been triggered, the drive can be rotated in the opposite direction
22	E-EXT	signal input for error messages from an external device (eg PLC). The reaction of the Servocontroller is determined by parameter R-EXT (_SCTY).
23 24	MP-UP, MP-DN	MOP function (controlling reference value via push button) The input MP-UP increments and the MP-DN decrements the reference value by the value of parameter RINC (_REF) (see also section on Reference Value Input).
25 26	OPTN1, OPTN2	the input is made available to the module in slot 1 or 2 the function is allocated to the input by the module (see description)
27, 28, 29, 30	USER0, USER1 USER2, USER3	The input can be used by custom software No function in the case of standard software

Warning!
A changed function is enabled immediately (this applies to all input function selectors). The drive will start immediately the function START is allocated to an input.

FOE00, FOE01 - FOE03

Function Selector Output External 0 - 3	Function Selectors for External Outputs 0 - 3
Parameter numbers:	471, 472, 473, 474
Physical unit:	-
Value range:	see table
Factory setting:	OFF
Customer setting:	
Display level:	2
Editing level:	2
SmartCard area:	OPTN2

Each of the outputs can take over one of the following functions. This is achieved by parametering the appropriate function selector (area _OPTN2). The output is high when the condition is fulfilled.

No.	Setting	Function (the output is set when ...)
0	OFF	switch off output (if not required)
1	ERR	... there is an error
2	WARN	... there is a warning (error or error response)
3	/ERR	... there is no error
4	/WARN	... there is no warning
5	ACTIV	... the control is enabled (green LED flashing)
6 7 8	ROT_R, ROT_L, ROT_0	... rotation clockwise, counterclockwise or stationary is recognized; depends on parameter SPD_0 (CONF).
9	LIMIT	... the actual value of the control has reached a limit value dependent on parameters RLIM1, RLIM2 (_REF).
10	REF	... the actual value has reached the reference value (window) dependent on parameter REF_R (_CONF).
11	ASM	... an asynchronous motor is parametered
12	SIO	the output is controlled by control word SCTL1 (_SIO)
13 14	OPTN1, OPTN2	the output is allocated to the module in slot 1 or 2 and assigned a function by the module (see description)
15	ERRW	... there is a warning or error
16	/ERRW	... there is no warning or error.
17, 18, 19, 20	USER0, USER1 USER2, USER3	the output can be used by custom software in the case of standard software no function

SIEXT

Status Word Input Extern	Status Word of External Inputs for Monitoring Inputs via Serial Interface
Parameter number:	479
Physical unit:	binary, 16 bit
Value range:	see table below
Factory setting:	0000h
Customer setting:	
Display level:	2
Editing level:	2
SmartCard area:	OPTN2

SIEXT (continued)

Bit	Function
0	monitor input IE00
1	monitor input IE01
:	:
:	:
7	monitor input IE07

SOEXT

Status Word Output Extern — Status word of external output for monitoring outputs via serial interface

Parameter number: 480
Physical unit: binary, 8 bit
Value range: see table below
Factory setting: 00h
Customer setting:
Display level: 3
Editing level: cannot be edited

Bit	Function
0	monitor output OE00
1	monitor output OE01
2	monitor output OE02
3	monitor OE03 output

SCTL2

Status Control 2 — Control word 2 for setting external outputs via serial interface

Parameter number: 494
Physical unit: binary, 8 bit
Value range: see table below
Factory setting: 00h
Customer setting:
Display level: 3
Editing level: 3
SmartCard area: OPTN2

Bit	Function
0	set/reset output OE00
1	set/reset output OE01
2	set/reset outputOE02
3	set/reset output OE03

Note:
The output must be assigned to the serial interface with the function selector: FOExx= SIO.

12 Servomotor Design Specifications

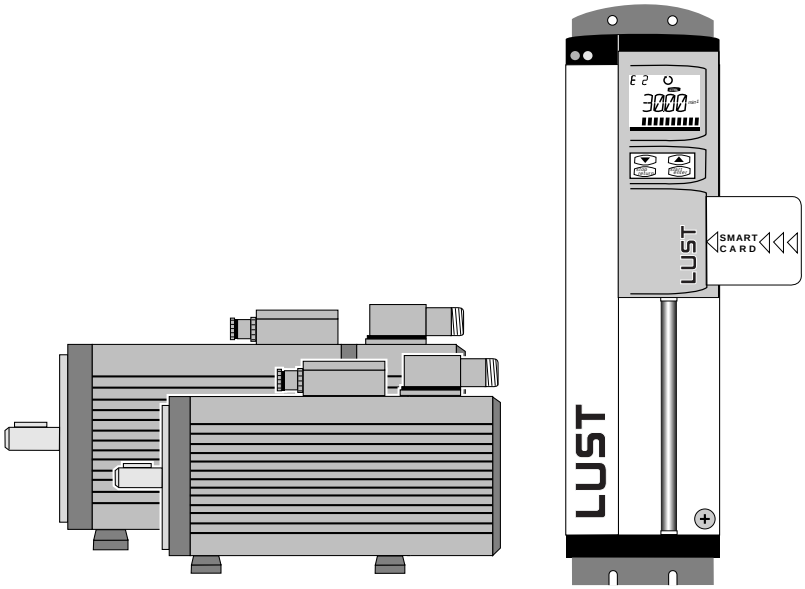
12.1 Synchronous and Asynchronous Servomotor Series

General

The synchronous and asynchronous Servomotors are designed to a uniform pattern for best results, especially with the MASTERCONTROL MC6000 Servocontroller in mind

From a design point of view the Servomotors differ basically in their rotor princple.

- squirrel cage winding rotor in ASx asynchronous Servomotors
- permanent magnet rotor in PSx synchronous Servomotors



Advantages

Features of the asynchronous ASx Servomotors	Features of the synchronous PSX Servomotors
most cost effective solution for applications in which the larger physical size is acceptable	compact design with no rotor losses
large speed range with constant maximum power output	low moment of inertia of rotor so excellent dynamic response
maintenance-friendly	high precision torque control

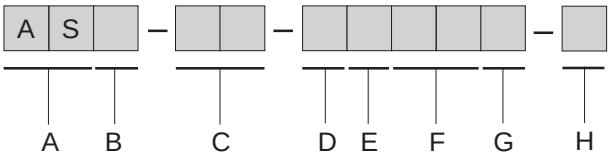
12.2 Ordering Details for ASx and PSx Servomotors

General

The specific Servomotor model is indicated by the order code. Each model code has a special meaning (see Servomotor Models 12.3). Model codes are also used for non-listed Servomotors.

Only one model option can be ordered per code section, (eg voltage, encoder system etc).

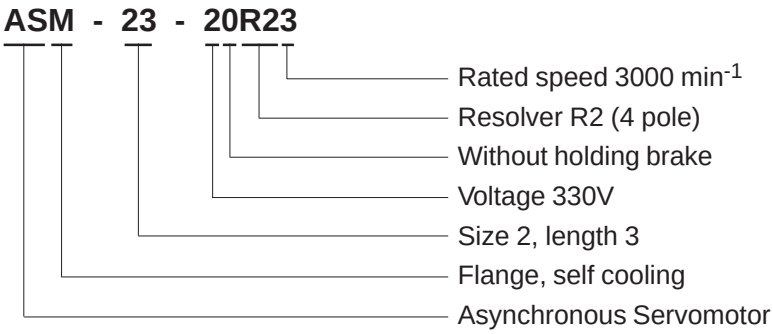
Order Code/
Type Code



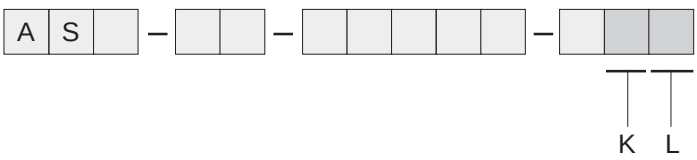
The order code must always be complete and in this sequence.

Code Section	Description
A	AS Asynchronous Servomotor PS Permanently excited Synchronous Servomotor
B	Type, cooling
C	Size, length
D	Voltage version
E	Holding brake
F	Encoder system
G	Rated speed

Example



Model Code
for options and
customer-specific
version



Code sections K and L are only used where there is a deviation from the standard version. See table "Servomotor Models".

12.3 Servomotor Models

	Code Section	Model Code	Description	Motor Type
Type, Cooling	B	M	Flange with self cooling	ASx-1x to 3x, PSx-Mx to 2x
		F	Flange with external cooling	ASx-1x to 4x, PSx-1x to 2x
		H	Flange, foot with self cooling	ASx-1x to 4x, PSx-1x to 2x
		V	Flange, foot with external cooling	ASx-1x to 4x, PSx-1x to 2x
Size, Length	C	Mx	Installation 55, 4 units long	PSM-Mx
		Nx	Installation 72, 3 units long	PSM-Nx
		0x	Installation 92, 4 units long	PSM-0x
		1x	Installation 110, 5 units long	ASx-1x, PSx-1x
		2x	Installation 140, 5 units long	ASx-2x, PSx-2x
		3x	Installation 190, 4 units long	ASx-3x
		4x	Installation 260, 3 units long	ASx-4x
Voltage Version	D	2	Rated voltage of motors 330V	All
Holding Brake	E	0	Without holding brake	All
		1	With permanently excited holding brake	All (Observe max speed)
Encoder System	F	0	Without encoder system	All
		R1	Resolver (2 pole)	All
		R2	Resolver (4-pole), preferred type for ASx	All ASx
		R8	Resolver (6-pole), preferred type for PSx	All PSx
		G1	Incremental encoder with sin/cos outputs	All ASx
		G2	Incremental encoder with sin/cos outputs as single turn	All ASx and PSx from sixe 1x
		G3	Incremental encoder with sin/cos outputs as multiturn encoder	All ASx and PSx from size 1x
		K1	Resolver (2 pole), with mounting flange [1)]	All
		K2	Resolver (4pole), with mounting flange [1)]	All ASx
		K8	Resolver (6 pole), with mounting flange [1)]	All PSx

[1)] For mounting a second encoder, eg (Heidenhain ROD426 or Stegmann DG60)

Rated Speed

Code Section	Model Code	Description	Motor Type
G	1	Rated speed 1500 min^{-1}	Please observe the technical specifications of the Servomotors
	2	Rated speed 2000 min^{-1}	
	3	Rated speed 3000 min^{-1}	
	4	Rated speed 4000 min^{-1}	
	6	Rated speed 6000 min^{-1}	

Connections

H	0	Power connection via terminal box, Resolver connector, output straight	All from size 0x
	2	Power connector socket output straight Resolver connector output straight	PSx-Mx, PSx-Nx, PSx-0x, PSx-1x and ASx-1x
	3	Power connection via terminal box, Resolver connector, output 90°	All from Size 0x with resolver
	4	Power connector, output 90°, Resolver connector, output 90°	PSx-Mx, PSx-Nx, PSx-0x, PSx-1x and ASx-1x

Notes:
- In all encoders G1, G2 and G3 the connector can be directed either straight or at 90°.
- For matching power connectors and for cable see Section 4 Accessories.

Options and customer-specific versions

K	0	Standard, shaft end A side with feather key	All
	1	Shaft end A side without feather key	All
	2	With radial shaft seal IP65	All (Observe maximum speed)
	3	Special version for 40°C	All
	4	Model code 1 and 2	All (Observe maximum speed)
	5	Model code 1 and 3	All

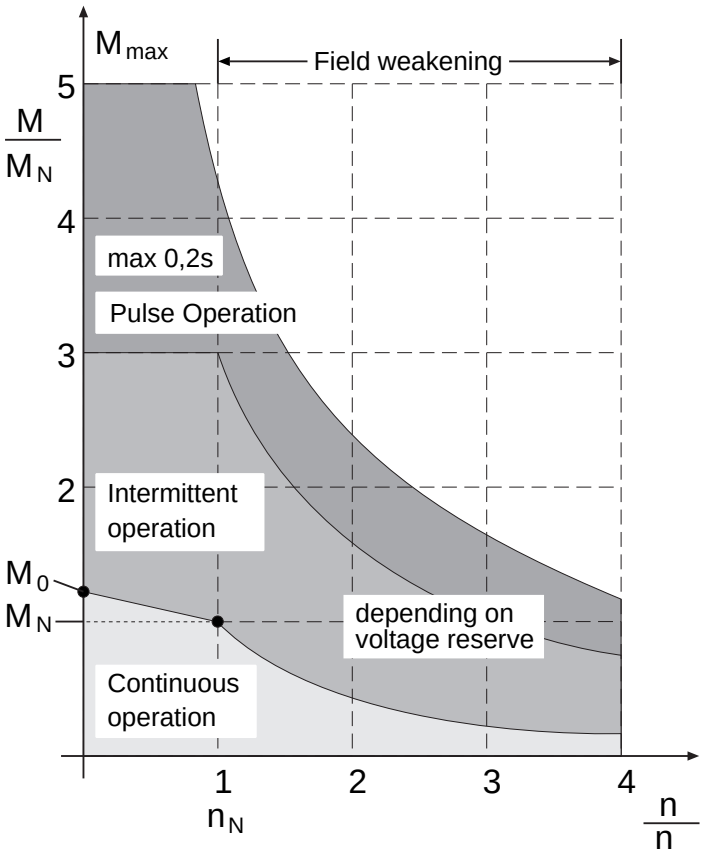
Options and customer-specific versions

L	0	Standard model	All
	1	Vibration to ISO 2373 R	All ASx
	2	Vibration to ISO 2373 S	All PSx
	3	Radial and axial run-out to DIN 42955 R	All
	4	Model code 1 and 3	All ASx
	5	Model code 2 and 3	All PSx

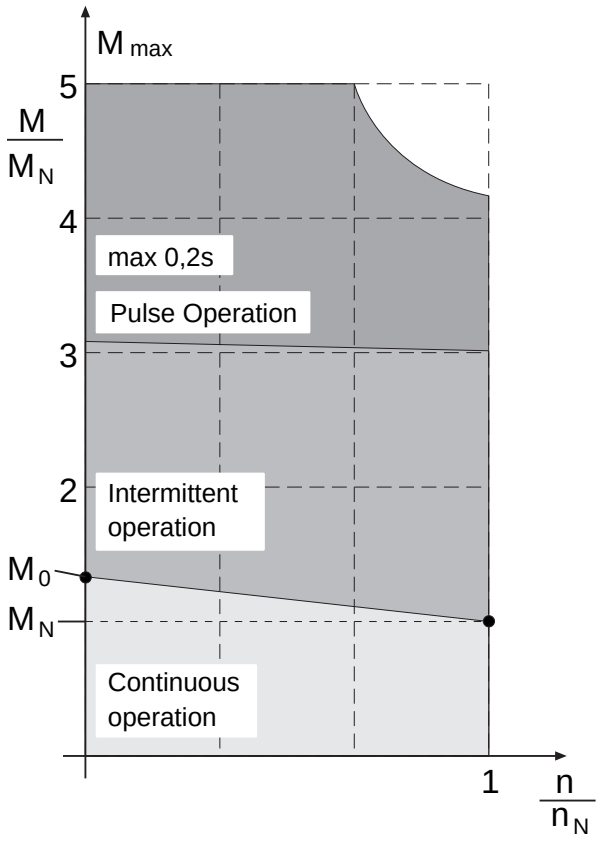
12.4 Basic Versions of Servomotors

Features \ Type	ASx Asynchronous Servomotors	PSx Synchronous Servomotors
General Technical Specifications		
Motor type	Asynchronous Servomotor	Permanently excited SynchronouServomotor
Magnet	-	Neodymium-iron-boron
Type (DIN 42948)	IM B35, IM B5, V1, V3	
Protection (DIN 40050)	IP65, Shaft Seal IP64 (Option IP65)	
Insulation Class	Insulation Class F to VDE0530 Windings over-temperature Δt = 105, coolant temperature t_u = +40 °C	
Cooling	Self cooling (IC 0041) IP65 External cooling (IC 0641) IP44, 54	
Finish	RAL 9005 (black)	
Shaft end on the A (D) side	Cylindrical shaft end DIN 748, feather key and feather key groove DIN 6885,clearance K6	
Flange dimension	DIN 42948 and IEC 72	
Eccentricity, concentricity and radial run-out DIN 42955	Tolerance N (normal) R (reduced) to order	
Vibration level ISO 2373	Step N, R available as option	Step R, S available as option
Thermal monitoring of motor	PTC Thermistor in Stator Windings	
Torque loading	In order to eliminate the risk of themal overload of motors the effective torque load must not be greater than the rated torque of the Servomotor $M_{eff} = \sqrt{\cdot \frac{M_n^2 x\, t_n}{t_{ges}}}$ $M_{eff} - M_N$	
Maximum pulse torque	Typically 2 to 5 times rated torque depending on controller allocation. 3 to 5 times the rated torque is only permissible for 0.2 s maximum only.	
Service life	All specifications assume a service life of 20,000 hours	
Connection		
Connections for motor, thermistor and holding brake	Threaded bolts in terminal box, connectors to order	
Encoder system connection	Signal Connector (no mating connector)	

12.5 Typical M-n Graph of Servomotors



M-n Graph for asynchronous motors



M-n Graph for synchronous motors

Term	Explanation
M_0 Static torque	Thermal limit torque of motor when stationary. This torque can be provided by the motor for any length of time.
I_0 Static current	Effective value of motor winding current which is required to generate the rated torque.
M_N Rated torque	Thermal torque limit of motor at rated speed n_N.
I_N Rated current	Effective value of motor winding current required to generate the rated torque.
P_N Rated power	Continous power of motor at rated working point (M_N, n_N) at rated current I_N and rated voltage U_N.
M_{max}, I_{max} Limit curve	Motors can only be loaded with 5 times the rated current
Field weakening area	The maximum peak torque output in the field weakening area depends on the voltage reserve. Typical torque characteristics are proportional to the function 1/f or 1/n.

12.6 Technical Specifications: ASx-xx Asynchronous Servomotors

Self cooling	M_0 [Nm]	M_N [Nm]	P_N [kW]	I_0 [A]	I_N [A]	n_N [min-1]	J_L [kgcm2]	m [kg]	n_{max} [min^{-1}]
ASM (H)-11-2xxx3	1,5	1,3	0,41	1,6	1,4	3000	2,8	6,5	12000
ASM (H)-12-2xxx3	2	1,7	0,54	2,1	1,8	3000	3,7	7,5	12000
ASM (H)-13-2xxx3	2,7	2,3	0,72	2,74	2,3	3000	4,7	8,5	12000
ASM (H)-14-2xxx3	4,2	3,5	1,1	4	3,3	3000	6,5	10,2	12000
ASM (H)-15-2xxx3	5,2	4,7	1,5	5,4	4,5	3000	8,9	12,8	12000
ASM (H)-21-2xxx3	4,2	3,5	1,1	3,6	3	3000	10,9	10,8	12000
ASM (H)-22-2xxx3	5,6	4,7	1,5	4,7	3,9	3000	14,4	13,2	12000
ASM (H)-23-2xxx3	8,4	7	2,2	6,7	5,6	3000	21,5	16,2	10000
ASM (H)-24-2xxx2	12	10	2,1	6,4	5,3	2000	29,8	20,3	10000
ASM (H)-25-2xxx2	15	13	2,7	7,7	6,6	2000	38,4	24	8000
ASM (H)-31-2xxx1	15,5	13	2,1	6,2	5,2	1500	70	29,8	8000
ASM (H)-32-2xxx1	20	17	2,7	8,2	6,8	1500	90	33	8000
ASM (H)-33-2xxx1	27,5	23	3,6	10,3	8,7	1500	130	41,5	8000
ASM (H)-34-2xxx1	42	35	5,5	15,1	12,6	1500	209	56,6	8000
ASM (H)-41-2xxx1	47	40	6,3	21	17,9	1500	450	87	8000
ASM (H)-42-2xxx1	70	60	9,4	30	25,5	1500	740	113	8000
ASM (H)-43-2xxx1	85	70	11	37	30,4	1500	960	135	8000

External Cooling	M_0 [Nm]	M_N [Nm]	P_N [kW]	I_0 [A]	I_N [A]	n_N [min^{-1}]	J_L [$kgcm^2$]	m [kg]	n_{max} [min^{-1}]
ASF (V)-11-2xxx3	2	1,7	0,54	2,1	1,8	3000	2,8	7,5	12000
ASF (V)-12-2xxx3	2,7	2,3	0,72	2,8	2,4	3000	3,7	8,6	12000
ASF (V)-13-2xxx3	3,6	3	0,94	3,54	2,9	3000	4,7	9,7	12000
ASF (V)-14-2xxx3	5,6	4,7	1,5	5,1	4,3	3000	6,5	12,5	12000
ASF (V)-15-2xxx3	7,7	6,5	2	7,3	6,2	3000	8,9	14,2	12000
ASF (V)-21-2xxx3	5,6	4,7	1,5	4,6	3,9	3000	10,9	13,8	12000
ASF (V)-22-2xxx3	8,4	6,5	2	6,5	5	3000	14,4	16,2	12000
ASF (V)-23-2xxx3	12	10	3,1	8,9	7,4	3000	21,5	19,2	10000
ASF (V)-24-2xxx2	15,5	13	2,7	8	6,7	2000	29,8	23,3	10000
ASF (V)-25-2xxx2	19,7	16,5	3,4	9,8	8,2	2000	38,4	27	8000
ASF (V)-31-2xxx1	21,5	18	2,8	8,4	7	1500	70	33,8	8000
ASF (V)-32-2xxx1	27,5	23	3,6	10,6	8,9	1500	90	37,5	8000
ASF (V)-33-2xxx1	38	32	5	13,8	11,6	1500	130	46,5	8000
ASF (V)-34-2xxx1	56	47	7,4	18,4	15,4	1500	209	62,1	8000
ASF (V)-41-2xxx1	83	70	11	33	27,5	1500	450	95	8000
ASF (V)-42-2xxx1	140	118	18,5	50	42	1500	740	121	8000
ASF (V)-43-2xxx1	170	143	22,5	61	51	1500	960	145	8000

Abbreviations:

M_0	Static torque	J_L	Rotor moment of inertia without holding brake
M_N	Rated torque	m	Mass (weight) excluding holding brake
P_N	Rated power		
I_0	Static current		
I_N	Rated current		
n_N	Rated speed		
n_{max}	Maximum speed		

12.7 Technical Specifications: PSx-xx Synchronous Servomotors

Self Cooling	M_0 [Nm]	M_N [Nm]	P_N [kW]	I_0 [A]	I_N [A]	n_N, n_{max} [min^{-1}]	J_L [$kgcm^2$]	m [kg]
PSM-M1-2xxx2	0,34	0,32	0,067	0,4	0,4	2000	0,17	1
PSM-M1-2xxx6	0,34	0,32	0,2	0,85	0,9	6000	0,17	1
PSM-M2-2xxx6	0,5	0,48	0,3	1	1,1	6000	0,24	1,2
PSM-M3-2xxx2	0,65	0,6	0,125	0,55	0,58	2000	0,31	1,4
PSM-M3-2xxx6	0,65	0,6	0,375	1,2	1,3	6000	0,31	1,4
PSM-M4-2xxx2	1	0,9	0,19	0,65	0,7	2000	0,45	1,8
PSM-M4-2xxx6	1	0,8	0,5	1,6	1,7	6000	0,45	1,8
PSM-N1-2xxx4	0,6	0,55	0,23	0,9	0,9	4000	0,26	2,1
PSM-N1-2xxx6	0,6	0,55	0,345	1,15	1,2	6000	0,26	2,1
PSM-N2-2xxx4	1,2	1,1	0,46	1,3	1,3	4000	0,43	2,7
PSM-N3-2xxx4	1,8	1,6	0,67	1,7	1,55	4000	0,63	3,4
PSM-01-2xxx3	0,95	0,8	0,25	0,7	0,6	3000	1,1	3,1
PSM-01-2xxx4	0,95	0,75	0,31	0,8	0,65	4000	1,1	3,1
PSM-01-2xxx6	0,95	0,6	0,6	1,1	0,7	6000	1,1	3,1
PSM-02-2xxx3	1,8	1,5	0,47	1,5	1,2	3000	3,2	3,9
PSM-02-2xxx4	1,8	1,4	0,59	1,6	1,15	4000	3,2	3,9
PSM-02-2xxx6	1,8	1,2	0,75	2,7	1,8	6000	3,2	3,9
PSM-03-2xxx3	2,8	2,3	0,72	1,8	1,5	3000	5,3	4,2
PSM-03-2xxx4	2,8	2,2	0,92	2,8	2,2	4000	5,3	4,2
PSM-03-2xxx6	2,8	1,8	1,1	4,5	2,9	6000	5,3	4,2
PSM-04-2xxx3	4,8	4,1	1,3	3,7	3,2	3000	7,4	5,3
PSM-04-2xxx4	4,8	3,9	1,6	5	4,1	4000	7,4	5,3
PSM-04-2xxx6	4,8	2,3	1,4	6,7	3,3	6000	7,4	5,3
PSM (H)-11-2xxx3	3,4	3,2	1	2,6	2,4	3000	5,6	6,5
PSM (H)-11-2xxx4	3,4	3	1,2	3,4	3	4000	5,6	6,5
PSM (H)-11-2xxx6	3,4	2,1	1,3	5	3,1	6000	5,6	6,5
PSM (H)-12-2xxx3	5,6	4,5	1,4	3,9	3,1	3000	8,6	8,3
PSM (H)-12-2xxx4	5,6	4,1	1,7	5,1	3,7	4000	8,6	8,3
PSM (H)-12-2xxx6	5,6	3,2	2	8,2	4,7	6000	8,6	8,3
PSM (H)-13-2xxx3	7,5	5,6	1,7	5,1	3,8	3000	11,7	10,1
PSM (H)-13-2xxx4	7,5	5,1	2,1	7,2	4,9	4000	11,7	10,1
PSM (H)-13-2xxx6	7,5	4,1	2,6	10,1	5,5	6000	11,7	10,1
PSM (H)-14-2xxx3	9,6	6,6	2,1	6,4	4,4	3000	14,8	11,8
PSM (H)-14-2xxx4	9,6	5,7	2,4	8,9	5,3	4000	14,8	11,8
PSM (H)-21-2xxx2	8,4	7	1,5	3,7	3,1	2000	12,5	10,2
PSM (H)-21-2xxx3	8,4	6,5	2	5,8	4,5	3000	12,5	10,2
PSM (H)-21-2xxx4	8,4	5,2	2,2	7,7	4,8	4000	12,5	10,2
PSM (H)-22-2xxx2	12	11	2,3	4,8	4,4	2000	21	12,3
PSM (H)-22-2xxx3	12	10	3,1	7,7	6,4	3000	21	12,3
PSM (H)-22-2xxx4	12	7,6	3,2	10,3	6,5	4000	21	12,3
PSM (H)-23-2xxx2	15,5	13	2,7	7,3	6,1	2000	28	15,5
PSM (H)-23-2xxx3	15,5	11,2	3,5	10,1	7,3	3000	28	15,5
PSM (H)-23-2xxx4	15,5	8,4	3,5	12,9	7	4000	28	15,5
PSM (H)-24-2xxx2	20,5	17	3,5	9	7,5	2000	41	20,4
PSM (H)-24-2xxx3	20,5	13	4,1	13,1	8,3	3000	41	20,4

External Cooling	M_0 [Nm]	M_N [Nm]	P_N [kW]	I_0 [A]	I_N [A]	n_N, n_{max} [min^{-1}]	J_L [$kgcm^2$]	m [kg]
PSF (V)-11-2xxx3	4,7	4,5	1,4	3,4	3,4	3000	5,6	7,3
PSF (V)-11-2xxx4	4,7	4,2	1,7	4,7	4,2	4000	5,6	7,3
PSF (V)-11-2xxx6	4,7	3	1,9	6,9	4,4	6000	5,6	7,3
PSF (V)-12-2xxx3	7,7	6,2	1,9	5,4	4,3	3000	8,6	9,1
PSF (V)-12-2xxx4	7,7	5,7	2,4	6,9	5,1	4000	8,6	9,1
PSF (V)-12-2xxx6	7,7	4,4	2,8	11,4	6,5	6000	8,6	9,1
PSF (V)-13-2xxx3	10,1	7,6	2,4	6,9	5,2	3000	11,7	10,9
PSF (V)-13-2xxx4	10,1	6,9	2,9	9,7	6,6	4000	11,7	10,9
PSF (V)-13-2xxx6	10,1	5,5	3,5	13,6	7,4	6000	11,7	10,9
PSF (V)-14-2xxx3	12,5	8,6	2,7	8,3	5,7	3000	14,7	12,7
PSF (V)-14-2xxx4	12,5	7,4	3,1	11,7	6,9	4000	14,74	12,7
PSF (V)-21-2xxx2	12,3	10,2	2,1	5,4	4,5	2000	12,5	13,2
PSF (V)-21-2xxx3	12,3	9,5	3	8,5	6,6	3000	12,5	13,2
PSF (V)-21-2xxx4	12,3	7,3	3,1	11,3	6,7	4000	12,5	13,2
PSF (V)-22-2xxx2	17,6	16	3,3	7	6,4	2000	21	15,3
PSF (V)-22-2xxx3	17,6	14,6	4,6	11,2	9,3	3000	21	15,3
PSF (V)-22-2xxx4	17,6	10,7	4,5	15	9,1	4000	21	15,3
PSF (V)-23-2xxx2	22,7	19	4	10,6	8,9	2000	28	18,5
PSF (V)-23-2xxx3	22,7	16,4	5,1	14,8	10,9	3000	28	18,5
PSF (V)-23-2xxx4	22,7	11,8	4,9	18,8	9,8	4000	28	18,5
PSF (V)-24-2xxx2	30	25	5,2	12,2	10,3	2000	41	23,4
PSF (V)-24-2xxx3	30	21	5,6	18,4	12,9	3000	41	23,4

Abbreviations:

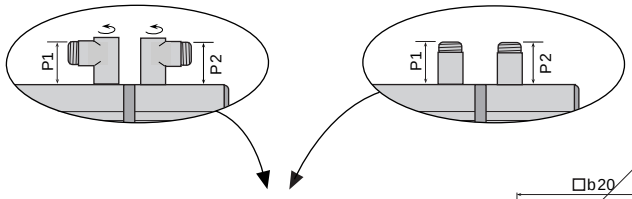
M0	Static torque
M_N	Rated torque
P_N	Rated power
I_0	Static current
I_N	Rated current
n_N	Rated speed
n_{max}	Maximum speed
J_L	Rotor moment of inertia without holding brake
m	Mass (weight) excluding holding brake

Warning!
In the case of PSx motors sizes M, N and 0, thermal monitoring by the motor PTC is inadequate for dynamic operation with overload. In such cases the overall design must be checked by LUST to avoid the motor being destroyed.

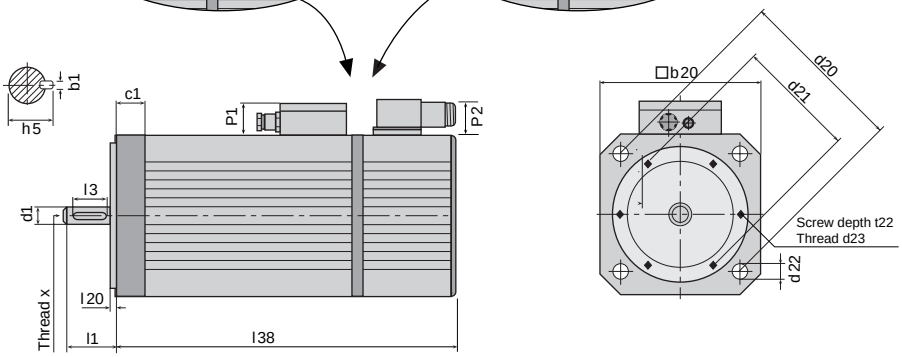
12.8 Servomotor Dimensions

Connection with connector at 90°

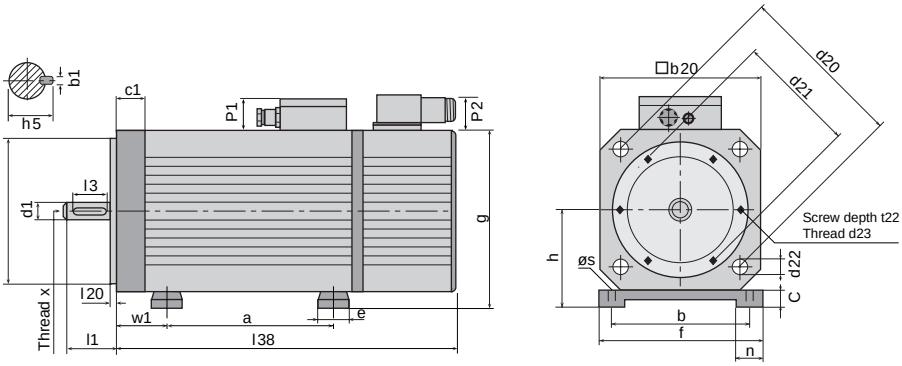
Connection with connector straight



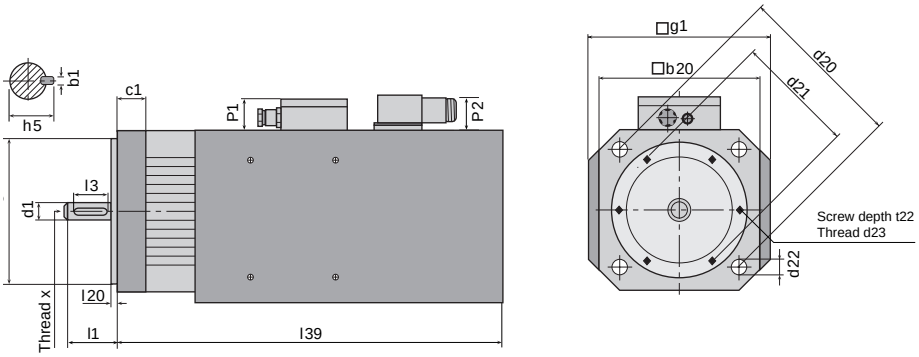
Flange with self cooling
ASM-xx
PSM-xx



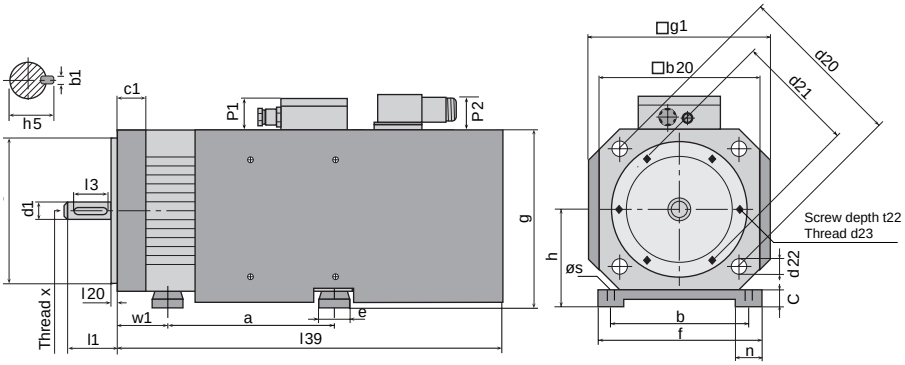
Flange/foot
with self cooling
ASH-xx
PSH-xx



Flange with external cooling
ASF-xx
PSF-xx



Flange/foot
with external cooling
ASV-xx
PSV-xx



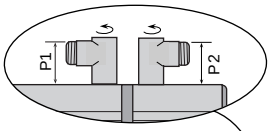
12.9 Dimensions of shaft, flange and toot

		Shaft						Flange								Foot										
Type	Size, Length	b1	d1	h5	l1	l3	x	c1	d20	d21	d22	d23	d25	l20	t22	a Type AS		a Type PS		b	c	e	f	n	s	w1
																No Br.	With Br.	No Br.	With Br.							
PS	M1 M2 M3 M4	3	9	10,2	20	12	M3	11	63	-	5,8	-	40	2,5	-	-	-	-	-	-	-	-	-	-	-	-
PS	N1 N2 N3	4	11	12,5	23	18	M4	5	75	-	5,3	-	60	2,5	-	-	-	-	-	-	-	-	-	-	-	-
PS	01 02 03 04	5	14	16	30	22	M4	8	100	-	7	-	80	3	-	-	-	-	-	-	-	-	-	-	-	-
AS u. PS	11 12 13 14	6	19	21,5	40	32	M6	10	115	-	9	-	95	3	-	110 130 150 180	120 140 160 190	75 105 135 165	75 105 135 165	100	8	30	120	25	7	63
AS	15															230	240	-	-							
AS u. PS	21 22 23 24	8	24	27	50	32	M8	17	165	110	11	M8	130	3,5	18	110 140 170 215	155 185 215 260	110 140 170 215	155 185 215 260	125	10	30	150	25	10	50
AS	25															260	305	-	-							
AS	31 32 33 34	10	32	35	58	50	M12	22	215	140	14	M10	180	4	25	145 170 215 310	200 225 270 365	- - - -	- - - -	190	17	40	215	27,5	12	70
AS	41 42 43	12	42	45	110	90	M16	18	300	-	18	-	250	5	-	245 335 405	245 335 405	- - -	- - -	216	18	40	270	65	12	89

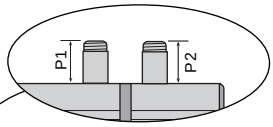
Abbreviations:

AS Asynchronous Servomotor Series
PS Synchronous Servomotor Series
Br. Permanently excited single disk holding brake
GX Incremental encoder (sin/cos), variants G1, G2, G3
RX Resolver, variants R1, R2, R8

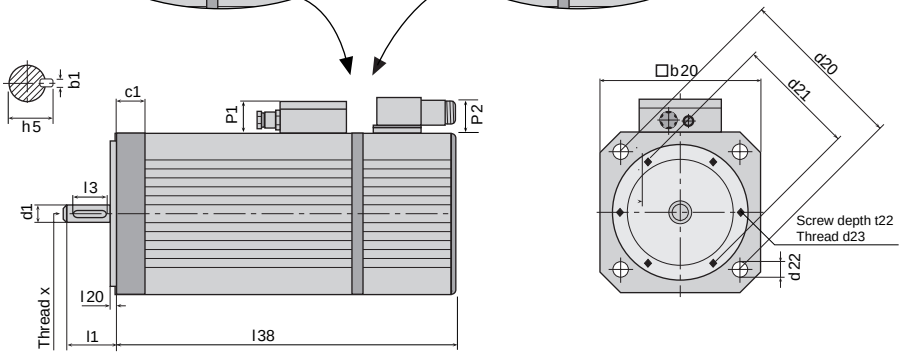
Connection with
connect at 90°



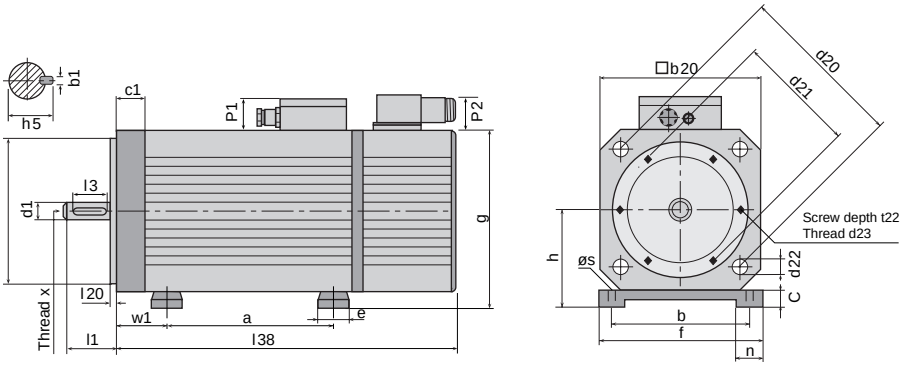
Connection with
connector straight



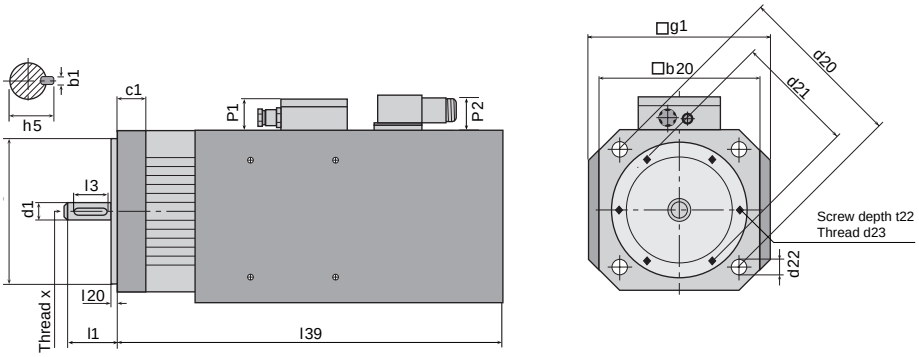
Flange with self cooling
ASM-xx
PSM-xx



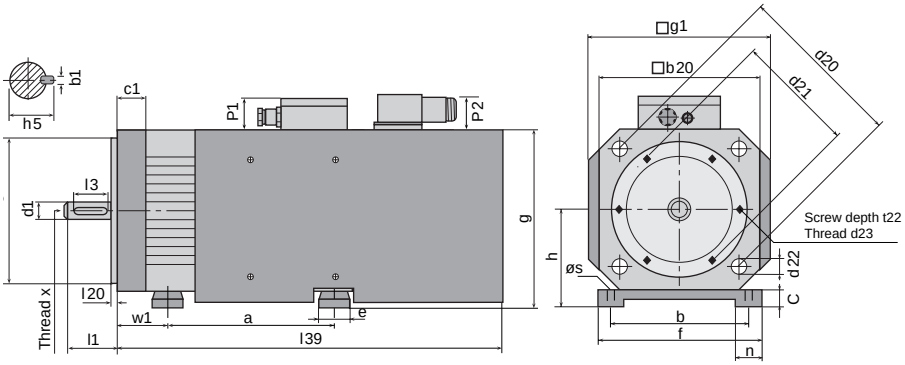
Flange/foot
with self cooling
ASH-xx
PSH-xx



Flange with external cooling
ASF-xx
PSF-xx



Flange/foot
with external cooling
ASV-xx
PSV-xx



12.10 Dimensions for motors with self cooling and external cooling

		Motor (Self Cooling)													External Cooling								
Type	Size, Length	b20 □	g	h	p1	p2	I38 for Type AS				I38 for Type PS				g1	I39 for Type AS				I39 for Type PS			
							No Br.	With Br.	No Br.	With Br.	No Br.		With Br.			No Br.	With Br.	No Br.	With Br.	No Br.	With Br.	No Br.	With Br.
							GX	GX	RX	RX	GX	RX	GX	RX		GX	GX	RX	RX	RX	RX	GX	GX
	M1						-	-	-	-	-	145	-	145		-	-	-	-	-	-	-	-
PS	M2	55	-	-	28	28	-	-	-	-	-	157	-	157	-	-	-	-	-	-	-	-	-
	M3						-	-	-	-	-	169	-	169		-	-	-	-	-	-	-	-
	M4						-	-	-	-	-	194	-	194		-	-	-	-	-	-	-	-
	N1						-	-	-	-	-	170	-	170	-	-	-	-	-	-	-	-	-
PS	N2	72	-	-	28	28	-	-	-	-	-	199	-	199	-	-	-	-	-	-	-	-	-
	N3						-	-	-	-	-	229	-	229	-	-	-	-	-	-	-	-	-
	01						-	-	-	-	-	202	-	202	-	-	-	-	-	-	-	-	-
PS	02	92	-	-	36,5	40	-	-	-	-	-	226	-	226	-	-	-	-	-	-	-	-	-
	03						-	-	-	-	-	260	-	260	-	-	-	-	-	-	-	-	-
	04						-	-	-	-	-	294	-	294	-	-	-	-	-	-	-	-	-
AS	11						286	294	254	293	246	216	254	224		358	366	315	354	273	281	318	326
u.	12						301	309	269	308	276	246	284	254		373	381	330	369	303	311	348	356
PS	13	110	118	63	36,5	40	321	329	289	328	306	272	314	284	123	393	401	350	389	333	341	378	386
	14						356	364	324	368	336	306	344	314		428	436	385	424	363	371	408	416
AS	15						401	409	369	408	-	-	-	-		473	481	430	469	-	-	-	-
AS	21						293	339	259	309	261	231	306	276		379	425	334	384	305	350	347	392
u.	22						313	359	279	329	291	261	336	306		399	445	354	404	335	480	377	422
PS	23	140	150	80	58	40	348	394	314	364	321	291	366	336	157	434	480	389	439	365	410	407	452
	24						393	439	359	409	366	336	411	381		479	525	434	484	410	455	452	497
AS	25						438	484	404	454	-	-	-	-		524	570	479	529	-	-	-	-
	31						343	399	316	372	-	-	-	-		442	498	404	460	-	-	-	-
AS	32						367	423	340	396	-	-	-	-		466	522	428	484	-	-	-	-
	33	190	207	112	71	40	414	470	387	443	-	-	-	-	203	512	569	475	531	-	-	-	-
	34						509	565	482	538	-	-	-	-		608	664	570	626	-	-	-	-
	41						449	449	416	416	-	-	-	-		542	542	509	509	-	-	-	-
AS	42	260	269	132	71	40	539	539	506	506	-	-	-	-	273	632	632	596	596	-	-	-	-
	43						609	609	576	576	-	-	-	-		702	702	666	666	-	-	-	-

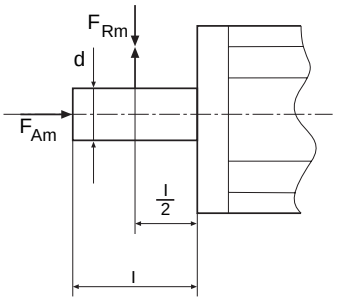
Abbreviations:

AS Asynchronous Servomotor Series
PS Synchronous Servomotor Series
Br. Permanently excited single disk holding brake
GX Incremental encoder (sin/cos), variants G1, G2, G3
RX Resolver, variants R1, R2, R8

12.11 Permissible axial and radial loads

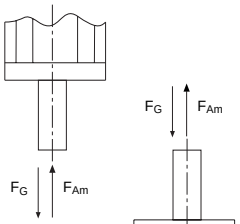
The following tables show the maximum permissible radial loads (F_{Rm}) at x=l/2 and maximum permissible axial loads F_{Am} assuming a service life of 20000 hours.

A radial load which is not in the middle of the shaft end can simply be re-calculated to take account of the different leverage effect.



B5, B35

V1



V3

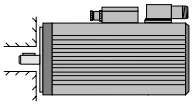
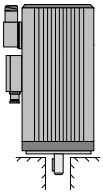
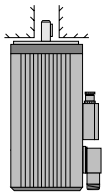
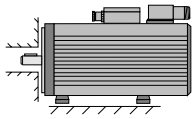
Size	Radial load F_{Rm} [N] at speed n [min^{-1}]					Axial load F_{Am} [N] at speed n [min^{-1}]					F_G [N]
	1500	2000	3000	6000	8000	1500	2000	3000	6000	8000	
ASx-11											9
ASx-12	800	750	640	500	430	650	600	500	370	320	12
ASx-13											15
ASx-14											22
ASx-15	800	750	580	420	230	550	500	440	290	210	30
ASx-12											17
ASx-22	1300	1200	1020	790	660	980	890	770	560	470	24
ASx-23											36
ASx-24											52
ASx-25	1220	1140	950	680	500	850	790	600	440	360	67
ASx-31											57
ASx-32	2760	2500	2100	1660	1450	2170	1900	1500	1160	1000	75
ASx-33											108
ASx-34											177
ASx-41	3750	3450	2750	2200	1800	3100	2700	2200	1650	1400	175
ASx-42											300
ASx-43	3550	3200	2450	1900	1300	2790	2400	1950	1400	1200	390

Size	Radial Load F_{Rm} [N] at Speed n [min^{-1}]				Axial Load F_{Am} [N] at Speed n [min^{-1}]				F_G [N]
	1500	2000	3000	6000	1500	2000	3000	6000	
PSx-M1									1
PSx-M2	310	260	240	210	250	200	170	140	2
PSx-M3									3
PSx-M4									4
PSx-N1									2
PSx-N2	330	280	250	220	260	210	180	150	4
PSx-N3									6
PSx-01									3
PSx-02	470	400	350	320	380	310	260	220	9
PSx-03									14
PSx-04	460	370	330	260	350	280	240	200	20
PSx-11									10
PSx-12	720	640	550	490	590	500	420	350	17
PSx-13									23
PSx-14									30
PSx-21									17
PSx-22	1100	1000	850	760	900	770	650	560	30
PSx-23									40
PSx-24									60

In vertical installations the permissible axial loads F_{Am} apply for the upward load direction. In the case of downward load they are reduced by F_G.

12.12 Technical Specifications: shape and shaft seal IP65

Arrangement

Shape		Description	
Drawing	Code	Shaft	Fixing or Mounting
	B5	Free shaft end	Flange installation Access from casing side
	V1	Free shaft end at bottom	Flange installation at bottom Access from casing side
	V3	Free shaft-end at top	Flange installation top Access form casing side
	B35	Free shaft-end	Mounting on sub-structure with additional flange Access from casing side

Shaft seal IP65 (Option see Code Section K)

Size \ Lubrication	Maximum speed with oil lubrication [min^{-1}]	Maximum speed with grease Lubrication [min^{-1}]
ASx-1x	12000	3500
ASx-2x	10500	3500
ASx-3x	9500	2500
ASx-4x	8000	2500
PSx-Mx	9000	6000
PSx-Nx	-	-
PSx-0x	9500	3500
PSx-1x	12000	3500
PSx-2x	10500	3500

Adequate lubrication is essential for reliability. Excessive speed causes the destruction of seal lips.

12.13 Technical Specifications: self cooling and external cooling

Cooling

The motor specific power data and torque data refer to

- operating temperature -5°C - 40°C
- operating temperature (coolant temperature) 40°C related to none insulated installation and that part of the motor heat loss will be conducted through the fixing flange of the mounting location.

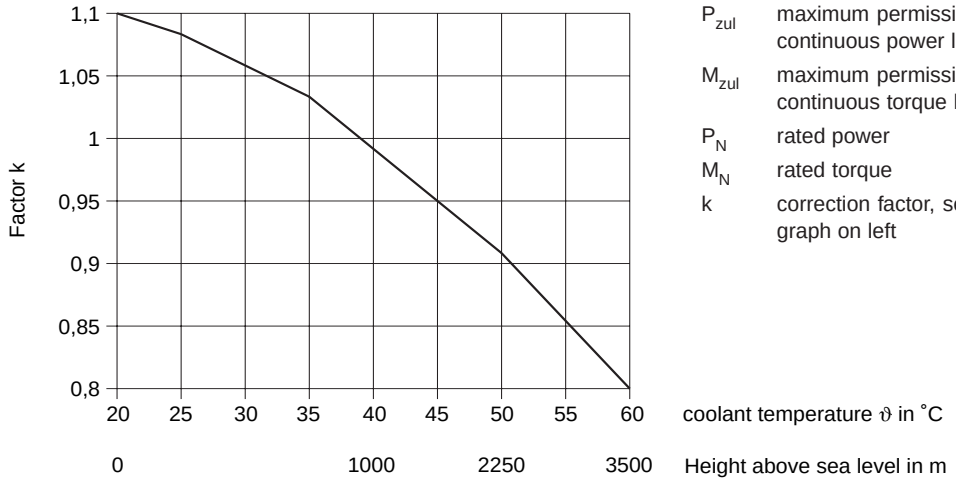
Minimum size of mounting flange

Size \ Mounting flange	Location of mounting flange	Mounting flange material
ASx-1x	230 x 150 x 15	steel
ASx-2x	300 x 300 x 20	steel
ASx-3x	300 x 300 x 20	steel
ASx-4x	380 x 310 x 20	steel
PSx-Mx	200 x 100 x 10	steel
PSx-Nx	230 x 150 x 15	steel
PSx-0x	230 x 150 x 15	steel
PSx-1x	230 x 150 x 15	steel
PSx-2x	300 x 300 x 20	steel

If the motor is installed thermally insulated from its mounting, the permissible rated torque must be reduced by 5 - 15%.

Altitude and coolant average temperature

Factor K



P_{zul} maximum permissible continuous power load (S1)

M_{zul} maximum permissible continuous torque load (S1)

P_N rated power

M_N rated torque

k correction factor, see graph on left

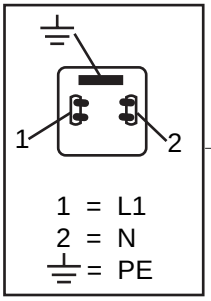
$$P_{zul} = k * P_N \qquad M_{zul} = k * M_N$$

External cooling

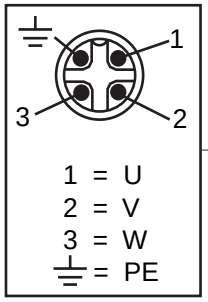
Size	Voltage [V]	Mains Frequency [Hz]	Rated Current [A]	Protection
ASF(V)-1x	1 x 230 +6%/-10%	48 ... 62	0,1	IP54
ASF(V)-2x	1 x 230 +6%/-10%	48 ... 62	0,18	IP54
ASF(V)-3x	3 x 400 +6%/-10%	48 ... 62	0,15	IP54
ASV-4x	3 x 400 +6%/-10%	48 ... 62	0,21	IP54
PSM-Mx	-	-	-	-
PSM-Nx	-	-	-	-
PSM-0x	-	-	-	-
PSF(V)-1x	1 x 230 +6%/-10%	48 ... 62	0,1	IP54
PSF(V)-2x	1 x 230 +6%/-10%	48 ... 62	0,18	IP54

Air is drawn into the B side by axial fans and ejected througth the A side. The mating connector for the fan connection is supplied.

Connection arrangement
Fan connector
(view of socket contacts)



Connection for ASF(V)-1x to ASF(V)-2x
and
PSF(V)-1x to PSF(V)-2x



Connection for ASF(V)-3x and ASV-4x

12.14 Technical Specifications: holding brake

The zero backlash permanently excited single disk holding brake works on a fail-safe basis which in practical terms means that the brake works when no voltage is applied.

The holding brake is switched on and off normally only when the motor is stationary. If the holding brake is to be used as an Emergency Stop brake, the permitted service life must be observed.

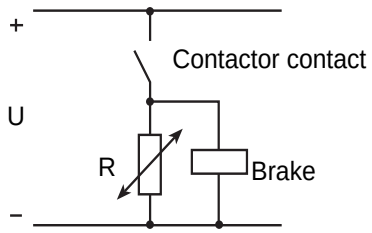
Technical specifications

Size	Brake type	M_H [Nm]	I_N [A]	U_N [V]	n_{max} [min^{-1}]	m [kg]	W_L [$10^6 W_S$]	J_B [$kgcm^2$]
ASx-1x	0,8M	8	0,75	24 ± 10%	8000	0,5	4	0,45
ASx-2x	2M	25	1	24 ± 10%	6000	1,2	7,5	4,5
ASx-3x	4M	80	1,5	24 ± 10%	6000	3,2	20	16
ASx-4x	8M	160	2,2	24 ± 10%	6000	6,7	60	50
PSx-Mx	1M	1,2	0,35	24 ± 10%	12000	0,2	0,8	0,07
PSx-Nx	0,6E	2,5	0,56	24 ± 10%	10000	0,3	2	0,38
PSx-0x	0,7M	5	0,7	24 ± 10%	10000	0,6	4	0,65
PSx-1x	0,8M	8	0,75	24 ± 10%	8000	0,5	4	0,45
PSx-2x	2M	25	1	24 ± 10%	6000	1,2	7,5	4,5

Abbreviations:

M_H adhesion
I_N exciter current
n_{max} maximum speed (unbraked)
U_N DC voltage for fan
m mass (weight)
W_L permissible service life switching cycles
J_B moment of inertia of the holding brake

Protection circuit



Suggested circuit for brake protection

As a consequence of the inductivity of the holding brakes there is a voltage peak spike which occurs when the exciter current is swtiched off: this peak can be over 1000 V. To avoid this peak voltage a protection suppressor circuit with a varistor should be used (recommended type Q69-X3022).

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Supplement to Instruction Manual

MASTERCONTROL MC6000

Status: 12.05.97

Software: V2.45

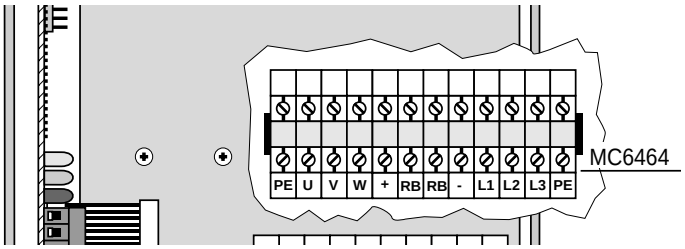
Valid for: Id.-Nr.: 0792.20B.0-02 Version: December 1995

Dear Customer!
In the course of further technical development, changes have been made that are not described in the Instruction Manual.

Note:
From Software Version V2.0 on, the positioning and sequence control POSMOD1 is not supported. This is the main difference to the earlier version V1.1. The special software V150.x is required for POSMOD1 (different EPROM).

1 Terminals of MC6464

The position for external braking resistance terminals has been changed (Page 2-1):



2 Technical Data

Corrected values are marked **bold**.

Output motor (Page 2-2)

	Des.	Dim.	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Rated power (400V-mains) 1)	S	kVA	2,7	5,5	8,3	11	22	44
Rated power (460V-mains) 1)	S	kVA	3,1	5,1	9,5	11	22	50
Voltage, effective	U	V	3 x 0 ... 400 / 460					
Cont. current (400V / 460V) 1)	I_N	A	4 / 4	8 / 6,5	12 / 12	16 / 14	32 / 28	64 / 64
Cont. current (400V / 460V) 2)	I_N	A	3 / 2	**3,5 / 2,7**	7,5 / 6	**9,0 / 7,0**	**22 / 18**	**60 / 56**
Pulse current for 10s	I_{max}	A	$2 \cdot I_N$					$1,5 \cdot I_N$
Switching frequency of power stage	f_S	kHz	4, 8, 16 (factory setting 8 kHz) 3)					
Motor system			synchronous or asynchronous					
Protection against short and earth fault			yes, but not at terminals for braking resistor					

1) At default of 8 kHz power stage switching frequency (4 kHz for MC6464).
2) At power stage switching frequency of 16 kHz (8 kHz for MC6464).
3) Servocontroller MC6464: Factory setting 4 kHz.

Power reduction (Page 2-3 and 4-4):

	Des.	Dim.	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Power reduction depending on the cooling air temperature	ΔP_T	%	5 %/°C above 40°C, max. 50°C				**3 %/°C above 40°C, max. 50°C**	
Power reduction depending on the motor cable length	ΔP_{ML}		50 mA/m (4 / 8 kHz), 70 mA/m (16 kHz) above 10 m				**100 mA/m (4 / 8 kHz), 150 mA/m (16 kHz) above 10 m**	

Recommended cable cross section for mains and motor connection (Page 4-3):

	Dim.	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Recommended cable cross section	mm²	1,5	2,5	4	4	**10**	**25**
Recommended mains fuse	A	10	**16**	25	**25**	50	**80**

Braking power (Page 4-7):

	Des.	Dim.	MC6404	MC6408	MC6412	MC6416	MC6432	MC6464
Minimum ohmic resistance of external braking resistors 1)	R_{min}	Ω	75		33		**13**	**10**
Peak braking power with external braking resistor	P_{SPex}	kW	7,2		16,7		**42**	**55**

1) Continuous braking for MC6404 ... MC6416 is only permissible with design code BR3.

3 Extensions of software functions

1. New encoder is supported (from V2.2)

The Heidenhain model ECN1313.5GS5 (13 Bit SSI) is now supported. To configure this encoder, a SMARTCARD corresponding to the motor must be read-in.

2. New resolvers are supported (from V2.05)

The number of resolver pole pairs can also be a whole-digit multiple of the number of motor pole pairs.

4 Known errors in software version 2.45

The functions listed below are not yet working or are only working to a limited extent. These are deviations with regard to the Instruction Manual.

Known errors in software version 2.45:	Chapter
In the case of + 24 V mains feed for control unit: if a fault already exists, the E-OV error is displayed instead of OFF once the mains is switched off.	4.4, 9
I²t-switch-off for protection of the servomotor (E-OLM): is not supported.	9.2.1
E-OFF error: The error is stored not only in the case of supply voltage dips (< 1 min) but also when the mains voltage is switched off.	9.2.1
Programming the error reaction for the E-OFF error: Under certain circumstances, the emergency stop error reaction is not executed correctly in the case of this error. (The link voltage is boosted again due to the motor recovery and the error is thus reset. The output is then automaticcaly blocked causing the motor to decelerate.)	10

Lust Antriebstechnik GmbH * Gewerbestr. 5-9 * D-35633 Lahnau * Germany * Phone +49 64 41 / 9 66 -0 * Fax +49 64 41 / 9 66 -137

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