SIEMENS

SIMODRIVE 611
Modular Transistor PWM Inverters for AC Feed Drives with Analog Control

Planning Guide

01.93 Edition

Manufacturer Documentation

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SIMODRIVE® documentation

Printing history

Brief details of this edition and previous editions are listed below.

The status of each edition is shown by the code in the 'Remarks' column.

Status code in the "Remarks" *column*:

A . . . New documentation.
B . . . Unrevised reprint with new Order No.
C . . . Revised edition with new status.
If factual changes have been made on the page since the last edition, this is indicated by a new edition coding in the header on that page.

Edition	Order No.	Remarks
01.93	6ZB5 420-0AS02-0AA0	**A**

Other functions not described in this documentation might be executable in the control. This does not, however, represent an obligation to supply such functions with a new control or when servicing.

This publication was produced on the Siemens 5800 Office System.
Subject to change without prior notice.

Contents

0 Preliminary information

This document is a part of the documentation developed for SIMODRIVE.
The complete listing of all Sales Brochures, Catalogs, Overviews, Product Briefs, Instruction Manuals and Technical Descriptions with Order No., ordering location and price, can be obtained from your local Siemens office.

This Planning Guide is intended to provide information regarding the following

- **Application examples**
- **Design overview**
- **Basic understanding of the mode of operation**
- **Instructions for configuring feed drives**

for the SIMODRIVE 611 converter system with 1FT5/1FT4 SIMODRIVE AC servomotors.

Before connecting-up or switching -on, the "mounting instructions" in Sections 2.11 and 3.9 must be observed.

When installing the connecting cables ensure that they

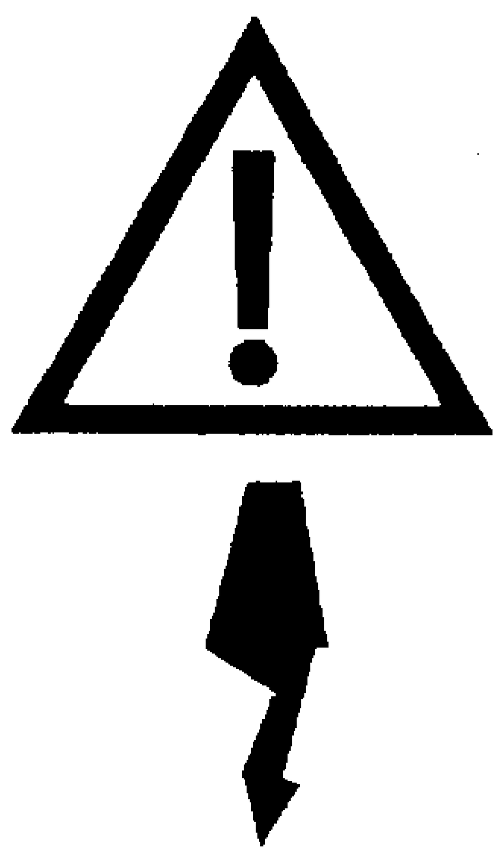
- ***are not damaged***
- ***are not stressed and***
- ***cannot be damaged by rotating components***

It is not permissible to connect the SIMODRIVE unit to a supply system with ELCBs (this restriction is permitted according to DIN VDE 0160, Section 6.5).

When operational, protection against direct contact is provided in a form to allow the unit to be used in enclosed electrical equipment rooms (DIN VDE 0558 Part 1, Section 5.4.3.2.4).

In compliance with DIN VDE 0160/05.88, all SIMODRIVE units are subject to a high-voltage test at the time of routine testing. If the electrical equipment of industrial tools is subject to a high voltage test, all connections must be disconnected so that sensitive electronic components in the SIMODRIVE converter are not damaged (permissible according to DIN VDE 0113 Part 1, Section 13.2).

Safety information



WARNING

Hazardous voltages are present in this electrical equipment during operation.

Non-observance of the safety instructions can result in severe personal injury or property damage.

Only qualified personnel should work on or around the equipment after first becoming thoroughly familiar with all warning and safety notices and maintenance procedures contained herein.

The successful and safe operation of this equipment is dependent on proper handling, installation, operation and maintenance.

Definitions

- **QUALIFIED PERSONNEL**

  For the purpose of this Instruction Manual and product labels, a "Qualified person" is someone who is familiar with the installation, construction and operation of the equipment and the hazards involved. He or she must have the following qualifications:

  1. Trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
  2. Trained in the proper care and use of protective equipment in accordance with established safety procedures.
  3. Trained in rendering first aid

- **DANGER**

  For the purpose of this Instruction Manual and product labels, "Danger" indicates death, severe personal injury or substantial property damage can result if proper precautions are not taken.

- **WARNING**

  For the purpose of this Instruction Manual and product labels, "Warning" indicates death, severe personal injury or substantial property damage can result if proper precautions are not taken.

- **CAUTION**

  For the purpose of this Instruction Manual and product labels, "Caution" indicates minor personal injury or property damage can result if proper precautions are not taken.

- **NOTE**

  For the purpose of this Instruction Manual, "Note" indicates information about the product or the respective part of the Instruction Manual which is essential to highlight.

WARNING

The information and instructions provided in all of the Manuals must be observed to prevent dangerous situations and damage.

- The Instruction Manual is accompanied by additional safety information (yellow) which provides supplementary information regarding electrical machines and equipment. This document should be considered as a supplement to all other Manuals and Instructions which are supplied with the equipment (e.g. for brakes etc.).
- The information provided in Catalogs and quotations is also valid for special machine and equipment versions .
- In addition, all relevant, binding national, and local regulations pertaining to the system must be observed.

WARNING

- The complete system must be in a no-voltage condition before any work is done on the system

  Voltage is present at the motor terminals when the rotor is turning as a result of the permanent magnets used in the motor.
- Connect-up the motor using the circuit diagram provided.
- After the motor has been mounted, the brake (if available) should be checked to ensure that it is working perfectly!

WARNING

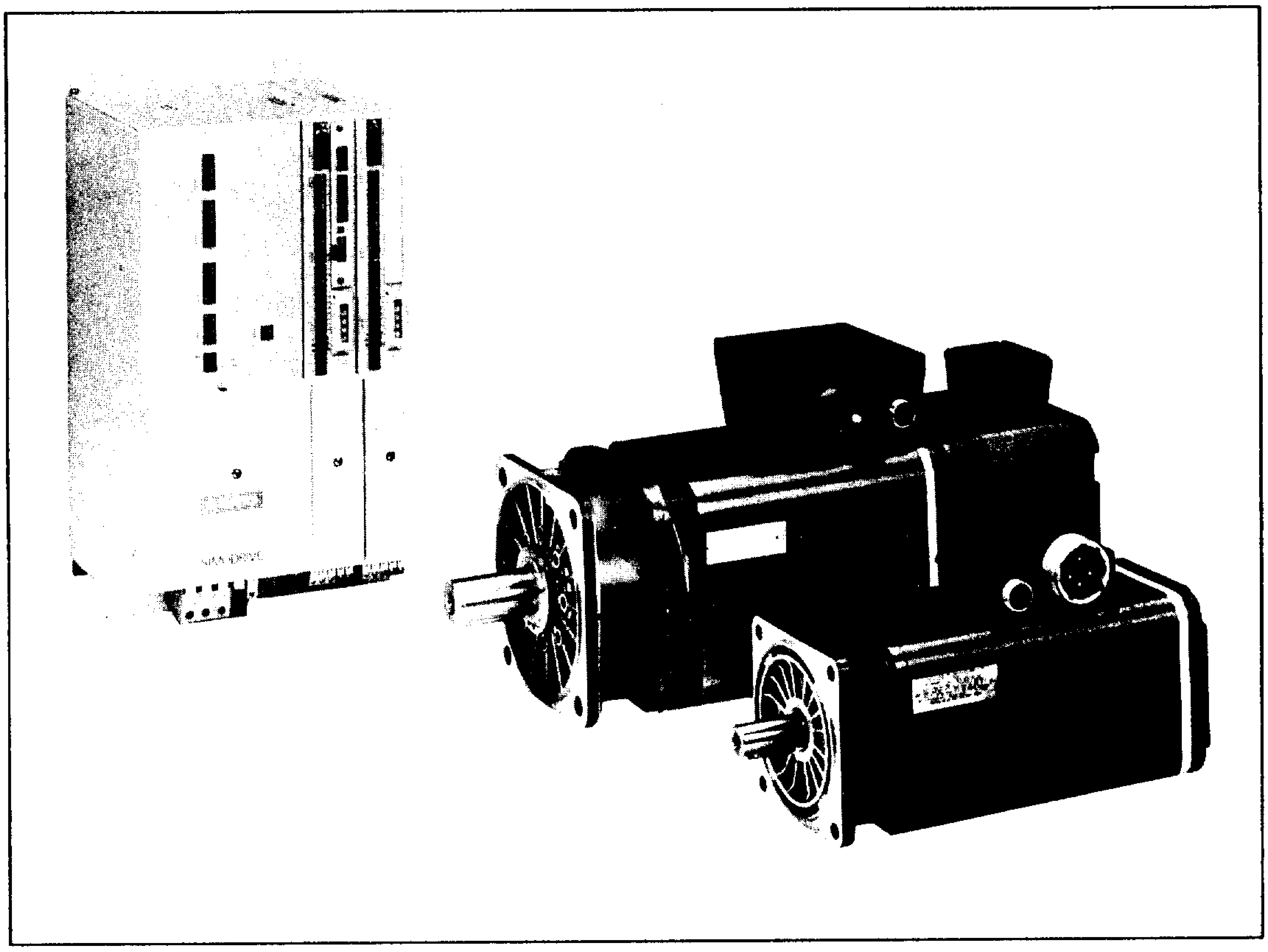
- Temperatures exceeding 100°C can occur at the motor outer surface. Temperature-sensitive components such as standard cables or electronic cables must not come in contact with the motor. Provide protection against accidental contact if required!
- The holding brake is only designed for a limited number of emergency stops and it cannot be used as working brake.

WARNING

- Before removing the solonoid assembly, the brake must be energized so that the membrane spring is not over-extended. (24 V DC ±10 %, observe polarity)
- The motor must not be directly connected to the three-phase supply (this would destroy the motor).

1 Introduction to AC feed drives

1.1 Application



SIMODRIVE AC feed drives with 1FT5 and 1FT4 AC servomotors and modular SIMODRIVE 611 transistor PWM converter

Modular SIMODRIVE AC feed drives combine the advantages of modern AC drive technology with the favorable control characteristics of DC drives. They are characterized by their excellent dynamic performance, good rotational accuracy and extremely low maintenance requirements. The axis-modular design provides space for connection systems.

SIMODRIVE AC feed drives are used for applications where a modular-axis design is required, high DC link voltages desired, and a higher level of kinetic energy must be injected back into the supply, as is for instance, required for:

- Machine tools (NC machining centers, modular systems, series machines)
- Transer lines
- Special machines

Further, SIMODRIVE 611 axis-modular AC feed drives can use a common DC link together with SIMODRIVE 650/660 AC main spindle drives. For a combined system, the SIMODRIVE 611 converter system also includes main spindle drive modules and induction motor modules with a field-oriented closed-loop control for specially developed induction motors (1PH, 1LA, 1PQ).

1) *Also refer to the special documentation, Descriptions 6ZB5 420-0AJ02-0BA2, and Instruction Manual 6SC6111-6AD76, 6SC6111-6AH76.*

The modular design concept provides the following advantages regarding handling:

- Axis-modular design
- All mounting points are in a uniform mounting grid (50 mm)
- Captive mechanical and electrical connecting components to adjacent modules
- Small conductor cross-sections ($V_{DC\ link}$ = 600 V DC)
- Codable plug-in terminals for the signals
- Direct supply connection
- Slot for options (e.g. main spindle drive functions)

Advantages during start-up:

- All adjustment and setting points are located on a parameter board which can be inserted from the front
- 7-segment display for operating signals and fault display
- High interference immunity due to separated power and signal connections

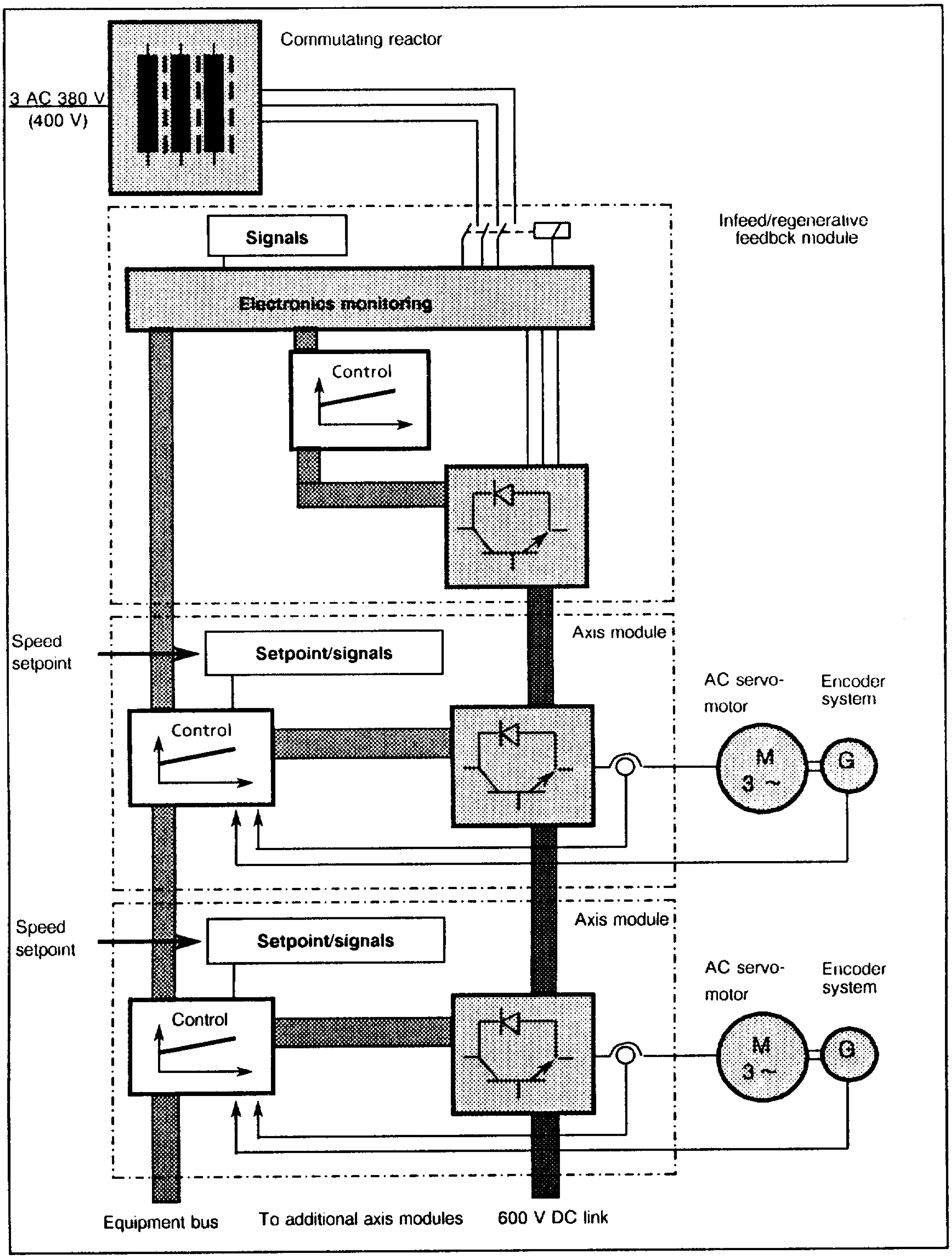
Operational advantages:

- Regenerative feedback into the supply
- Axis-specific fault signal outputs
- Setting-up operation
- Protected against contact according to VDE 0106 VBG4
- Monitors all parameters critical for operation.

Modular SIMODRIVE AC feed drives are designed for a 600 V DC link voltage and are available with rated torques from 0.5 Nm to 130 Nm (self-cooled) or 185 Nm (force-cooled) at rated speeds from 1200 RPM to 8000 RPM.

1.2 Design

The SIMODRIVE AC feed drives described here are brushless drives. They consist of a 1FT□ AC servomotor, and a modular SIMODRIVE 611 transistor PWM converter. These two units are matched to one another.

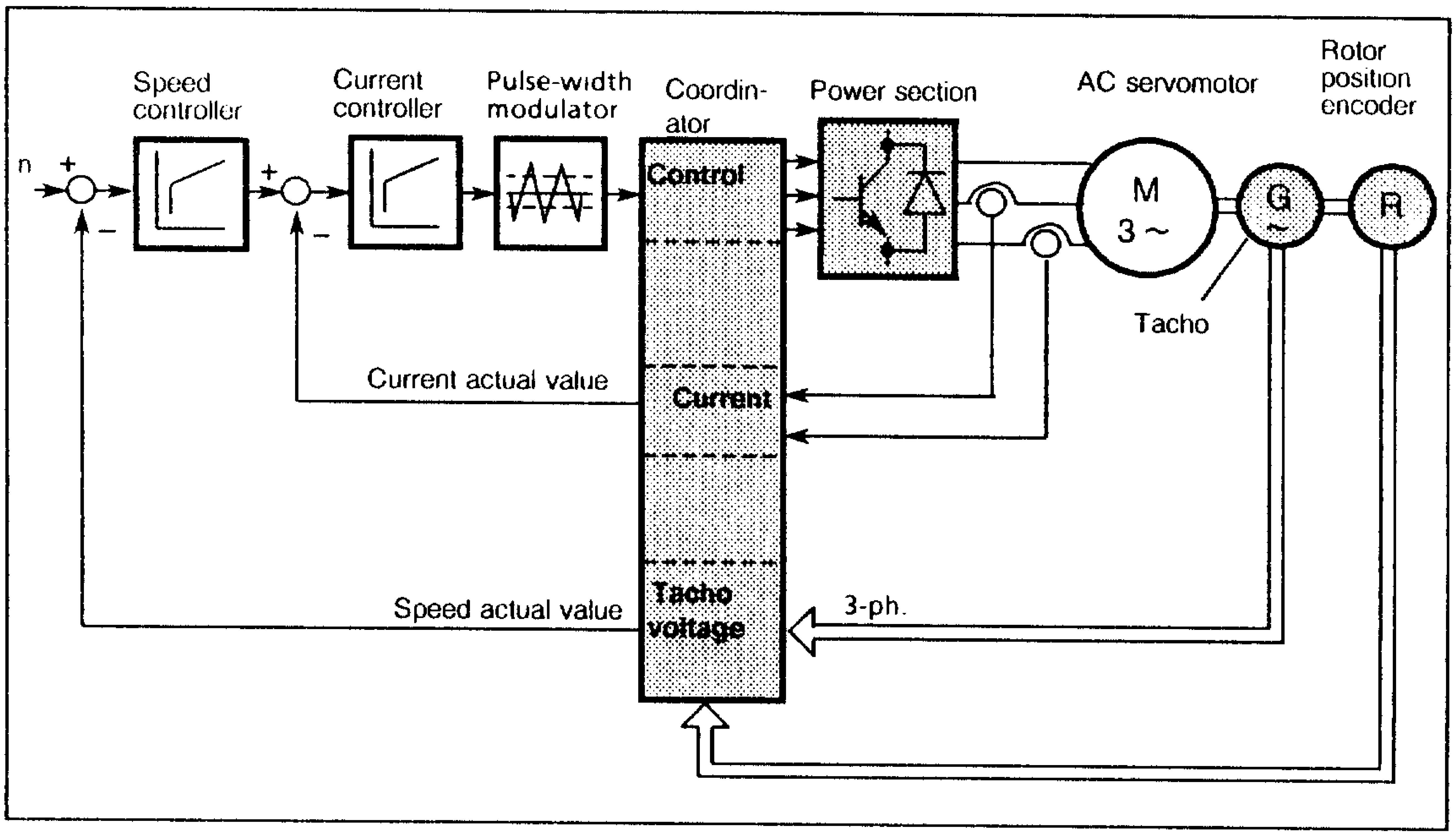


Block diagram of an AC feed drive with SIMODRIVE 611

1.3 Mode of operation

AC feed drives operate in principle as "brushless DC drives". The mechanical commutator used in DC motors is replaced, in this case, by an arcless electronic commutation device.

The rotor angle encoder (utilizing Hall sensors) signals the servomotor rotor position to the electronic commutation device and the converter switches the current to the correct conductor.



Block diagram of the transistor PWM converter for feeding AC servomotors

The rotor position encoder used with the 1FT□ AC servomotors has a resolution of 60° el, which corresponds to a mechanical resolution of 20°, i.e. 18 pulses are output per mechanical revolution. There is a fixed mechanical relationship between the rotor position encoder elements, the magnetic system of the servomotor and the motor-winding arrangement.

The rotor position encoder pulses control the switching elements in the PWM converter power section. The coordinator ensures that the power section supplies the current to the motor winding allocated to the current rotor position.

This design reduces the rotor moment of inertia over mechanically commutated designs. The drive has higher acceleration peformance, and the cooling is enhanced by the stator winding design, thus permitting a higher power-to-size ratio and higher speeds.

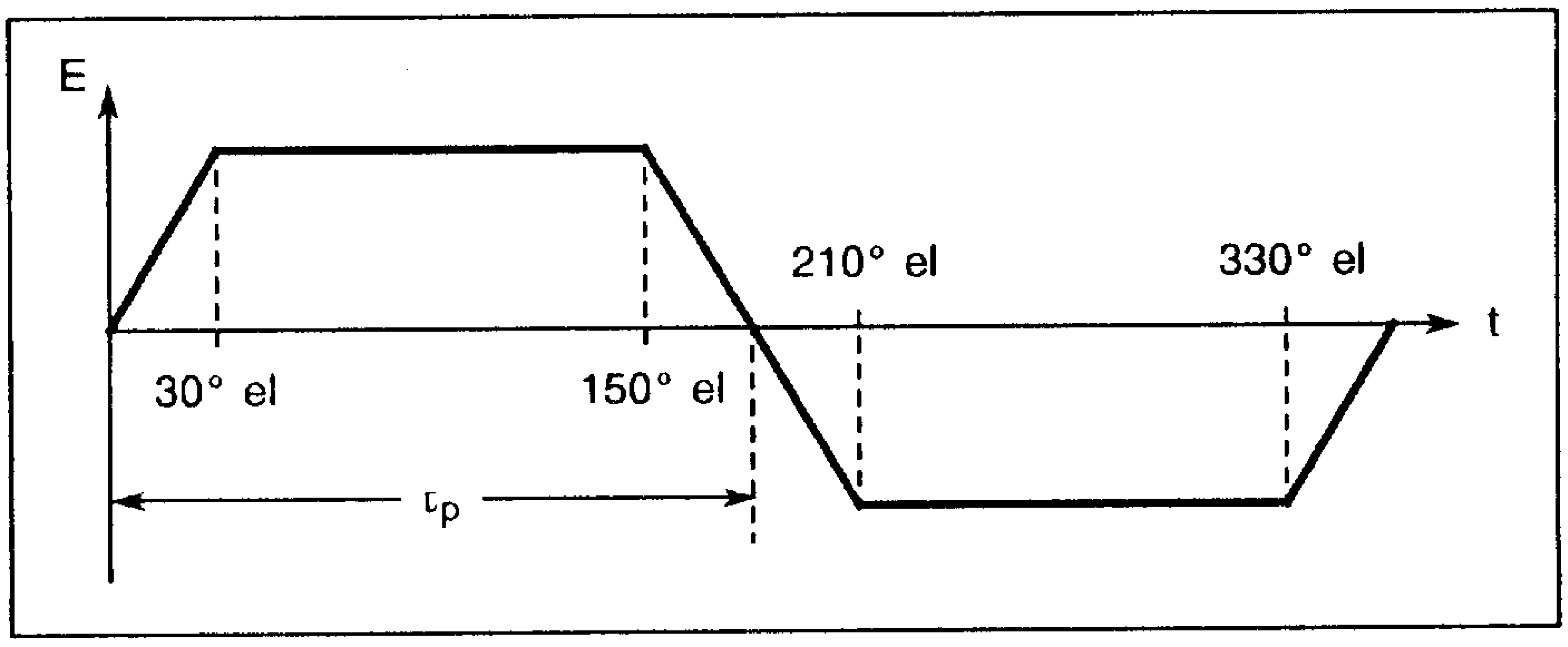
1.3.1 Generation of the rotating field

The rotor position encoder, the coordinator and inverter generate the rotating field. The rotor position encoder and the coordinator together define the sequence in which the motor windings are fed.

The inverter connects the U, V and W motor phases to the DC link voltage with alternating polarity, thus generating a rotating field. The frequency of this field is proportional to the speed of the AC servomotor. For 6-pole AC servomotors 1FT□, 1 period corresponds to 1/3 of a motor revolution.

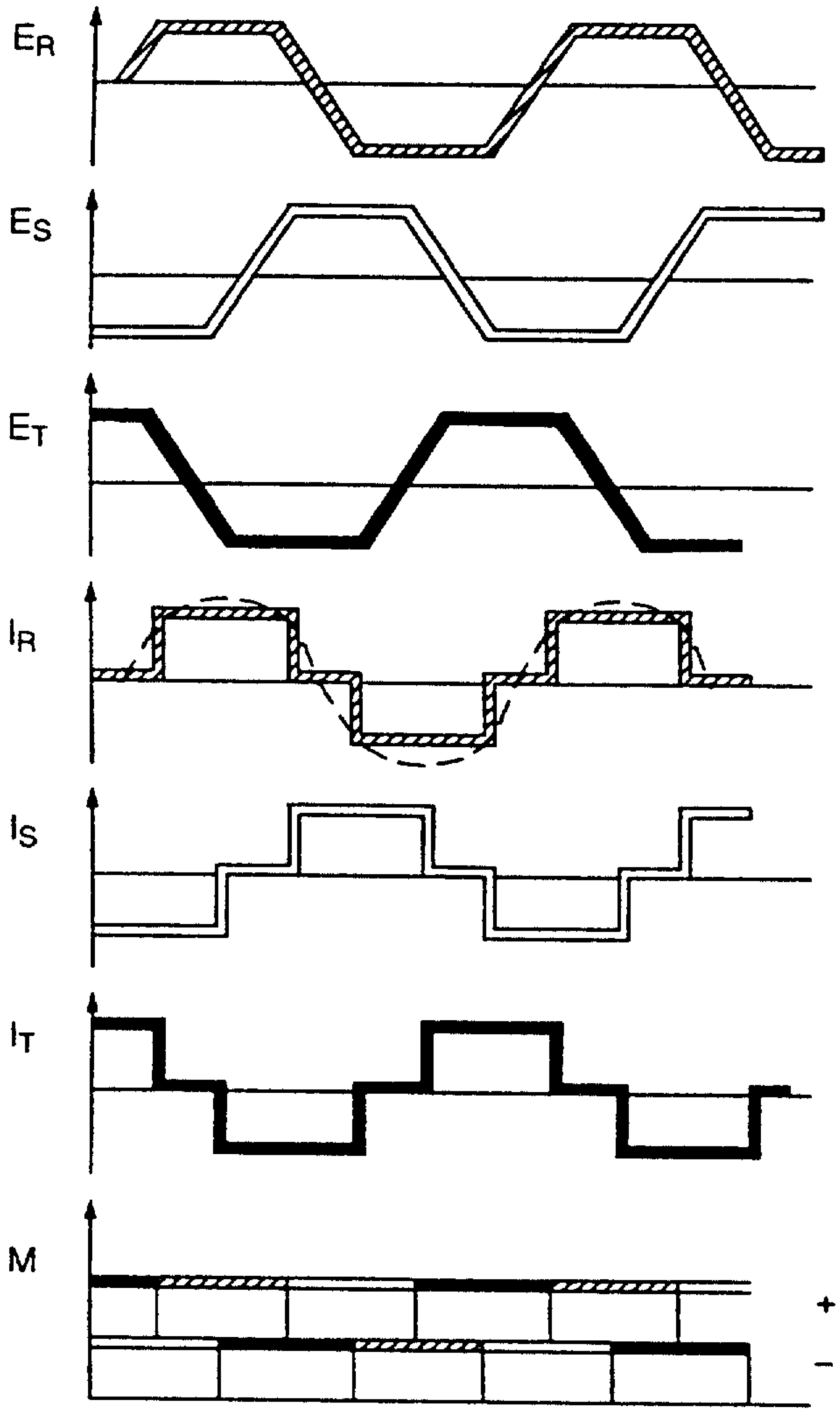
As a result of the "electronic commutation", the performance characteristics of these AC feed drives are similar to those of conventional DC drives: The speed is a function of the load and is proportional to the motor terminal voltage. A variable voltage is available at the converter output as a result of the pulse-width modulation of the DC link voltage. The mark-to-space ratio is variable and the clock frequency is fixed. The instantaneous value of the voltage at the motor is the full DC link voltage; the output voltage is the arithmetic mean of the voltage-time areas.

1.3.2 Torque generation



Induced voltage in a winding phase of a 1FT□ AC servomotor

1FT□ AC servomotors are designed to have a trapezoidal flux distribution. The flux is displaced by 120° el. for each of the three phases. With positive induction (30 ° el to 150° el), a positive current is fed through the motor winding and with negative induction (210° el to 330° el) a negative current. By switching the three phases it is ensured that two of the three phases are always positioned in the linear field maximum. The resulting total torque is then the sum of the two individual torques of both phases. A uniform torque is produced at the motor shaft as a result of this displaced commutation.



$$M = \frac{m \cdot E \cdot I}{2\pi \cdot n}$$

E_R, E_S, E_T	EMF
I_R, I_S, I_T	Motor phase currents
M	Torque
m	Motor constant
n	Speed

Torque generation

1.3.3 Current actual value generation

The current is measured using shunts in two motor feeders, and the current signals transferred, floating to the control. The measured AC currents are rectified and conditioned for the current control loop by the coordinator.

1.3.4 Speed actual value generation

The actual speed of SIMODRIVE AC drives is measured brushlessly. A permanent-magnet synchronous generator with the same number of pole pairs and the same field orientation as the servomotor produces a three-phase voltage with a voltage amplitude proportional to speed. The coordinator rectifies this three-phase voltage and conditions it to form an analog actual speed value which is fed to the speed control loop.

2 AC servomotors

2.1 1FT5 AC servomotors

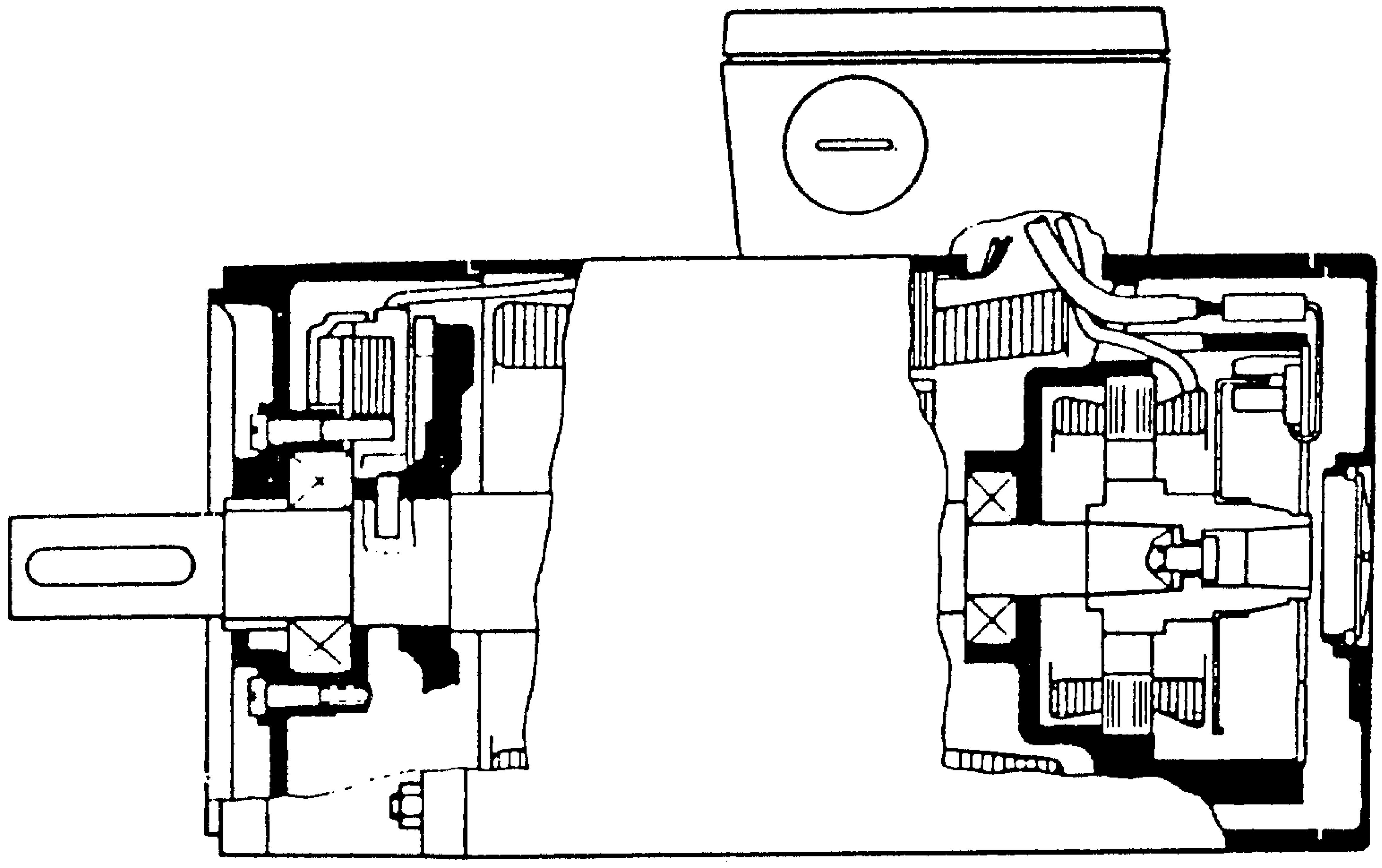
2.1.1 Applications

1FT5□□□-0□□7 AC servomotors are specially adapted to the axis-modular SIMODRIVE PWM transistor converters and are designed for a 600 V DC link voltage. They are used for feed drive axes on machine tools and robots. They can be mounted directly on feed spindles or on gearboxes with pinion wheels or toothed belts. 1FT5 motors generate a high torque at the motor shaft even at low speeds, but are characterized by compact dimensions and low volume.

Essential features of the servomotors:

- Identical mounting dimensions (DIN/IEC flange) within a frame size
- Enclosed design (IP64 degree of protection)
- High resistance to de-magnetization
- High power-to-size and weight ratio
- Low rotor inertia
- Essentially maintenance-free
- Smooth running characteristics
- Integrated encoder system for sensing motor speed and rotor position
- Constant accelerating torque up to maximum speed in the standard overload range
- Low temperature sensitivity of the torque
- Good linearity between current and torque
- Standard connector for motors 1FT503□ to 1FT504□, alternative standard connection method for motors 1FT506□ to 1FT513□ Connecting type 1: Connector; connecting type 2: Terminal box
- Options
  - Integrated holding brake
  - Integrated pulse encoder
  - Mounted pulse encoder
  - Prepared for mounting absolute shaft angle encoders
  - Forced-cooling for 1FT513□ motors
  - Alternative shaft end design and motor flange/shaft end sealing
  - Vibration severity grade according to DIN ISO 2373
  - Radial eccentricity tolerance, according to DIN 42955

2.1.2 Design



1FT5 AC servomotor (6 pole): Sectional view

The basic servomotor consists of:

- motor active components,
- encoder system for sensing motor speed and rotor position (tachogenerator system) and
- temperature sensor (PTC thermistor).

Power can be connected to the AC servomotors in two ways:

- With the power connector version, the motor and holding brake connections are fed through a common connector. A second connector is provided for the encoder system and the PTC thermistor.
- With the terminal box version (only for 1FT5062 to 1FT5138 motors), the motor and holding brake connections are fed to a terminal board in the terminal box. A connector is provided at the terminal box for connecting the encoder system and the PTC thermistor.

Standard scope of supply

1FT5 AC servomotors, with the following specifications

- Type of construction IM B5
- Degree of protection IP 64
- Vibration severity grade N
- Connector with outlet to the right
- PTC thermistor in the stator winding
- With tachogenerator, type 1FU1050 or 1FU1030 (dependent on the motor type)

Mating connectors are not part of the scope of supply. 1FT5 motors are provided with a 12-pin flange-mounted connector socket for connecting the rotor position encoder. The required mating connector 6FC9348-7AD[1] must be ordered separately.

2.1.2.1 Tachogenerator system

1FT5 AC servomotors are equipped with a brushless encoder system.

The tachogenerator including rotor position encoder is mounted on the tapered non-drive shaft end.

The tachogenerator system is used for providing a speed actual value for the speed control loop.

This rugged AC tachogenerator system has been especially adapted to the rugged requirements of feed drive systems. In addition to the AC tachogenerator for the speed actual value signal for the speed control loop, the encoder system has the rotor position encoder for the inverter control. Magnetic sensors are used in the 1FU1050 and the Hall system in the 1FU1030.

Main features:

- High signal-voltage quality
- High thermal stability
- Insensitive to noise interference

Trapezoidal voltage signals are available at the tachogenerator output for sensing the motor speed. The rotor position encoder provides an absolute signal with 18 pieces of information per revolution.

1) Or 6FC9348-7 AL, version with 13.5 mm PG thread.

2.1.2.2 Temperature monitor

PTC thermistors for temperature monitoring are installed as standard in the servomotors. The PTC thermistors are optimally located in the motor so that the stator winding temperature rise is reliably sensed. However, the thermal time constants should be taken into account. Very high, brief overload conditions require additional protective measures.

1FT503☐ to 1FT504☐ motors are equipped with two PTC thermistors, and 1FT506☐ to 1FT513☐ motors with one PTC thermistor. The connection is fed through the rotor position encoder cable. The signals can be directly evaluated using the 3UN8 or 3UN6 tripping units. The 3UN6 has a visual indicating device, and a mechanical restart lockout (Catalog NS2, Part 5).

SIMODRIVE 611 PWM converters have, as standard an adapted PTC thermistor evaluation circuit. The signal must be externally processed in the interface control.

Caution

The integrated temperature monitors protect the servomotors from overload under normal operating conditions. However, if brief overload conditions occur for the lower-rating servomotors of more than $2 \cdot I_0$, appropriate protection is no longer provided. In this case, additional protective measures must be provided, e.g. a thermal overload relay (refer to Section 2.11 Mounting instructions).

2.1.2.3 Bearings and motor shaft

The motor is equipped with a locating bearing at the drive end and with a floating bearing at the non-drive end. Thermal expansion in the rotor therefore does not affect the drive end. The bearings are sealed on both sides using packing washers, are pre-lubricated and have a rated service life of 20,000 hours. The bearings are designed for a minimum ambient temperature of -15°C in operation.

When mounted on a gear unit, or for sealing against oil mist and spray, the drive end of the servomotor can be equipped with a rotary shaft seal according to DIN 3760 (option K18).

The standard servomotor design has a cylindrical shaft end according to DIN 748 and fitted key with keyway according to DIN 6885.
The shaft and bearings are subject to higher radial stresses when pinion drives or tooth belts are used. The permissible cantilever force F_Q is dependent on the shaft shoulder distance, the load application point, and average operating speed. The permissible cantilever forces are listed in the cantilever force diagrams in Section 2.9.

Three different versions of the drive shaft end are available, all of which have a centering thread to DIN 332 Part 2.

Designation	Servomotor with cylindrical shaft end	Comments
Version a Standard version	With fitted key and keyway to DIN 6885 Tolerance zone k6 [3] Peak-to-valley height on the shaft surface	Shaft connections with fitted key, keyed or multiple-spline connections are positive-locking. The fit quality deteriorates under continuous stressing and varying torque. Rotationally symmetrical displacement increases torque oscillations reducing the smooth running quality. Increasing deformation can lead to fractures.
Version b Option K42	Without fitted key and without keyway Tolerance zone k6[3]	With a frictional connection, the torque must be transmitted through surface pressure only. Reliable power transmission is guaranteed.
Version c Option K43	Dimensions as for version b, but ground with high precision for oil-pressure fitting, tolerance zone k5[3]	

Drive shaft end versions [1]

1) *Data and cantilever forces for other special shaft ends on request.*
2) *According to DIN 4768*
3) *Tolerance zones for shafts and flange according to DIN ISO 286*

The following table lists the various friction-locked connections between the motor shaft and drive pinion.

Designation	Establishing and releasing friction-locked connections	
	Operations required	Comments
Shrink fitting	Thermal expansion and shrinking of drive element onto the shaft. Separation of connection without irreparable damage or impairment of surface virtually impossible.	Note internal stress characteristics of material and form and changes in diameter/pitch circle.
Combined shrink/oil-pressure fitting	Thermal expansion and shrinking of drive elements onto the shaft. Separation of connection through oil-hydraulic expansion and withdrawal.	Make allowance for oil grooves. Note, if necessary, internal stress characteristics of hub material and for thermal shrinkage and any changes in diameter.
Oil-pressure fitting	Hydraulic expansion using high oil pressure. Hydraulic or mechanical fitting and withdrawal. Shaft end: Fit dimension k5[1)] Peak-to-valley height: $R_z = 1.6$ µm	Special mechanical design of parts and special equipment are required. Note any changes in diameter/pitch circle, inadmissible form variations and inferior surface quality of the parts to be connected.

Friction-locked connections between the motor shaft and drive pinion

Designation	Manufacturer	Comments
"Ringfeder system" clamping sets and elements (Uerdinger Ringfeder)	Messrs. Ringfeder GmbH 4150 Krefeld-Uerdingen	Motor shaft end required: Version b Any changes in diameter, form and positional variations and rotational asymmetry must be noted.
Spieth thrust sleeves, DSM series	Messrs. Spieth, Machine components 7301 Zell am Neckar	Motor shaft end required: Version a or b Any changes in diameter, form and positional variations and rotational asymmetry must be noted.

Manufacturers of friction-locking components

1) *Tolerance zones for shafts and flange according to DIN ISO 286*

- **Rotary shaft seal** (option)
  A rotary shaft seal is available for the drive-end bearing. The sealing ring lip runs on a shaft sleeve ground under minimal axial feed conditions according to DIN 3760. The running surface must be reliably lubricated to prevent excessive sealing ring wear.

  The rotary shaft seal is predominantly used on motors with flange-mounted gearboxes, lubricated with oil or oil mist.

  The rotary shaft seal and sealing of the screw connections using VSIT washers increase the degree of protection of the drive-end shaft to IP67. The rotary shaft seal cannot be retrofitted.

  If the motor is required with increased vibration severity grade, grade S or better, the rotary shaft seal cannot be used as a result of the balancing disk.

- **Radial eccentricity of the motor shaft ends, concentricity and axial eccentricity of the mounting flange**
  1FT5 motors are, according to DIN 42955, designed as standard, with the standard tolerance limits (N) for shaft end radial eccentricity, concentricity and axial eccentricity to the mounting flange.

  If tighter tolerances are required, this is possible with version DIN 42955-R, option code K04.

Radial eccentricity of the shaft to the housing axis	**Standard** N (normal)	**Option K04** R (reduced)
1FT 503□; 1FT 504□	0.035 mm	0.018 mm
1FT 506□; 1FT 507□	0.04 mm	0.021 mm
1FT 510□; 1FT 513□	0.05 mm	0.025 mm

Referred to the cylindrical shaft end according to the test method to DIN 42955

Concentricity- and axial eccentricity of the flange surface to the shaft axis	**Standard** N (normal)	**Option K04** R (reduced)
1FT 503□; 1FT 504□; 1FT 506□	0.08 mm	0.04 mm
1FT 507□; 1FT 510□;	0.1 mm	0.05 mm
1FT 513□	0.125 mm	0.063 mm

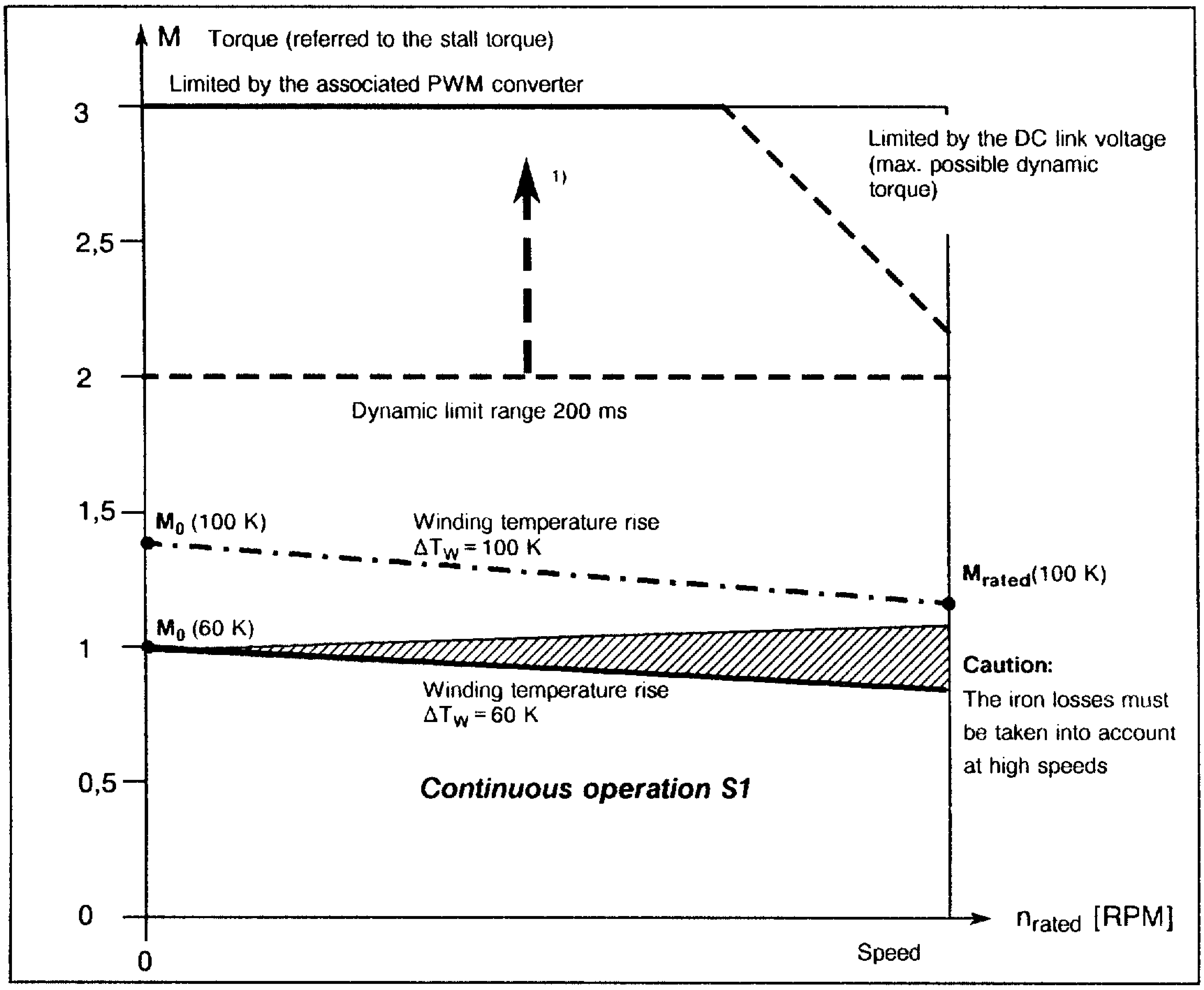
Referred to the centering diameter of the mounting flange, according to test method to DIN 42955

2.1.3 Mode of operation

1FT5 AC servomotors are permanent-magnet synchronous motors. A samarium-cobalt alloy is used as magnet material. The motor operates like a DC motor with electronic commutator in conjunction with the rotor position encoder system and the inverter in the converter. This is also reflected in the applicable characteristic data.

2.1.3.1 Torque characteristics

The AC servomotors provide an almost constant continuous torque and constant overload capability over the entire speed range. The overload capability can be matched to the dynamic requirements and the total moment of inertia of the drive by appropriately selecting the SIMODRIVE transistor PWM converter.



Speed-torque characteristics of 1FT5 AC servomotors

With the control loop open, i.e. no closed-loop control, e.g. the tachogenerator is not connected, the motor can accelerate to n_{max}[2] at rated voltage, and even significantly exceed this value. This speed can also be exceeded at higher supply voltages and higher DC link voltages. In this case, limited dynamic torque is available as a result of the voltage limiting curve.

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1) *Dynamic limit range 2. M_0 (60 K) corresponds to the standard drive arrangement. If required, the converter arrangement can be adapted to the actual drive application. If necessary, additional motor overload protection must be provided; the mechanical limit of the motors is 4 · $M_{0\,100\,K}$.*

2) *According to Technical data, Section 2.1.4*

2.1.3.2 Armature short-circuit braking

The transistor PWM converter cannot be used for electrical braking when the DC link voltage limit values are exceeded or in the event of an electronics failure. The motor can be braked by armature short-circuit if the coasting drive represents any kind of risk. This braking function should be activated via the emergency limit switches in the feed axis traversing range.

The friction between the mechanical transmission elements and the switching delay times of the contactors must be taken into account when calculating the overrun travel of the feed axis. Mechanical shock absorbers must be mounted at the end of the absolute machine-axis traversing range in order to prevent any mechanical damage.

Caution

Pulses must always be cancelled using terminal 63 on the PWM converter before the armature short-circuit contactor is switched-in which in turn is interlocked with the line contactor. This measure prevents the contactor contacts burning and destroying the PWM converter.

For servomotors with integrated holding brake, the holding brake can be simultaneously de-energized in order to generate, with some delay, an additional braking torque (the holding brake is not an operational brake).

Routine braking of the drive must always be initiated via the setpoint input. Braking in response to an "emergency OFF" signal should be initiated via termial 64.

The braking torque of the servomotor during regenerative operation can be optimized using a three-pole armature short-circuit using a matched external resistor circuit. The resistors, which must be mounted externally, are specified in Section 2.1.4 in the tables under technical data: Standard motors (600 V DC link) and technical data: short motors (600 V DC link). An optimum braking time is achieved with this design. The tables also indicate the available braking torques. The data applies for braking from rated speed. If braking is initiated at another speed, the stopping time cannot be reduced proportionally, but will not exceed those times specified for rated speed. The resistor rating must be matched to the relevant I^2t rating.

3TB4 or 3TF4 power contactors (Catalog NS2) can be used, depending on the rated power section current, for armature short-circuit braking and to isolate the motor feeder cables from the converter. The auxiliary contacts, in some cases they must be connected in parallel depending on the short-circuit currents, are used for armature short-circuiting. The NC auxiliary contacts of the contactors can withstand the I^2t load occuring for this special type of application.
However, this measure is not sufficient for a safe operational stop (i.e. where the drive must not accidently start-up). In this case, positively driven contacts and redundant, fail-safe monitoring circuits are also required.

When conductor cross-sections are reduced at junction points, fuse protection or short-circuit proof cables (e.g. Teflon) must be provided. Various cross-sections can be connected to the same contact at the terminals of the 3TB4 and 3TF4 power contactors.

Please note, that the braking current may only be switched-on and conducted, but not switched-off. It must be ensured, using appropriate circuitry, that the contacts will not open again after short-circuiting until the current has decayed to 0.

2.1.4 Technical data

2.1.4.1 General

The AC servomotors comply with DIN standards and VDE specifications, in particular VDE 0530 and DIN 57530, "Specifications for rotating electrical machines".

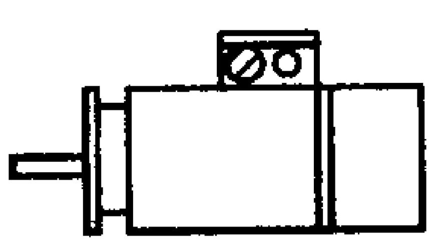
Motor voltage Motor frequency Number of poles	0 V to 380 V[1)] 0 Hz to 300 Hz 2p = 6
Types of construction	IM B5 to DIN 42950 IEC 34-7 (as standard); IM V1; IM V3[3)]
Coolant temperature Cooling Insulation	up to +40 °C Natural cooling, type A DURIGNIT® 2000 corresponding to insulation class F for a maximum temperature rise ΔT = 100 K at a coolant temperature of 40 °C to VDE 0530.
Degree of protection	IP64 acc. to DIN IEC 34-5 (VDE 0530 Part 5) (special version: IP67; individual testing required)
Motor noise level	approx. 52 dB(A) up to70 dB(A) under load, dependent on the frame size
Short-circuit resistance	Short-circuit currents of 4 · I_0 may occur in the case of a 3-phase short-circuit. This does not lead to any irreversible de-magnetization[2)]. The peak current I_{max} specified in the technical data tables for standard motors (Section 2.1.4.2) must not be exceeded.
Vibrational severity grade Shock resistance Cantilever forces	N to ISO 2373/DIN 45665 (limiting value of the RMS value of the oscillation velocity 1.8 mm/s) 6g; functionality of the equipment is not impaired during this shock stressing Refer to the diagrams in Section 2.9 for permissible shaft cantilever forces
Paint finish	Anthrazite (SN30901 -614) with dark green ring on the non-drive end (SN30901-615); climatic stressing, dry to moderately humid for indoor installation.
Operating temperature range	–15°C to +40°C

Technical data of 1FT5 AC servomotors

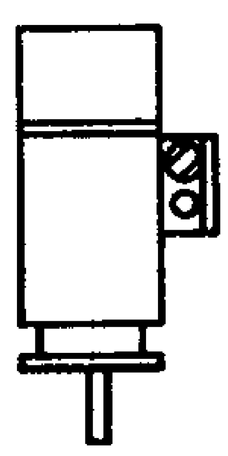
1) Matched to a 600 V DC link voltage

2) For 1FT513. motors, the short-circuit braking must always be realized using the braking resistors $R_{a\ opt}$ specified in the Technical Data tables, Standard motors (Section 2.1.4.2)!

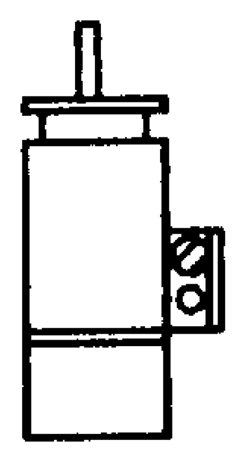
3) Type of construction:



IM B 5 (Standard design)



IM V 1



IM V 3

 6ZB5 420-0AS02
SIMODRIVE 611 (PJ)

2.1.4.2 Standard motors

An explanation of the terms used in the tables is given in Section 2.7.

Servomotor 1FT5	Rated speed n_{rated} [RPM]	Standstill torque M_0, $\Delta T = 60K$ [Nm]	Standstill torque M_0, $\Delta T = 100K$ [Nm]	Phase current at M_0, I_0, $\Delta T = 60K$ [A]	Phase current at M_0, I_0, $\Delta T = 100K$ [A]	Moment of inertia 1) J_{mot} [10^{-4} kgm²]	Rated torque (S1) $\Delta T = 100K$ M_{rated} [Nm]	Max. speed n_{max} [RPM]	Peak current I_{max} [A]	Time constant electr. T_{el} [ms]	Time constant therm. T_{th} [min]	Torque const. K_T [Nm/A]	Voltage constant (phase to phase) K_E [V/1000 RPM]	Winding resistance R [Ω]	Winding inductance L_A [mH]	Ext. brake. resistor $R_{a\,opt}$ [Ω]	Brake. torque $M_{B\,opt}$ [Nm]	Weight w/o hold brake m [kg]
034-0AK71	6000	0.5	0.6	0.93	1.1	0.67	0.5	9800	8.1	1.3	40	0.54	61	16.3	21.8	4.7	1.1	2.4
036-0AK71	6000	0.75	0.9	1.4	1.7	0.96	0.6	9850	12.0	1.5	45	0.53	61	8.6	13.7	4.7	1.8	3.1
042-0AF71	3000	0.66	0.85	0.75	0.96	1.73	0.85	6000	5.5	1.7	40	0.88	100	28.2	48.4	0	1.5	3.2
042-0AK71	6000			1.2	1.5		0.75	8300	8.5			0.57	65	11.8	20.3	7.8	1.5	
044-0AF71	3000	1.3	1.7	1.5	1.9	2.8	1.6	6000	10.5	2.8	45	0.88	100	9.0	24.2	2.8	2.7	4.2
044-0AK71	6000			2.3	3.0		1.4	8300	17.0			0.56	63	3.4	9.5	5.9	2.8	
046-0AF71	3000	2.6	3.4	3.0	3.9	4.93	3.1	6000	22.0	3.8	50	0.88	100	3.1	11.7	2.7	5.6	6.4
046-0AK71	6000			4.7	6.2		2.5	8300	35.0			0.55	62	1.2	4.6	3.4	5.5	
062-0AC71	2000	2.2	2.6	1.3	1.6	4.7	2.4	3200	6.6	5.6	25	1.65	187	15.1	85.3	0	3.0	6.5
-0AF71	3000			2.0	2.4		2.3	4800	10.0			1.10	125	7.1	38.1	0	3.1	
-0AG71	4000			2.7	3.2		2.2	6400	13.5			0.82	93	3.8	21.0	10.0	2.8	
-0AK71	6000			3.9	4.6		2.1	8600	20.0			0.56	62	1.7	9.3	6.8	2.9	
064-0AC71	2000	4.5	5.5	2.7	3.3	8.3	4.7	3200	14.0	7.5	30	1.65	187	5.0	39.3	0	6.6	8.5
-0AF71	3000			4.1	5.0		4.3	4800	20.0			1.10	125	2.2	17.5	0	6.5	
-0AG71	4000			5.5	6.7		3.8	6400	29.0			0.82	93	1.2	9.5	4.7	6.2	
-0AK71	6000			8.0	9.8		3.0	8600	42.0			0.56	63	0.56	4.4	3.9	6.9	
066-0AC71	2000	6.5	8	3.9	4.9	11.8	6.7	3200	20.0	9.2	35	1.65	187	2.8	25.6	5.6	9.5	10.5
-0AF71	3000			6.0	7.3		6.1	4900	31.0			1.09	123	1.2	11.4	3.9	9.7	
-0AG71	4000			7.9	9.6		5.5	6400	41.0			0.82	93	0.68	6.3	3.3	9.3	
-0AK71	6000			11.6	14.5		4.2	8600	61.0			0.56	63	0.37	3.4	2.7	7.9	
072-0AC71	2000	10	12	6.1	7.3	22.8	9.5	3200	29.0	11	35	1.64	186	2.6	23.2	4.7	10.0	13.5
-0AF71	3000			9.1	11.0		8.5	4800	43.0			1.10	124	1.2	10.3	3.9	9.4	
-0AG71	4000			12.0	14.5		7.5	6300	60.0			0.84	95	0.63	5.7	3.3	11.0	
-0AK71	6000			17.5	21.0		5.0	7000	89.0			0.57	65	0.32	2.9	2.7	10.0	
074-0AC71	2000	14	18	8.5	11.0	36.7	14.0	3200	45.0	11	40	1.64	186	1.2	13.2	2.7	14.1	17.2
-0AF71	3000			13.0	17.0		12.5	4900	67.0			1.08	122	0.52	5.6	2.2	17.0	
-0AG71	4000			16.5	21.5		11.0	6200	90.0			0.85	96	0.33	3.6	3.9	17.4	
-0AK71	6000			25.0	32.0		7.0	7000	104			0.57	65	0.14	1.5	2.2	19.0	

Standard motors (600 V DC link voltage)

1) *Does not include the tachogenerator and rotor position encoder system; refer to Sec. 2.3, 2.5.2, and 2.5.3*

Servomotor 1FT5	Rated speed n_{rated} [RPM]	Standstill torque M_0 ΔT=60K [Nm]	Standstill torque M_0 ΔT=100K [Nm]	Phase current at M_0 I_0 ΔT=60K [A]	Phase current at M_0 I_0 ΔT=100K [A]	Moment of inertia 2) J_{mot} [10^{-4} kgm²]	Rated torque (S1) ΔT=100K M_{rated} [Nm]	Max. speed n_{max} [RPM]	Peak curent I_{max} [A]	Time constant electr. T_{el} [ms]	Time constant therm. T_{th} [min]	Torque const. K_T [Nm/A]	Voltage constant (phase to phase) K_E [V/1000 RPM]	Winding resistance R [Ω]	Winding inductance L_A [mH]	Ext. brake. resistor $R_{a\,opt}$ [Ω]	Brake. torque $M_{B\,opt}$ [Nm]	Weight w/o hold brake m [kg]
076-0AC71	2000	18	22	11.5	13.5	50.9	18.5	3200	52	12	45	1.63	185	0.75	9.1	2.2	23.8	21
-0AF71	3000			16.5	20.0		16.5	4800	78			1.10	125	0.35	4.2	1.5	19.3	
-0AG71	4000			21.5	26.0		13.0	6200	110			0.85	96	0.20	2.4	1.2	26	
-0AK71	6000			32.0	39.0		4.0	7000	163			0.57	65	0.093	1.1	1	26	
102-0AA71	1200	27	33	9.9	12.5	136	31.0	1900	47	16	45	2.74	310	0.9	14.2	1.8	36.5	31
-0AC71	2000			16.5	20.5		29.0	3200	80			1.64	186	0.33	5.2	1.2	34.7	
-0AF71	3000			25.0	31.0		25.0	4900	120			1.08	122	0.14	2.2	0.82	33.9	
-0AG71	4000			31.5	38.5		30.0 1)	6200	164			0.86	97	0.097	1.4	0.82	42.0	
104-0AA71	1200	37	45	14.0	17.0	185	40.0	1900	64	18	50	2.72	308	0.56	9.5	1.2	42.4	39
-0AC71	2000			22.5	27.5		35.0	3200	110			1.66	188	0.2	3.5	0.82	38.1	
-0AF71	3000			34.0	41.5		29.0	4800	164			1.09	123	0.095	1.7	0.68	62.0	
106-0AA71	1200	45	55	17.0	20.5	239	47.0	1900	80	19	50	2.72	308	0.39	7.4	1.0	53.0	45
-0AC71	2000			26.8	33.0		39.0	3200	130			1.68	190	0.15	2.9	0.68	47.7	
-0AF71	3000			42.5	52.0		28.0	5000	200			1.06	120	0.066	1.2	0.47	88.0	
108-0AA71	1200	55	68	20.5	25.5	290	55.0	2000	95	19	55	2.70	306	0.29	5.8	0.82	59.0	51
-0AC71	2000			32.5	40.0		42.5	3100	164			1.70	192	0.13	2.5	0.56	73.3	
-0AF71	3000			50.5	62.5		20.0	4900	247			1.09	123	0.054	1.0	0.39	106.0	
132-0AA71	1200	60	75	22.5	28.0	464	55.0	2000	112	23	80	2.70	306	0.28	6.4	1.0	106.0	75
-0AC71	2000			35.5	44.0		45.0	3100	186			1.71	194	0.10	2.3	0.56	98.0	
-0AF71	3000			47.5	59.0		30.0	3200	236			1.27	144	0.062	1.4	0.56	100.0	
134-0AA71	1200	75	90	28.0	33.5	590	65.0	2000	134	25	85	2.70	306	0.19	4.8	0.68	134.0	95
-0AC71	2000			47.0	56.0		50.0	3200	222			1.61	182	0.073	1.8	0.47	125.0	
136-0AA71	1200	85	105	31.5	39.0	716	82.0	1900	156	27	90	2.70	306	0.14	3.8	0.56	155.8	115
-0AC71	2000			47.5	59.0		60.0	2900	234			1.79	203	0.063	1.7	0.47	164.0	
138-0AA71	1200	105	130	39.0	48.5	905	100	2000	194	29	100	2.70	306	0.11	3.2	0.47	208.0	145

Standard motors (600 V DC link voltage)

1) *Value valid for (S3 - 60 %)*

2) *Does not include the tachogenerator and rotor position encoder system; refer to Sec. 2.3, 2.5.2, and 2.5.3*

Servo-motor 1FT5	Rated speed n_{rated} [RPM]	Standstill torque M_0 ΔT=60K [Nm]	Standstill torque M_0 ΔT=100K [Nm]	Phase current at M_0 I_0 ΔT=60K [A]	Phase current at M_0 I_0 ΔT=100K [A]	Moment of inertia 1) J_{mot} [10^{-4} kgm²]	Rated torque (S1) ΔT=100K M_{nenn} [Nm]	Max. speed n_{max} [RPM]	Peak current I_{max} [A]	Time constant electr. T_{el} [ms]	Time constant therm. T_{th} [min]	Torque constant K_T [Nm/A]	Voltage constant (phase to phase) K_E [V/1000 RPM]	Wind. resistance R [Ω]	Wind. inductance L_A [mH]	Ext. brake resistance $R_{a\,opt}$ [Ω]	Brake. torque $M_{B\,opt}$ [Nm]	Weight w/o hold. brake m [kg]
132-0SA71	1200	70	95	26.0	35.0	464	85	1900	112	23	80	2.7	306	0.28	6.4	0.15	106	80
-0SC71	2000			41.0	56.0		80	3000	186			1.71	194	0.10	2.3	0.56	98	
-0SF71	3000			55.5	75.0		75	3200	236			1.27	144	0.062	1.4	0.56	100	
134-0SA71	1200	90	120	34.0	45.0	590	115	1900	134	25	85	2.7	306	0.19	4.8	0.68	134	100
-0SC71	2000			56.0	75.0		110	3200	222			1.61	182	0.073	1.8	0.47	125	
136-0SA71	1200	110	145	41.0	54.0	716	135	1900	156	27	90	2.7	306	0.14	3.8	0.56	156	120
-0SC71	2000			61.5	81.0		130	2900	234			1.79	203	0.063	1.7	0.47	164	
138-0SA71	1200	140	185	52.0	69.0	905	170	1900	194	29	100	2.7	306	0.11	3.2	0.47	208	150

Standard motors force-ventilated (600 V DC link voltage)

Voltage [V]	Frequency [Hz]	Power consumption [W]	Current drain [A]
Y 380	50	160	0.29
Y 380	60	225	0.36

Radial fan for 1FT5 servomotors

1) *Does not include the tachogenerator and rotor position encoder system; refer to Sec. 2.3, 2.5.2, and 2.5.3*

2.1.4.3 Short motors

An explanation of the terms used in the tables is give in Section 2.7.

Servo-motor 1FT5	Rated speed n_{rated} [RPM]	Standstill torque M_0 ΔT=60K [Nm]	Standstill torque M_0 ΔT=100K [Nm]	Phase current at M_0 I_0 ΔT=60K [A]	Phase current at M_0 I_0 ΔT=100K [A]	Moment of inertia 1) J_{mot} [10^{-4} kgm²]	Rated torque (S1) ΔT=100K M_{rated} [Nm]	Max. speed n_{max} [RPM]	Peak current I_{max} [A]	Time constant electr. T_{el} [ms]	Time constant therm. T_{th} [min]	Torque constant K_T [Nm/A]	Voltage constant (phase to phase) K_E [V/1000 RPM]	Wind. resistance R [Ω]	Wind. inductance L_A [mH]	Brake resistance $R_{a\,opt}$ [Ω]	Brake. torque $M_{B\,opt}$ [Nm]	Weight w/o hold.brake m [kg]
070-0AC71	2000	3	3.5	1.8	2.1	9.0	3.1	3000	8.0	5.3	25	1.72	195	16.35	85.2	0	2.6	7.5
-0AF71	3000			2.6	3.1		3.0	4600	12.0			1.15	130	7.86	39.1	0	2.6	
-0AG71	4000			3.6	4.2		2.8	6300	17.6			0.84	95	4.25	22.5	10	2.8	
-0AK71	6000			5.3	6.2		2.1	7000	26.0			0.57	65	2.1	11.0	8.2	2.6	
071-0AC71	2000	4.5	5.5	2.9	3.5	13	5.0	3300	13.0	6.8	30	1.59	180	6.44	43.8	0	4.4	8.5
-0AF71	3000			4.3	5.2		4.8	5000	21.0			1.06	120	2.9	18.9	0	4.4	
-0AG71	4000			5.2	6.4		4.4	6100	27.5			0.87	98	1.9	12.9	6.8	4.8	
-0AK71	6000			7.9	9.7		3.3	7000	41.0			0.57	65	0.73	5.0	3.9	5.7	
073-0AC71	2000	7	9	4.3	5.5	20	8.0	3200	21.0	8.5	35	1.64	186	3.06	25.7	4.7	7.9	10.5
-0AF71	3000			6.4	8.2		7.2	4800	32.0			1.10	124	1.35	11.4	3.9	8.6	
-0AG71	4000			8.1	10.5		6.5	6100	45.0			0.87	98	0.85	7.2	1.8	8.7	
-0AK71	6000			12.5	16.0		5.0	7000	66.5			0.57	65	0.32	2.7	1.2	10.6	
100-0AC71	2000	10	13	6.2	8.0	59	12.0	3200	32.0	11	35	1.63	185	1.4	15.7	3.3	14.0	15.5
-0AF71	3000			9.2	12.0		11.0	4800	47.0			1.09	123	0.62	7.0	2.7	14.2	
-0AG71	4000			12.5	16.0		9.5	6300	64.4			0.83	94	0.38	4.2	2.2	15.2	
-0AK71	6000			18.0	23.0		4.0	8000	96.0			0.57	65	0.18	2.0	1.8	14.3	
101-0AC71	2000	15	19	9.4	12.0	85	17.0	2700	46	14	40	1.61	182	0.71	9.4	2.2	21.4	19
-0AF71	3000			14.5	18.0		15.0	4200	66			1.06	120	0.33	4.2	1.5	22.4	
-0AG71	4000			17.5	22.5		12.0	6200	94			0.86	97	0.21	2.7	1.5	23.6	
-0AK71	6000			26.5	33.5		4.0	8000	141			0.57	65	0.09	1.2	1.0	23.9	
103-0AC71	2000	19	25	12.0	16.0	110	22.5	2700	62	17	45	1.60	181	0.47	6.5	1.5	29.1	22
-0AF71	3000			17.5	23.0		20.0	4200	93			1.10	124	0.2	3.0	1.2	27.9	
-0AG71	4000			23.0	30.0		12.0	6000	124			0.84	95	0.13	1.9	1.0	32.9	

Short motors (600 V DC link voltage)

1) *Does not include the rotor position encoder system: refer to Sections 2.3, 2.5.2, and 2.5.3*

2.2 1FT4 AC servomotors

2.2.1 Application

1FT4 motors are permanent-magnet motors for low outputs, which are especially designed for main spindle operation. They have the following special features differentiating them from1FT5 servomotors:

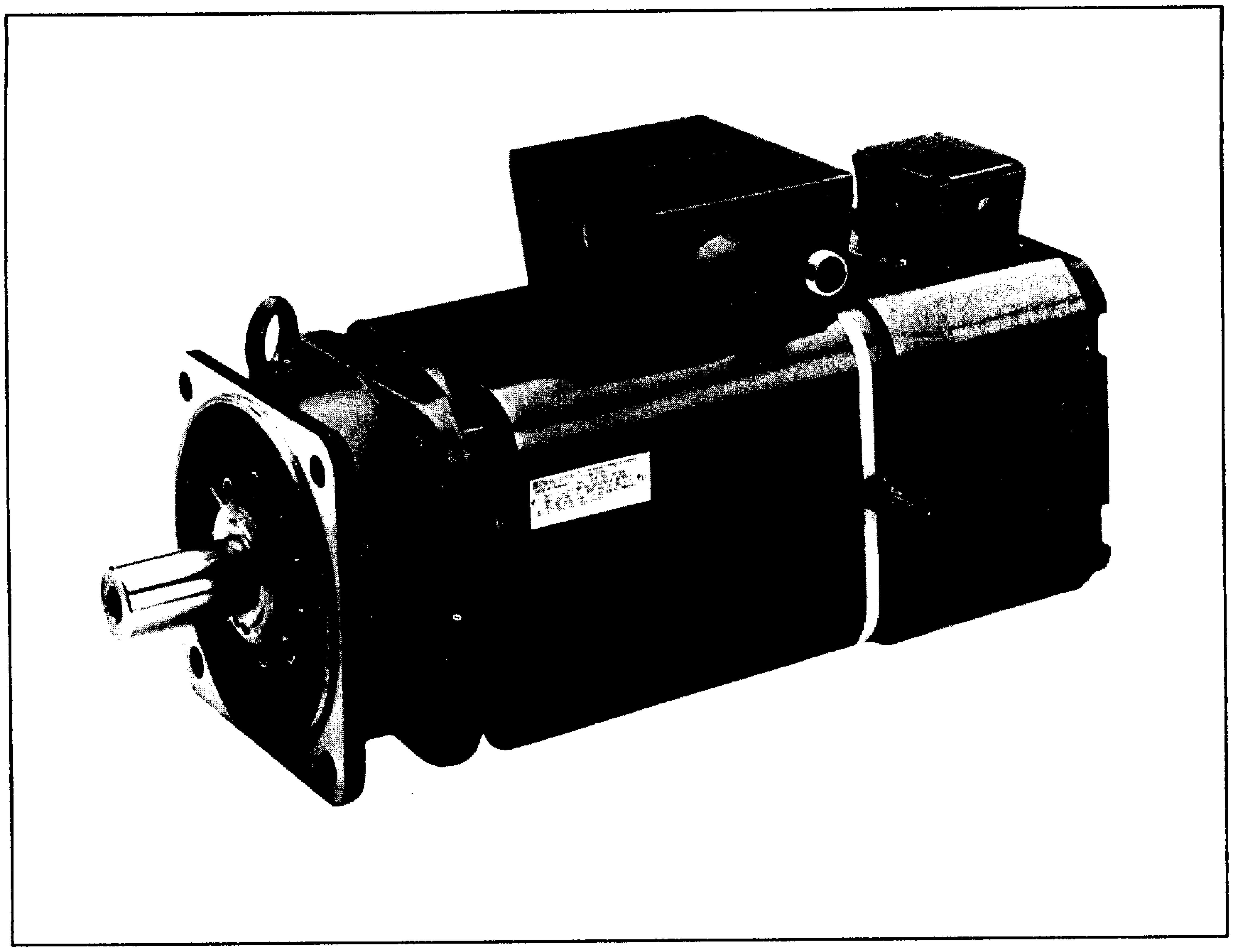
- Forced air cooling
- Strengthened shaft end (38 x 80 mm, compatible with 1PH61 motors)
- Optional double-bearing design for increased cantilever forces (option K20)
- Vibrational severity grade R. Vibrational severity grade S[1] is required for gearbox mounting (option K02).

1FT4 motors are available with shaft height 100. 1FT4 motors can be fed from SIMODRIVE 611 converters. Full main spindle operation is possible using the main spindle function option board.

They can be used as feed motors with higher torques. However, a holding brake cannot be incorporated. ROD 320 incremental shaft angle encoders or 6FC9320 pulse encoders are available as shaft angle encoders.

1) *The drive shaft end is 70 mm long for vibrational severity grade S.*

2.2.2 Design



1FT4 AC servomotor (6 pole)

1FT4 AC servomotors are permanent-magnet, brushless synchronous motors. The basic motor version consists of:

- active components,
- encoder system for sensing the motor speed and rotor position (tachogenerator system),
- temperature monitor (PTC thermistor) and
- separately driven fan

2.2.2.1 Tachogenerator system

A brushless three-phase tachogenerator system has been developed for low-maintenance AC feed drives. It consists of the three-phase tachogenerator and the shaft angle encoder, type 1FU1050.

Main features:

- High signal voltage quality
- High thermal stability
- Insensitive to noise interference

Trapezoidal voltage signals are available at the tachogenerator output for sensing the motor speed.

2.2.2.2 Temperature monitoring

PTC thermistors for temperature monitoring are installed as standard in the servomotors. SIMODRIVE 611 PWM converters are equipped as standard with a matched PTC evaluation circuit. The signal must be externally processed in the interface control. The connection is established through the rotor position encoder cable. Direct evaluation is also possible using the 3UN□□□ tripping unit. The 3UN6 unit has a visual indicating device and a mechanical restart lockout (Catalog NS2, Part 5).

Caution

The integrated temperature monitors protect the servomotors against overload under normal operating conditions. If, however, the servomotors are subject to brief overloads of more than 4 . I_0, then adequate protection is no longer provided and additional protective measures must be provided, e.g. a thermal overcurrent relay (refer to Section 2.11, Mounting instructions).

2.2.2.3 Bearings and motor shaft

The motor is fitted with a locating bearing at the drive end and with floating bearing at the non-drive end. Thermal rotor expansion therefore does not affect the drive end. The bearings are sealed on both ends using packing washers and are pre-lubricated and have a rated bearing life of 20,000 hours.

When mounted on a gear unit, the servomotor can also be equipped with rotary shaft seal according to DIN 3760 at the drive end to protect it against oil mist and spray.

Standard servomotors have a cylindrical shaft end to DIN 748 and fitted key with keyway to DIN 6885. The tachogenerator and shaft encoder are fitted on a taper at the non-drive shaft end.

The shaft end bearings are subject to higher radial stresses (cantilever forces) when pinion drives or toothed belts are used. The permissible cantilever force SF_Q is dependent on the shaft shoulder distance, the load application point and the average operating speed. The permissible cantilever forces are listed in the cantilever force diagrams, Section 2.9.

1FT4 motors can be optionally equipped with double-bearings if higher cantilever forces are present. Motors with double-bearing designs have a maximum speed of 6000 RPM. The maximum cantilever forces are specified in the diagrams, Section 2.9.

There are two different drive shaft end versions. All versions have a centering thread to DIN 332 Part 2.

Designation	Servomotor with cylindrical shaft end	Comments
Version a Standard version	With fitted key and keyway to DIN 6885 Tolerance zone k6[1]	Shaft connections with fitted key, keyed or multiple-spline connections are positive locking. The fit quality deteriorates under continuous stressing and varying torque. Rotationally symmetrical displacement increases torque oscillations reducing the smooth running quality. Increasing deformation can lead to fractures.
Version b Option K42	Without fitted key and keyway Tolerance zone k6[1]	With a frictional connection, the torque must be transmitted through surface pressure only. Reliable power transmission is guaranteed.

Drive shaft end versions for 1FT4 motors

Designation	Establishing and releasing friction-locked connections	
	Operations required	Comments
Shrink fitting	Thermal expansion and shrinking of drive elements onto the shaft. It is hardly possible to separate the connection without destroying the shaft surface.	Note internal stress characteristics of material and form and changes in diameter/pitch circle if necessary.

Friction-locked connections between motor shaft and drive pinion

- **Rotary shaft seal** (option)
  A rotary shaft seal is available for the drive-end bearing. The sealing ring lip runs on a shaft sleeve ground under minimal axial feed conditions according to DIN 3760. The running surface must be reliably lubricated in order to prevent excessive sealing ring wear. The rotary shaft seal is predominantly used on motors with flange-mounted gearboxes lubricated with oil or oil mist.

  The rotary shaft seal and sealing of the screw connection using VSIT washers increases the degree of protection of the drive-end shaft gland to IP67. The rotary shaft seal **cannot** be retrofitted.

1) Tolerance zones for shaft ends according to DIN ISO 286.

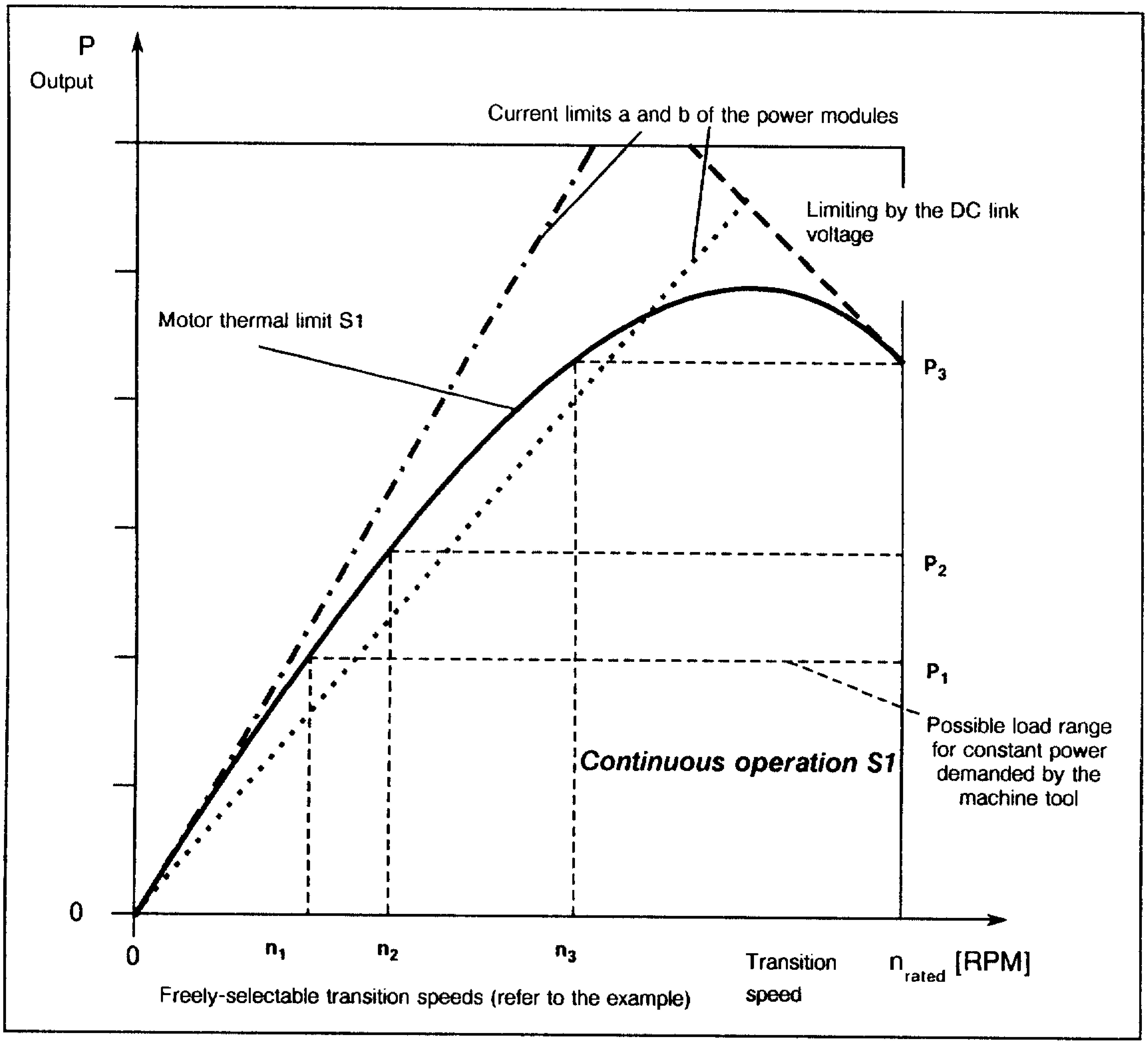
2.2.3 Mode of operation of 1FT4 servomotors

The AC servomotors provide an almost constant continuous torque and overload capability over the complete speed range. Characteristic S1 defines the thermal limiting characteristic of the motor. Points above this curve can only be operated in the S3 range. Straight lines a and b, going through the origin, define the current limiting, and thus the thermal limit of various power components of the transistor PWM converter system.

The possible drive rating is specified by the lowest value of the limits, i.e. the drive can be operated at each speed/power point below the limiting curves.

- Motor thermal limits
- Power module thermal limits
- Limiting voltage curve

The drive can operate at each point below these power gradients, assuming that no other limits respond, i.e. operating points are reached which lie outside the power gradients of the constant power range specified by the user. The speed-dependent current limiting on the main spindle option board can be used to prevent this.



Power-speed characteristics of 1FT4 AC servomotors

The output (S1 duty/100 K) is normally specified at a specific transition speed. If the particular application requires a lower transition speed, the output is correspondingly reduced, i.e. the possible output (S1 duty/100 K) at the transition point must be reduced in the same ratio as the speeds.

Example: Output P_{1000} at a transition speed $n_{transition} = 1000$ RPM, and the speed range are required.

Motor 1FT4104-OSK21 is selected with a maximum speed $n_{max} = 6000$ RPM, $P_{3000} = 13.5$ kW at $n_{transition} = 3000$ RPM. The speed range at constant power is 1:2.

Solution: $$P_{1000} = \frac{13{,}5 \text{ kW} \cdot 1000 \text{ RPM}}{3000 \text{ RPM}} = 4.5 \text{ kW}$$

The speed range at constant power is 1:6.

2.2.4 Technical data

2.2.4.1 General

The AC servomotors comply with the DIN standards and VDE specifications, in particular VDE 0530 and DIN 57530, specifications for rotating electrical machines.

Motor voltage Motor frequency Number of poles	0 V to 480 V[1] 0 Hz to 400 Hz 2p = 6
Types of construction	IM B5 to DIN 42950 (standard); IM V1; IM V3 (IEC34-7)
Coolant temperature Cooling Insulation	up to +40 °C Forced cooling DURIGNIT® 2000 corresponding to insulation class F for a maximum temperature rise ΔT = 100 K at a cooling medium temperature of 40 °C acc. to VDE 0530.
Degree of protection	IP54 acc. to DIN IEC34-5 (VDE 0530 Part S)
Motor noise	up to 70 dB(A) under load; dependent on the frame size
Short-circuit capability	Short-circuit currents of 4 · I_0 can occur with a 3-phase short-circuit. Irreversible de-magnetization does not occur. Peak currents I_{max}, specified in Section 2.2.4.2, must not be exceeded.
Vibration severity grade Shock loading Cantilever forces	R acc. to DIN ISO 2373, optionally S 6 g; function is not impaired during shock stressing. Refer to the diagrams in Section 2.9 for permissible shaft cantilever forces
Paint finish	Anthracite (SN30901-614) with dark green ring on the non-drive end (SN30901-615); climatic stressing is dry to moderately damp for indoor installation.

Technical data of 1FT4 AC servomotors

1) *Adapted to the 600 V DC link voltage*

2.2.4.2 Motor-specific data

Servo-motor 1FT4	Rated speed n_{rated} [RPM]	Standstill torque M_0		Phase current at M_0 I_0		Moment of inertia J_{mot} [10^{-4} kgm²]	Rated torque (S1) ΔT=100K M_{rated} [Nm]	Max. speed n_{max} [RPM]	Peak current I_{max} [A]	Time constant		Torque constant K_T [Nm/A]	Voltage constant (phase to phase) K_E [V/1000 RPM]	Wind. resistance R [Ω]	Wind. inductance L_A [mH]	Ext. brake resistance $R_{a\,opt}$ [Ω]	Brake. torque $M_{B\,opt}$ [Nm]	Weight w/o hold. brake m [kg]
		ΔT=60K [Nm]	ΔT=100K [Nm]	ΔT=60K [A]	ΔT=100K [A]					electr. T_{el} [ms]	therm. T_{th} [min]							
101-0SK71	6000	20	25	33	40	90	17	8000	160	14	25	0.62	74	0.122	1.15	1	32	27
0SN71	8000	20	25	39	48	90	10	9000	190	14	25	0.52	62	0.085	0.8	1	33	27
102-0SG71	4000	33	40	35	42	138	32	5200	170	16	30	0.95	113	0.133	2.24	1.2	39	37
0SK71	6000	33	40	47	57	138	27	7000	230	16	30	0.70	82	0.70	1.18	1	39	37
104-0SG71	4000	45	55	46	56	182	42	5200	220	18	35	0.98	114	0.084	1.4	0.82	63	46
0SK71	6000	45	--	60	--	182	35	7000	300	18	35	0.73	86	0.047	0.8	0.68	63	46
106-0SG71	4000	--	70	--	66.7	242	53	5000	260	19	40	1.05	119	0.1	1.2	0.68	80	55

1FT4 AC servomotors (600 V DC link voltage)

Servo-motor 1FT4	Transition speed n_E [RPM]	S1 rating at n_E P_E [kW]	S6 rating		Current at P_E I_E [A]
			60% at n_E P_{E60} [kW]	25% at n_E P_{E25} [kW]	
101-0SK71	3000	7.0	8.7	10.5	36
0SN71	3000	7.0	8.7	--	43
102-0SG71	3000	11.0	13.7	16.5	37
0SK71	3000	11.0	--	--	50
104-0SG71	3000	15.0	--	--	49
0SK71	3000	--	--	--	60
106-0SG71	3000	18.1	--	--	55

1FT4 AC servomotors (600 V DC link voltage)

Voltage [V]	Frequency [Hz]	Power consumption [W]	Current drain [A]
Y 380	50	160	0.29
Y 380	60	225	0.36

Radial fans for 1FT4 AC servomotors

2.3 Technical data of tachogenerator systems for 1FT5 and 1FT4 motors

Technical data	**1FU1030**	**1FU1050**
Speed (mechanical critical speed)	8000 RPM	8000 RPM
Number of poles	2p = 6	2p = 6
Magnet material	$SmCo_5$	AlNiCo
Peak value of the phase voltage at rated speed	[1]	40 V
Voltage tolerance	+ 15 –5 %	± 8 %
Voltage adjustment[2]	± 20 %	± 20 %
Ripple factor	≤ 1.0 %	≤ 0.5 %
Linearity error	≤ 0.2 %	≤ 0.2 %
Reversing error	≤ 0.2 %	≤ 0.2 %
Tachogenerator moment of inertia [x 10^{-4} kgm^2]	0.14	1.2

Technical data: Tachogenerator system

Type designation of the tachogenerator system:

1 F U 1 0 . 0 - 6 . .

Frame size
3 = for 1FT502. to 1FT504. servomotors
5 = for 1FT506. to 1FT513 and 1FT410 servomotors

Number of poles

Cable length [3]
G = Used in 1FT5072 to 1FT5138 and 1FT410
H = Used in 1FT5062 to 1FT5073

Armature
A = 1200 RPM (not for 1FU1030)
C = 2000 RPM
F = 3000 RPM
G = 4000 RPM (not for 1FU1030)
H = 4500 RPM (only for 1FU1030)
K = 6000 RPM
N = 8000 RPM

2.4 Temperature monitors

Type	Q63100-P426-M135 (characteristic DIN 44081)
Resistance when cold	< 250 Ω
Response temperature	155 °C ± 5 °C

Technical data: PTC thermistor

1) *Armature circuit C/F: 11 V/16.5 V; armature circuit H/K: 30 V/40 V*
2) *In the SIMODRIVE 611 PWM converter*
3) *Only coupled to the special motor type for 1FU1050*

2.5 Options

Servo-motor	Holding brake[1]	Encoder systems[2]			
		Pulse encod.[4] ROD426	Pulse encoder ROD320	Abs. shaft angle encoder[3]	
				AG-661-21...26	Tensioning band flange⌀95mm[5]
Standard motors					
1FT503 □	EBD 0,1 B	x		x[6]	
1FT504 □	EBD 0,2 B	x		x[6]	
1FT506 □	EBD 0,8 M/[7] EBD 1,6 S	x	o	x	x
1FT507 □	EBD 2 M/[7] EBD 2 B	x	o	x	x
1FT510 □	EBD 4 M	x	o	x	x
1FT513 □	EBD 8 MF	x	o	x	x
Short motors					
1FT507 □	EBD 0,4 B	x	o	x	x
1FT510 □	EBD 2,2 B	x	o	x	x

AC servomotor options

o = can be built-in
x = can be built-on

	CAUTION
⚠	Motors cannot be subject to axial forces if they have an integrated holding brake!

1) *Installed in the drive-end bearing shield.*
2) *Only one encoder system can be installed or mounted*
3) *With this option, the motors are prepared for mounting the specified encoder*
4) *Flange- and shaft-compatible absolute shaft angle encoders can also be mounted.*
5) *AG-100 M/SS/Stegmann; ROC 221 S/240113 Heidenhain; CE 120 M/04-700-060 T&R*
6) *On request*
7) *Equipped as standard, with option G45.*

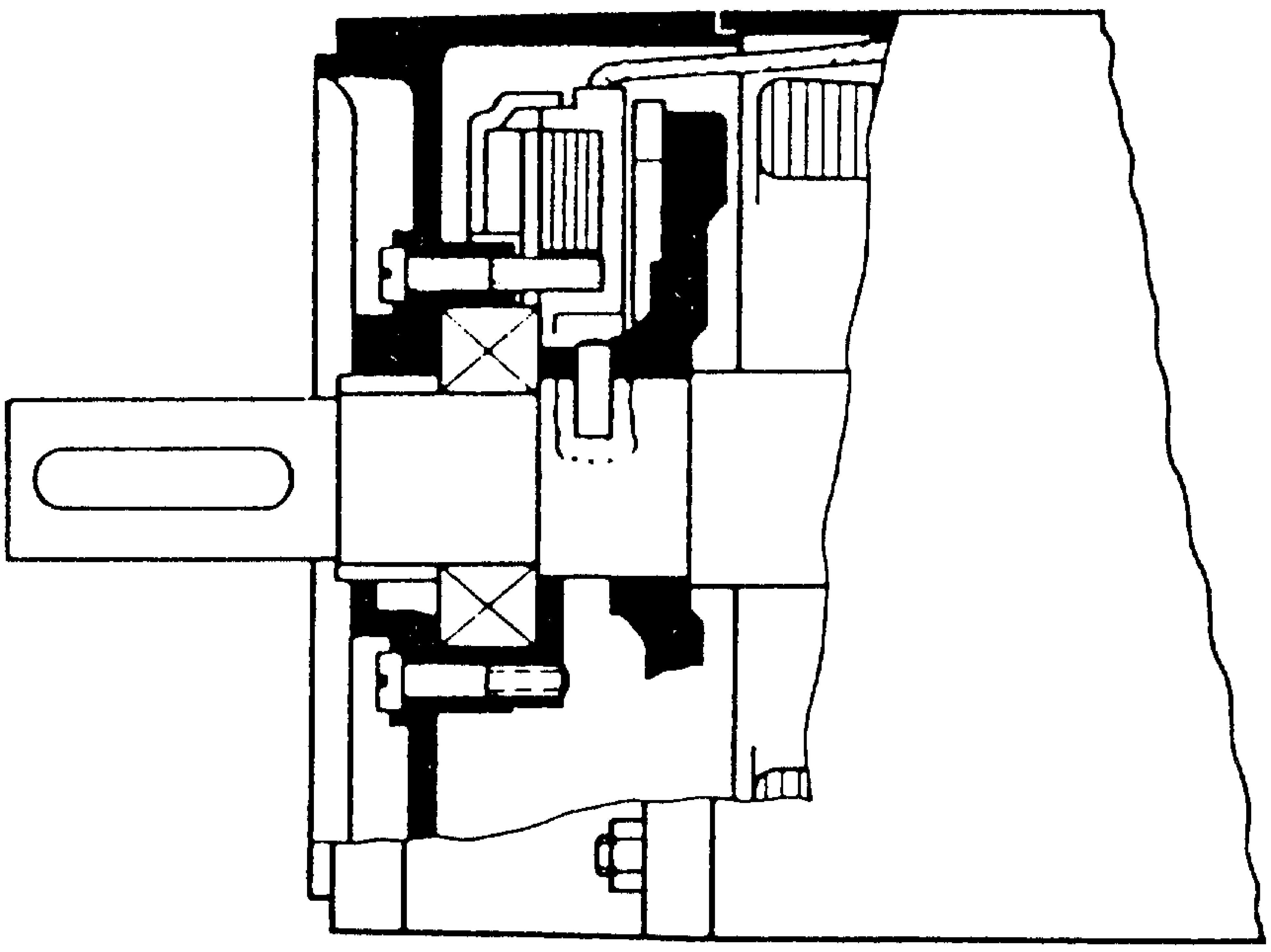
2.5.1 Holding brake

Holding brakes cannot be installed in 1FT4 motors.

The servomotors can be equipped with a holding brake to hold the feed axis stationary, free of backlash at standstill or when the system is de-energized (no-voltage condition). The specially developed permanent magnet single-disk brake operates according to the closed-circuit principle and is thus fail-safe.

The permanent magnet exerts a pulling force on the armature disk of the brake, i.e. the holding brake is applied when de-energized, and the feed axis is thus locked in position. When 24 V DC is connected to the holding brake, an opposing field is established in the coil which counteracts the permanent magnet effect and releases the holding brake. The brake must be connected so that it is electrically energized, i.e. mechanically released, when the servomotor runs.

The short overall brake length permits it to be installed in the drive-end bearing shield without any motor housing extension. There is no residual torque when the brake is released; when it is applied, the feed axis is locked reliably with no backlash.



1FT5 AC servomotor with holding brake: Sectional view

The holding brake is not an operating brake. Approx. 2000 braking operations can be executed for "emergency STOP" or in the case of power failures without excessive brake armature disk wear.

Connecting-up the holding brake

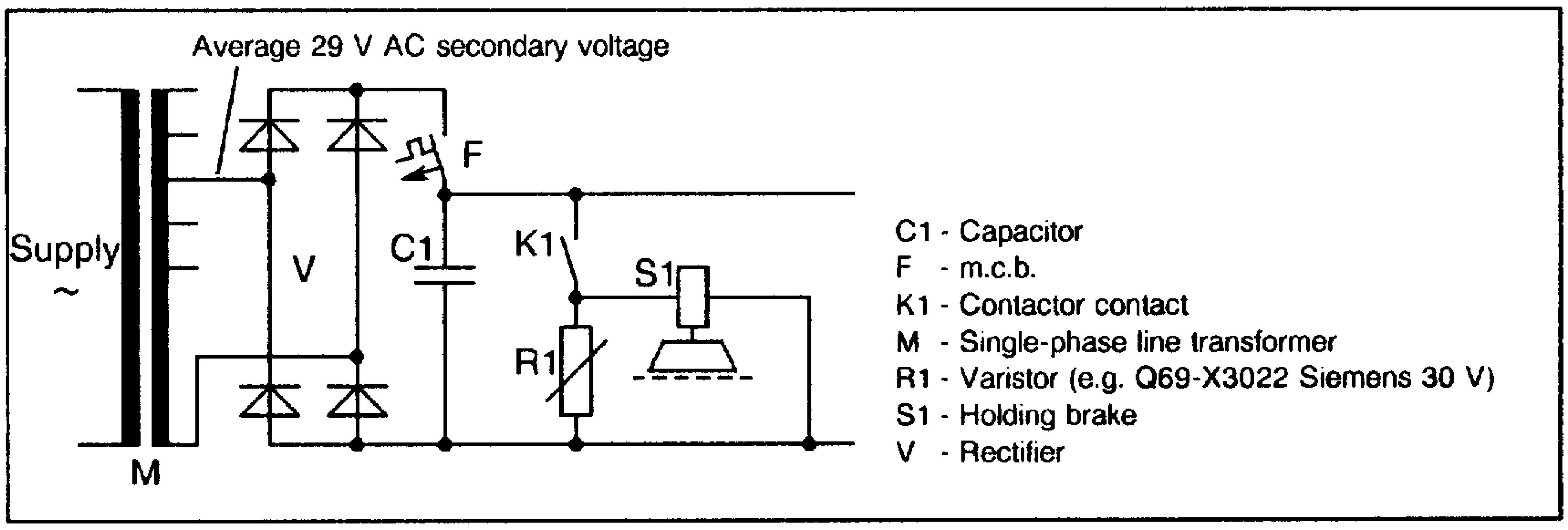
24 V DC ± 10 % must be available at the holding brake terminals for it to operate satisfactorily.

The brake can be connected to a central DC power supply, which, for example, is used to supply a number of solonoid valves, provided that the voltage fluctuations do not **exceed** the specified tolerances. A separate power supply must be used if these voltage tolerances are exceeded.

The brake should be fitted with a free-wheeling diode or matched varistor to prevent overvoltage spikes at switch-off which would create an electrically noisy environment.

It is advisable to fit a 220 µF/60 V capacitor when a Graetz bridge (rectifier bridge) is used in order to prevent noise caused by pulsating currents when the brake has been released. Depending on the connected load, the voltage is increased by the capacitor, so that it is not possible to exactly specify the transformer secondary voltage. It is advantageous to have approximately fives taps on the transformer secondary, in steps of approximatey 2 V, assuming that the average secondary voltage is 29 V AC.

When SIMODRIVE power cables are used, the brake can be fed through as a functional extra-low voltage circuit without reliable isolation.



Recommended circuit for the external holding brake power supply

Technical data

Supply voltage 24 V DC ± 10 %

Holding brake	Holding brake torque		Dynamic torque at 120 °C	DC current	Power consump-tion at 20 °C	Release time (power on)	Closing time (power off)	Brake inertia
	at 20 °C [Nm]	at 120 °C [Nm]	[Nm]	[A]	[W]	[ms]	[ms]	[10^{-4} kgm^2]
Standard motors								
EBD 0,1 B	1.2	1	0.75	0.4	8	6	5	0.07
EBD 0,2 B	2.0	1.5	1.3	0.45	10	9	7	0.38
EBD 0,8 M	10	7	3.5	0.75	18	35	15	1.06
EBD 1,6 S	16	15	12	0.83	20	35	15	1.1
EBD 2 M	33	12	10	1	23	50	20	7.5
EBD 2 B	28	23	13	1.1	21.3	64	30	7.5
EBD 4 M	100	70	40	1.5	34	70	30	25
EBD 8 MF	225	160	135	3.25	78	160	45	75
Short motors								
EBD 0,4 B	6.5	5	3.5	0.75	18	18	9	1.06
EBD 2,2 B	20	15	13	0.6	14	64	21	9.5

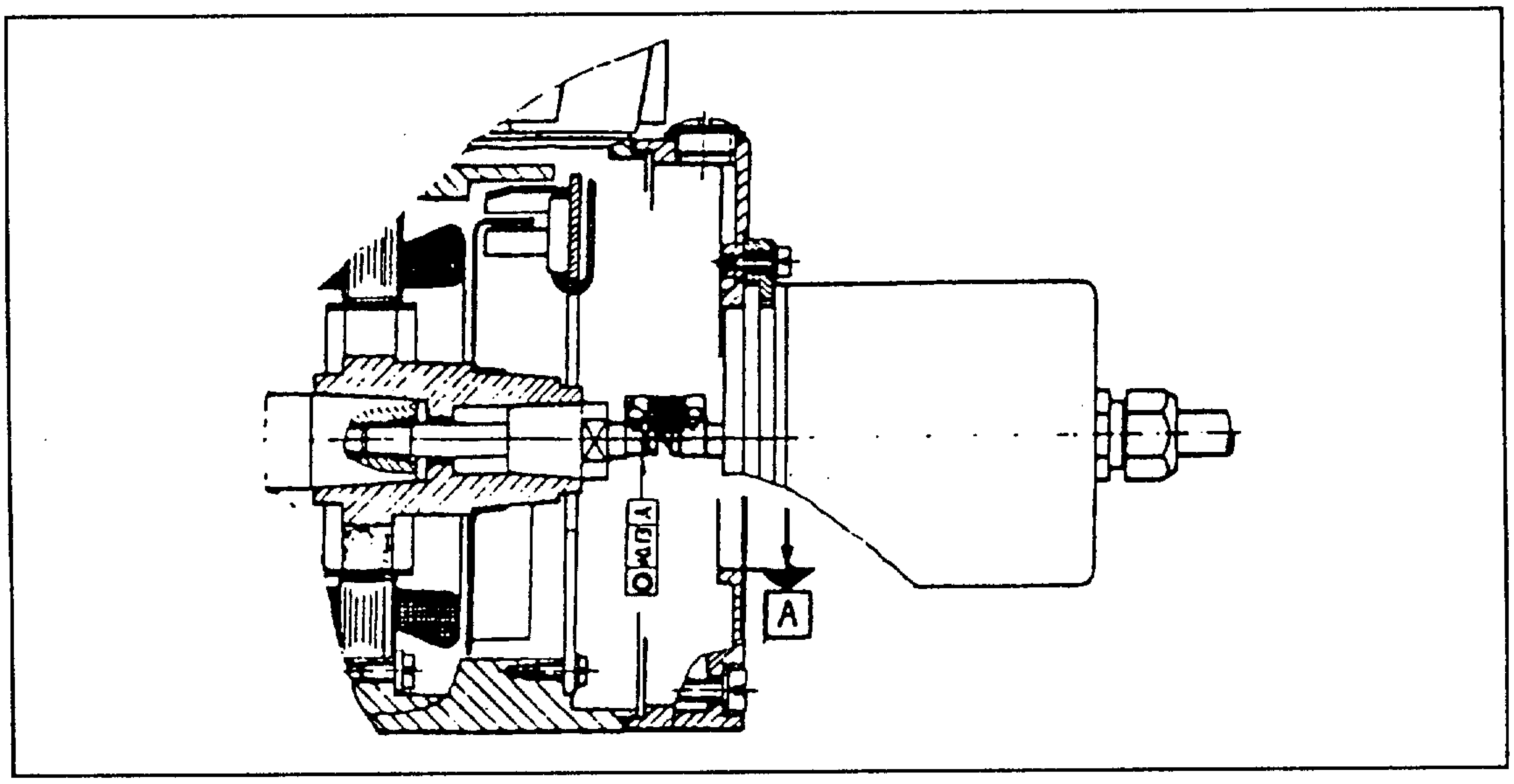
Technical data: Holding brakes for standard and short motors

2.5.2 ROD 426 pulse encoders

For 1FT4 motors, the version “prepared for encoder mounting” is not possible.

ROD 426 pulse encoders can be mounted for digital closed-loop position circuits.

ROD 426 pulse encoders can be supplied for different pulse numbers/revolution (Section 2.6).



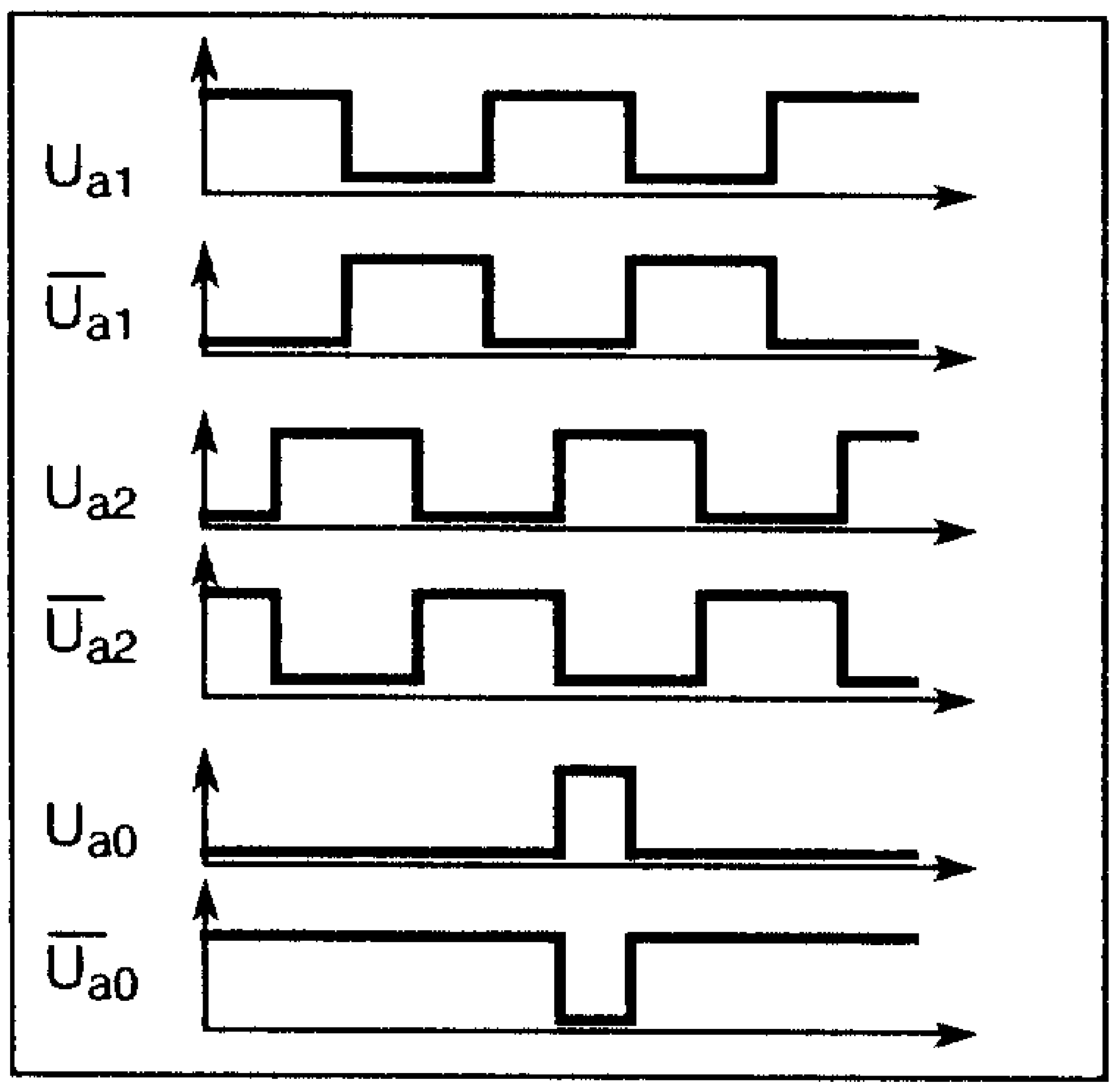
The 1FT5 servomotor with mounted ROD 426 pulse encoder

Technical data of the ROD 426 pulse encoder

Speed Operating voltage Current consumption Frequency range	Max. 12 000 RPM 5 V DC ±5 % (TTL) Typ. 170 mA max. 220 mA 0 kHz to 300 kHz
Signal level Phase angle between channels U_{a1} and U_{a2} Electrical resolution	TTL level; L≤0.45 V DC; H≥2.4 V DC 90° ±10° to 20 kHz 90° ±30° to 100 kHz 90° ±45° to 300 kHz Max. 5000 pulses/revolution (corresponds to the resolution of the pulse disk); up to 20,000 pulses/revolution with external multiplication circuit)
Degree of protection Operating temperature Storage temperature	DIN 406050-IP 65 (with the exception of the shaft gland) 0 °C to +70 °C –30 °C to +80 °C
Vibration resistance Shock resistance	100 m/s² (10 Hz/24 h to 200 Hz/24 h) acc. to DIN 40046 Fc test 300 m/s² (11 times) acc. to DIN 40046. Ea test
Moment of inertia of the mounted encoder including coupling and motor shaft	$0.0175 \cdot 10^{-4}$ kgm²
Encoder moment of inertia	$0.0145 \cdot 10^{-4}$ kgm²
Weight	0.45 kg

Output signals

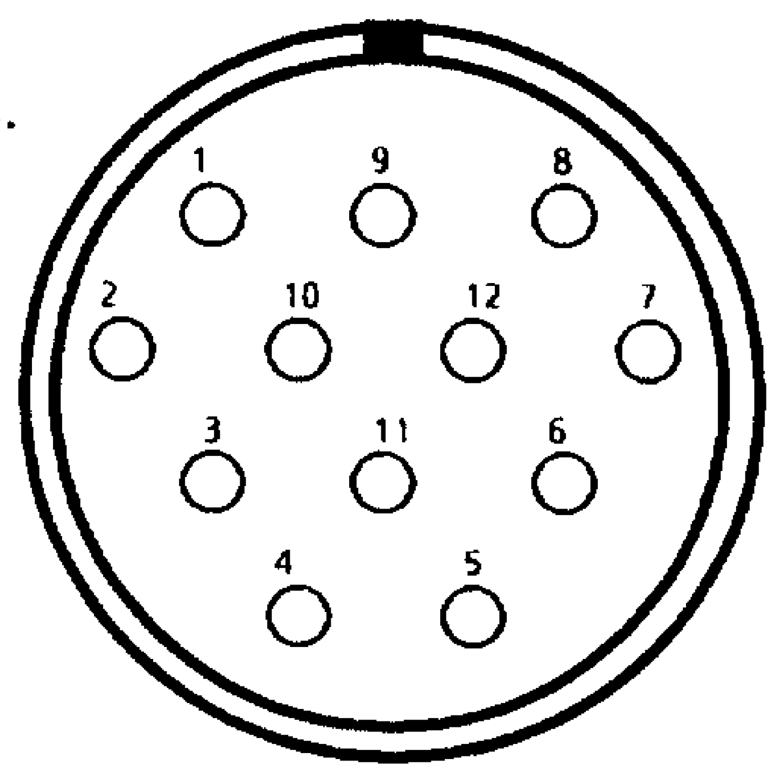
1:1 square-wave signal; 2 channels electrically offset by 90° and one zero pulse (once per revolution: length 90° electrical), inverted in each case. U_{a2} lags U_{a1} for clockwise direction of rotation (when viewing the shaft).



Connection

The encoders are supplied as standard with one free cable end. A 6FC9341-1FC coupler plug (pin complement[1]) is fitted at this end of the cable for connecting the encoder.

Pin No.	Signal
1	$\overline{U_{a2}}$
2	+5 V Sens.
3	U_{a0}
4	$\overline{U_{a0}}$
5	U_{a1}
6	$\overline{U_{a1}}$
7	-
8	U_{a2}
9	-
10	0 V
11	0 V Sens.
12	+5 V



View of the connector end (pins)

Mating connector

A round connector 6FC9341-1FD[2] with socket contacts must be used as the mating connector. This type of connector is designed for 10 mm cable diameters. In addition to connector types for other cable diameters, pre-assembled cables are also available as accessories (refer to the SINUMERIK and SIMATIC Catalogs).

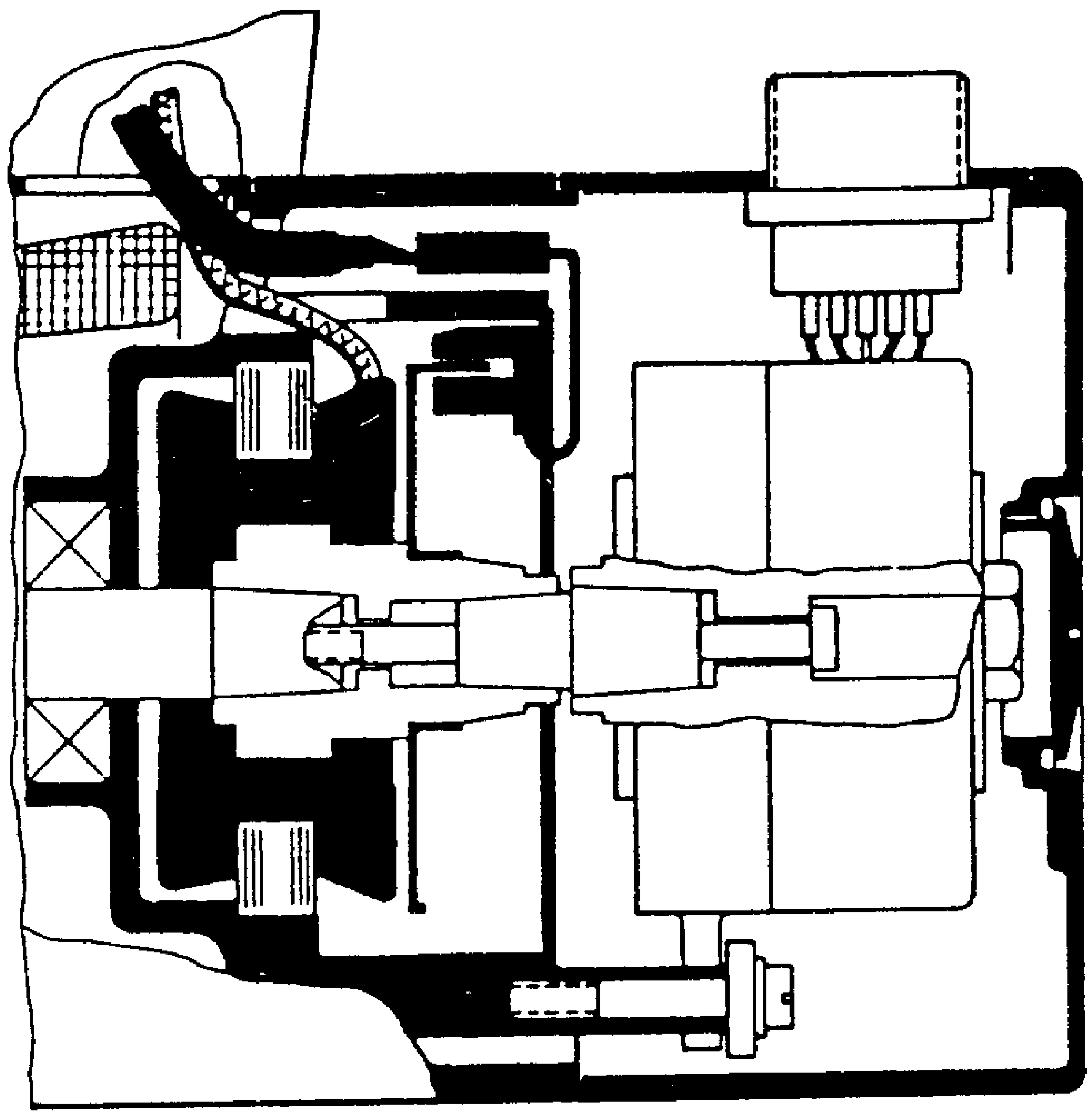
1) *In some cases, only the actually assigned pins are provided for these connectors.*

2) *Not included with the motor.*

2.5.3 ROD 320 pulse encoders

When ROD 320 pulse encoders are used, servomotors equipped with them can only be used with torques for $\Delta T = 60$ K temperature rise.

The ROD 320 pulse encoder can be used as built-in encoder for digital closed-loop position control circuits. ROD 320 pulse encoders are available for different pulse numbers/revolutions (Section 2.6).



1FT5 servomotor with built-in ROD 320 pulse encoder

Technical data of ROD 320 pulse encoders

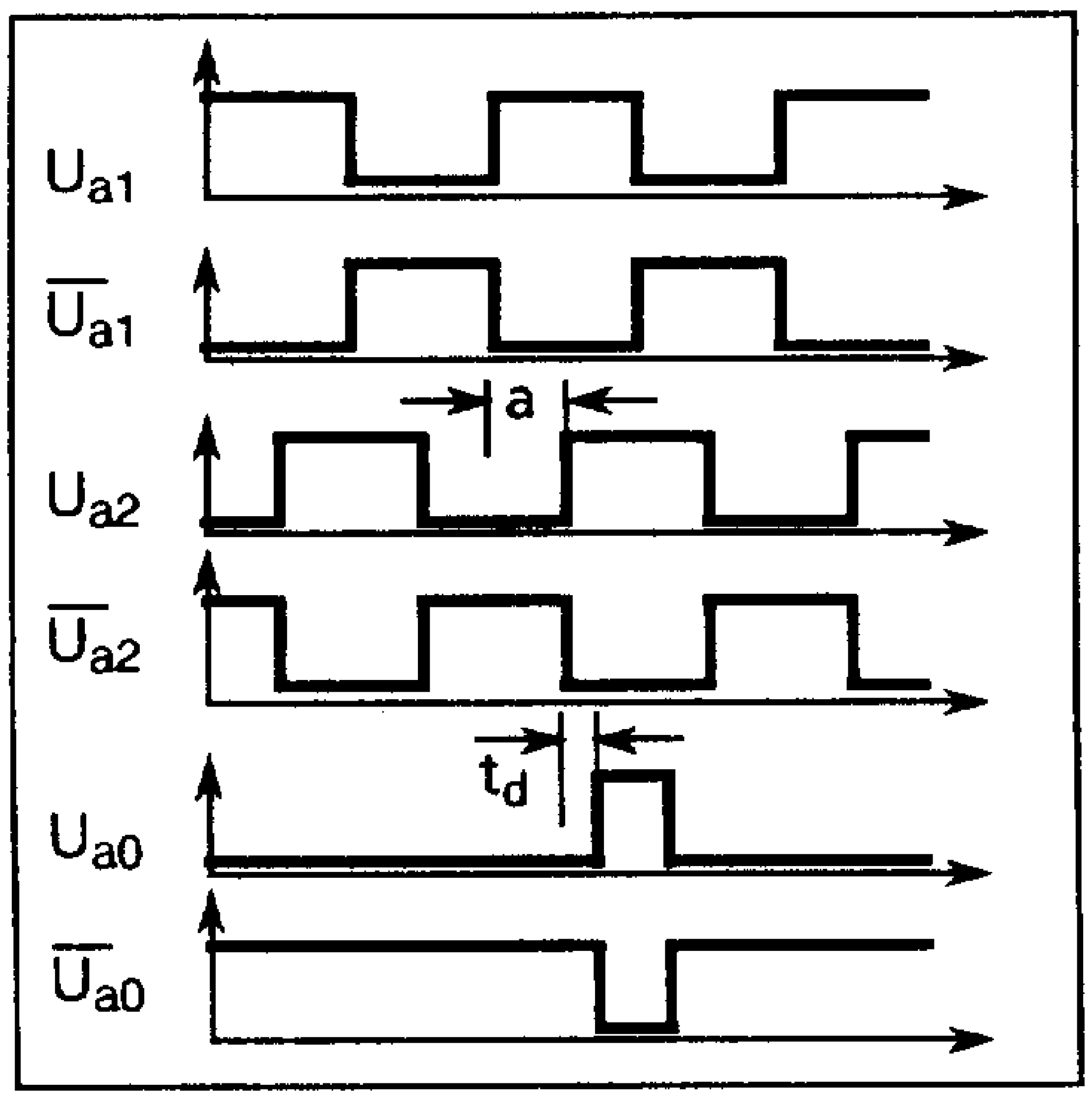
Speed (mech.)[2] Operating voltage Current consumption Frequency range	Max. 17 000 RPM with an average service life of approx. 10 000 hours 5 V DC ±5 % ≤170 mA (with no load) 0 kHz to 250 kHz
Edge distance (a) Output load capability	≥500 ns (signal U_{a0} is delayed with respect to signals U_{a1} and U_{a2} : $t_d \leq$ 50 ns) $I_{high} \leq$ 20 mA DC (at 100 °C) $I_{low} \leq$ 20 mA DC. $C_{load} \leq$ 1000 pF
Short-circuit resistance	All outputs briefly to 0 V; 1 output continuously at an ambient temperature ≤ 25 °C
Light source	5 V/0.6 W filament lamp; average lifetime, 40 000 hours
Operating temperature[1] Storage temperature	0 °C to +100 °C -30 °C to +100 °C
Moment of inertia including coupling to the motor (double taper connection)	$0.414 \cdot 10^{-4}$ kgm^2
Weight	0.7 kg

1) When using ROD 320 pulse encoders, servomotors equipped with the encoder, can only be utilized with a torque for ΔT= 60 K temperature rise.

2) The electrically permissible maximum speed is dependent on the encoder resolution. This is the quotient of the max. scanning frequency divided by the resolution (I/revolution) multiplied by 60 (RPM).
For a max. scanning frequency of 160 kHz for the ROD 320 encoder, an encoder resolution of 5000 pulses per revolution (also refer to Section 2.6, type designation) gives a maximum speed of
$n_{max} = (160 \cdot 10^3 \cdot 60)/5000 = 1920$ RPM.

Output signals

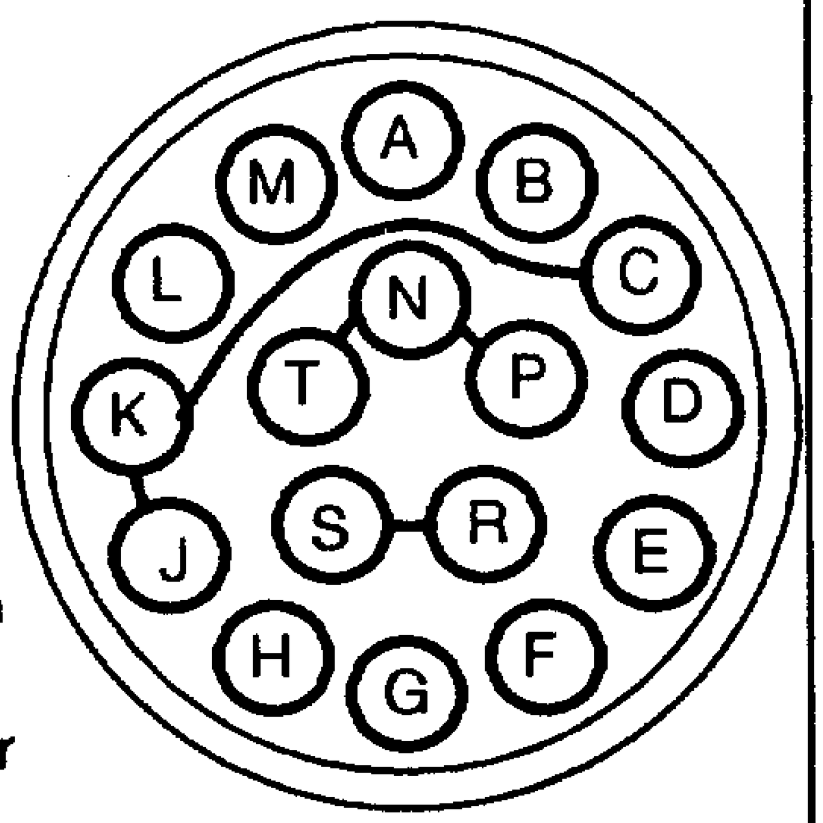
TTL-compatible; Square-wave pulse trains U_{a1} and U_{a2} as well as inverted signals. U_{a2} lags behind U_{a1} for clockwise direction of rotation (when viewing the shaft).



Connection

The encoder is connected via the flange socket CA 02 COM-E20-29P (pin contacts) on the outer motor housing.

Pin No.	Signal
A	U_{a1}
B	U_{a2}
C, J, K	+5 V
D	$\overline{U}_{a1}$
E	$\overline{U}_{a2}$
F	U_{a0}
G	$\overline{U}_{a0}$
H	Screen
N, P, T	0 V
R, S	Jumper



View of connector end (pins)

Mating connector (angled)

6FC9341-1AC (socket contacts)[1] (not watertight). Pre-assembled cables are also available as accessories (refer to the SINUMERIK and SIMATIC Catalogs). 6FC9348-7AV
(degree of protection IP67)

Cable length

Maximum cable length between the electronics with differential cable receiver at the input of the electronics is 50 m, whereby the specified power supply voltage at the ROD 320 must be maintained.

1) *Not included with the motor*

2.5.4 Absolute shaft angle encoder mounting

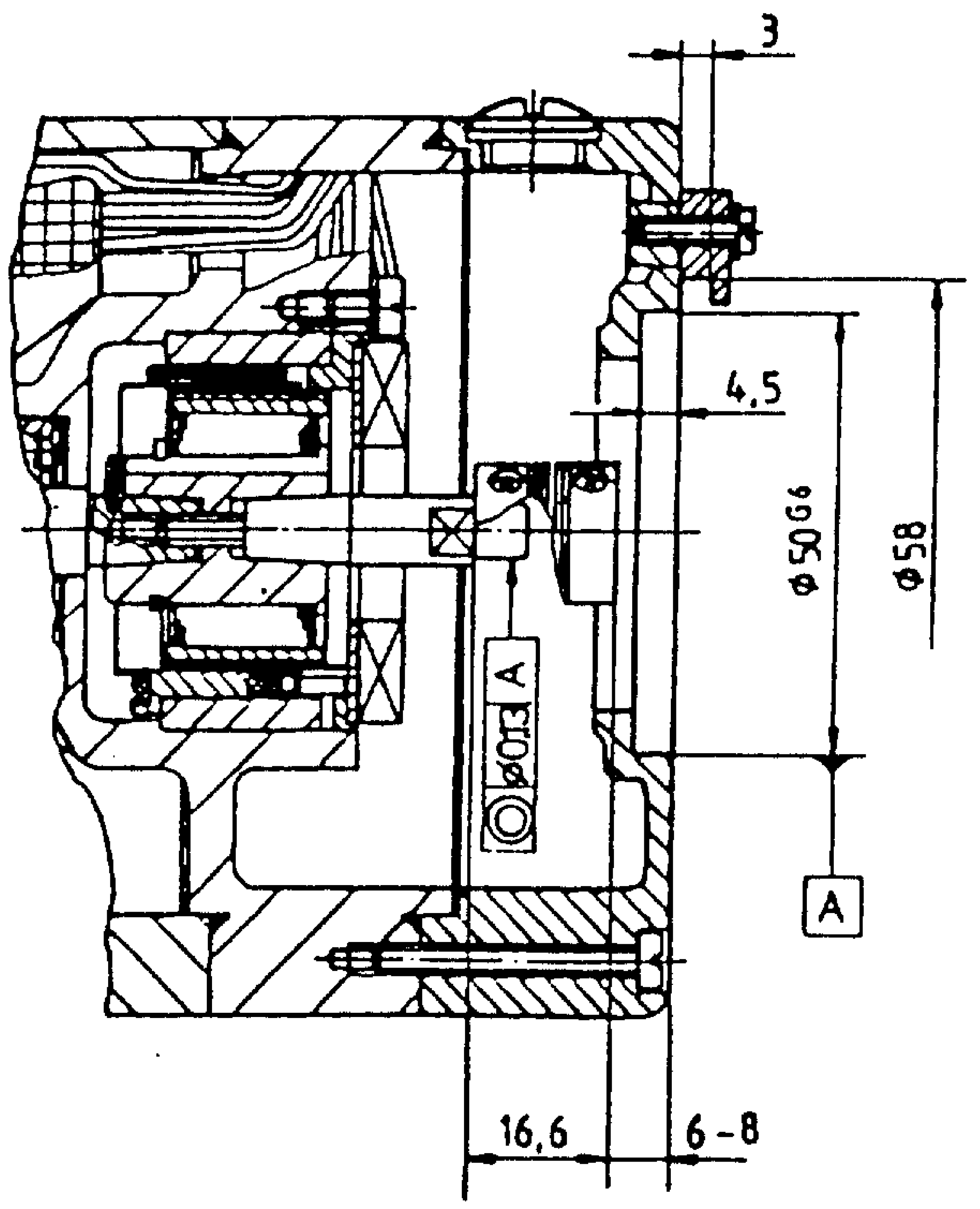
Absolute shaft angle encoders cannot be mounted on 1FT4 motors.

1FT5 servomotors are available with a flange prepared for mounting an absolute shaft angle encoder with limit switch, or an absolute shaft angle encoder.

2.5.4.1 Mounting absolute shaft angle encoders on the servo flange of the ROD 426-□□□ encoder on 1FT503□[1)] to 1FT513□ motors

Absolute shaft angle encoders, which have a standardized servoflange with 50 mm centering diameter and 6 mm shaft diameter, as is standard for pulse encoders, can be mounted on the adapter flange, according to Section 2.5.2. The version prepared for mounting can be ordered with the code Z = G51. The following information is required as plain text: "with spring-plate coupling"
The user can mount, for example, the following absolute shaft angle encoders:

AG661-21...24 Messrs. Stegmann
ROC 424 Messrs Heidenhain,
CE 65/04-418-031 Messrs T&R;
CR 58 Messrs TWK



Mounting absolute shaft angle encoders with standard pulse encoder flange on 1FT503□[1)] to 1FT513□ motors

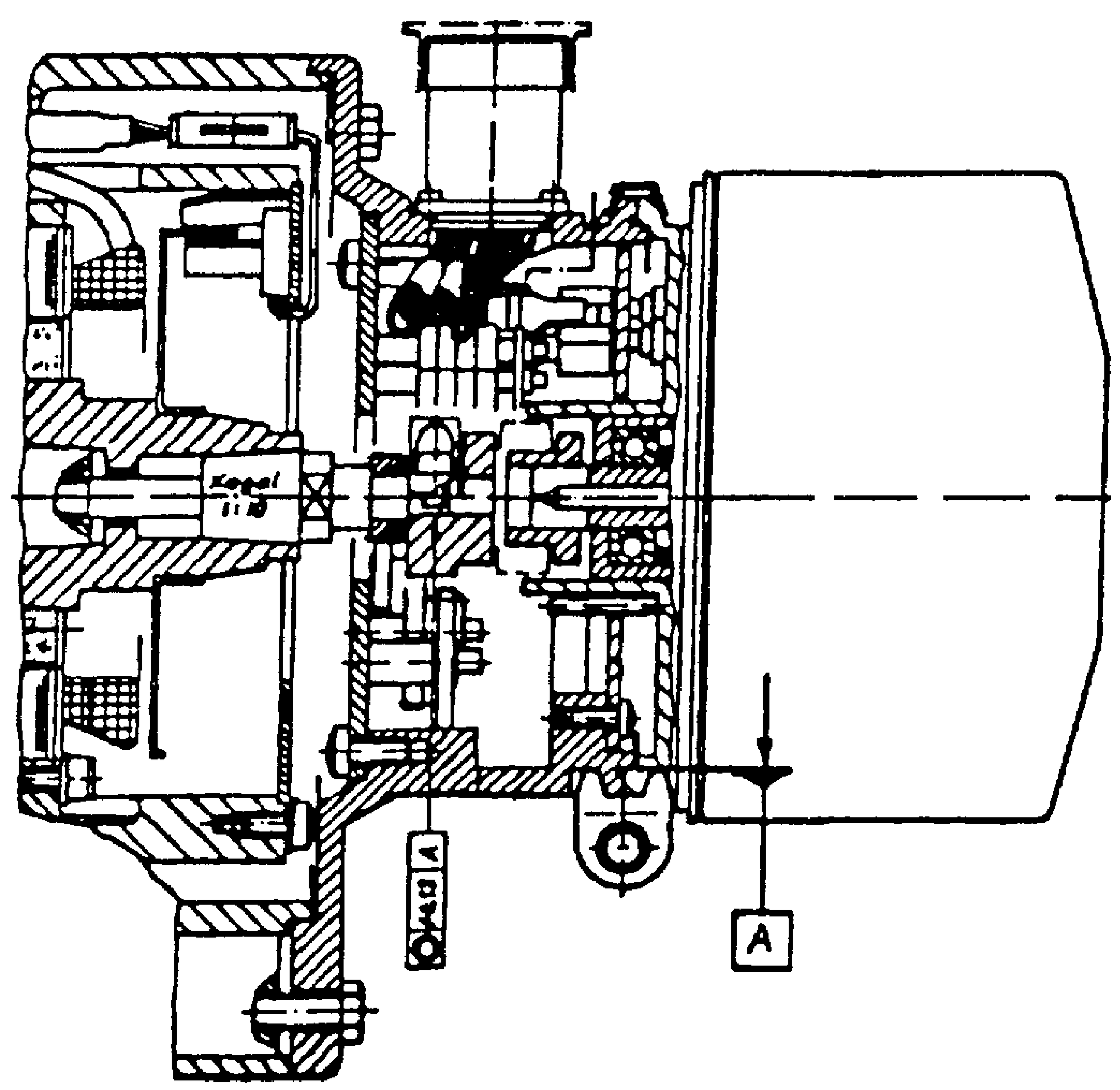
1) *for 1FT503□; 1FT504□ motors on request*

2.5.4.2 Absolute shaft angle encoders with profiled clamping clip

- **Flange for 1FT506☐ to 1FT513☐ motors for mounting encoders which are axially electrically connected**
  The prepared mounting includes the adapter flange with the profiled clamping clip centering. The wired connecting socket for the connector and connector for making contact with the adapter board[4] to connect the encoder, are accommodated in the adapter flange. The adapter flange can also accept a limit switch gear unit[1].

  The encoder is mounted to the motor adapter gearbox using the expanding shaft and through the profiled clamping flange. The following absolute shaft angle encoders, which are axially electrically connected, can be mounted on this flange:

  ROC 221S Messrs. Heidenhain[2];
  AG 100M/SSI Messrs. Stegmann;
  CE 102 M/04-700-900 Messrs. T&R[3]



Mounting absolute shaft angle encoders with profiled clamping clip with limit switch gear unit [1] on 1FT506☐ to 1FT513☐ motors

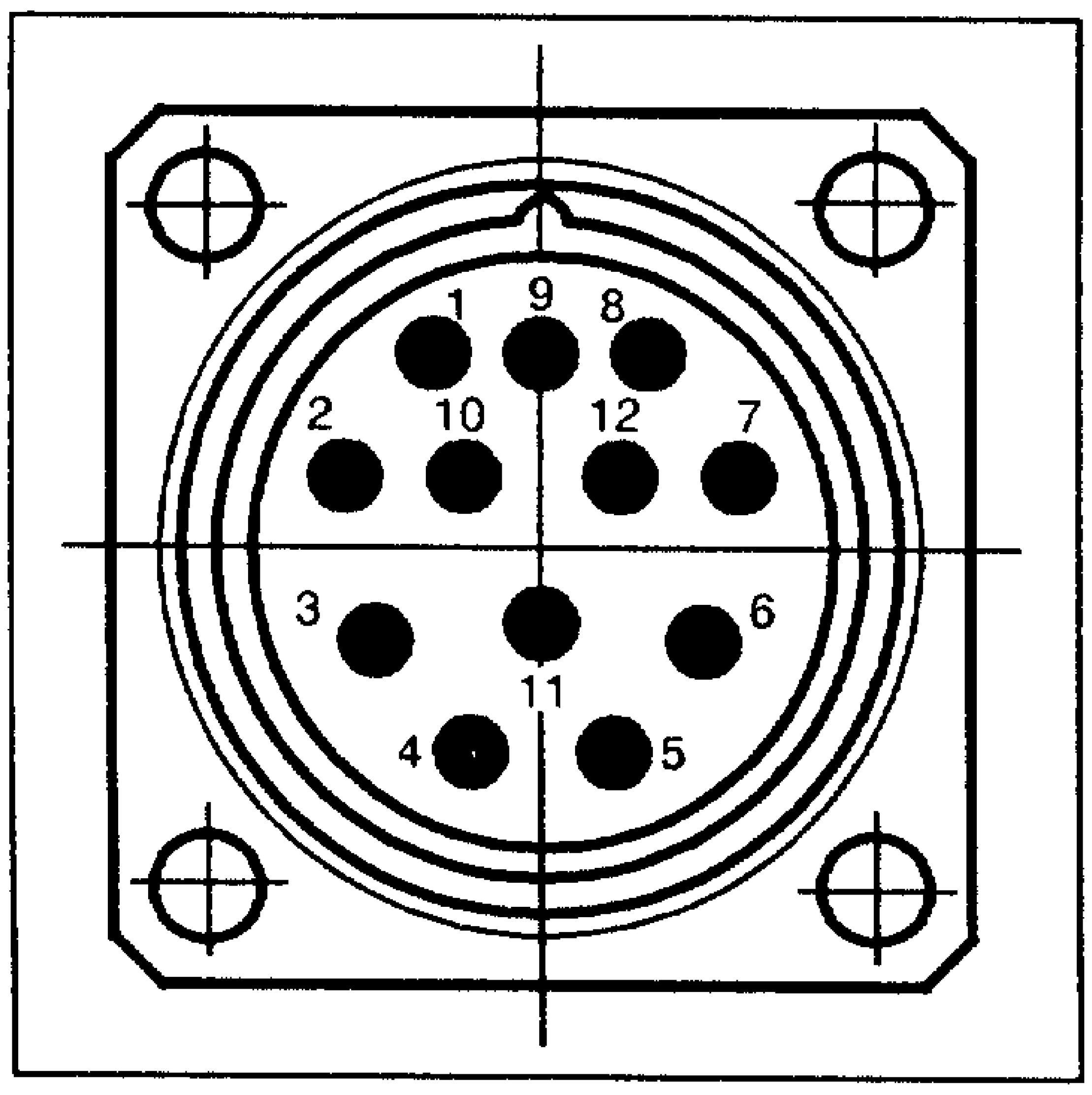
1) *e.g. 2E9026 limit switch gear unit, from Max Stegmann GmbH, Dürrheimer Str. 36, W-7710 Donaueschingen*
2) *.Dr.Johannes Heidenhain GmbH, Dr. Johannes Heidenhain-Straße 5, W-8225 Traunreut*
3) *.T&R Electronic GmbH, Eglishalde 6, W-7218 Trossingen*
4) *Is not included with the motor*

The encoder connector is also located on the adapter flange.

Pin assignment

Pin No.	Signal
1	(Encoder) GND, 0 V
2	Data +
3	Clock +
4	Switch 1 center [3]
5	Switch 1 NC contact[1][3]
6	Switch 1 NO contact[1][3]
7	Switch 2 center[1][3]
8	U_S (encoder)
9	Switch 2 NC contact[1][3]
10	Data –
11	Clock –
12	Switch 2 NO contact[1][3]

Flange-mounted connector with pin contacts



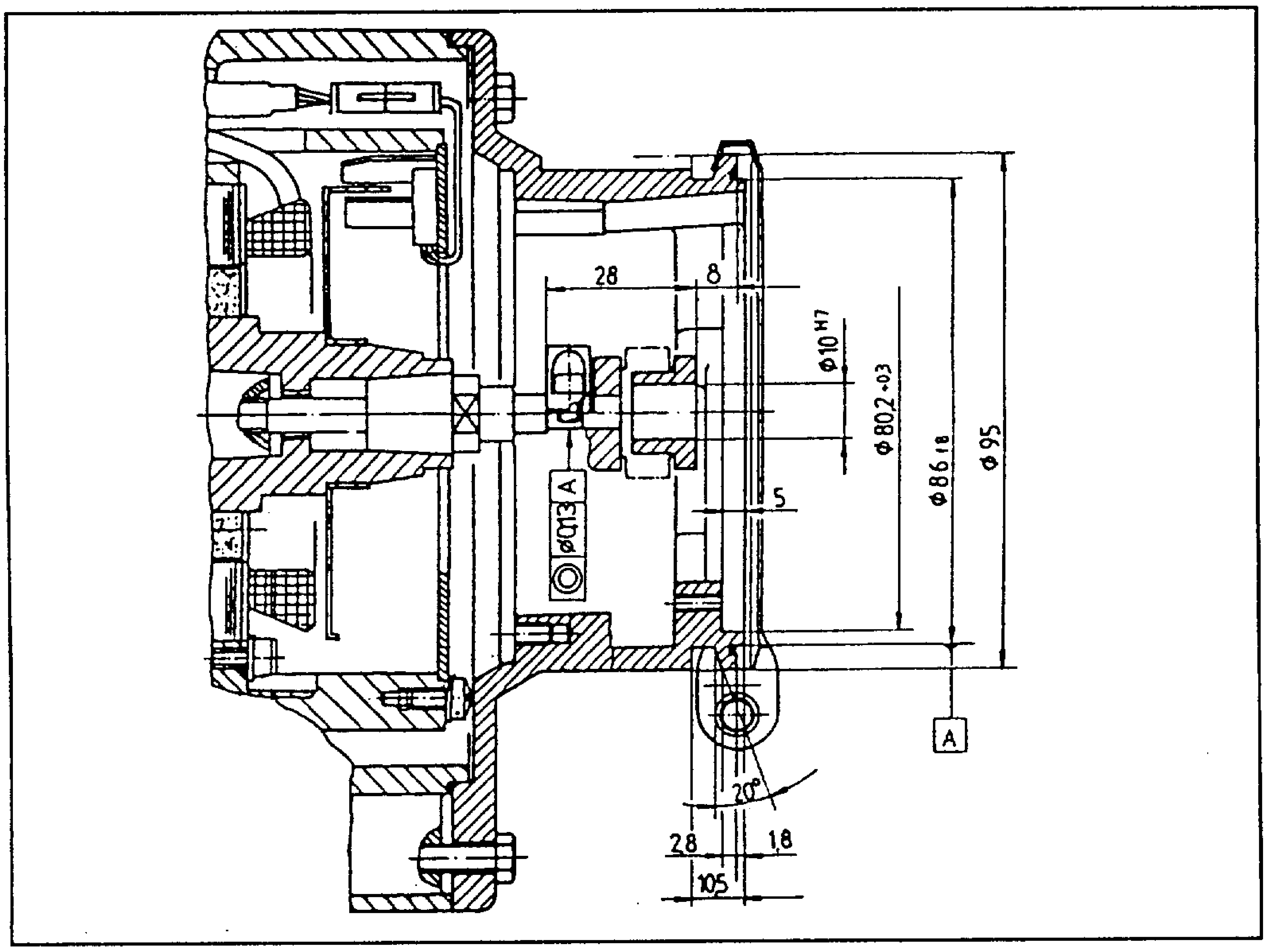
Mating connector, e.g. 6FC9341-1FD[2]

The adapter flange is prepared for accepting the contact PC board. The contact PC board[2] is used to axially establish the contact with the encoder and is included with the encoder.

The following are included when prepared for mounting:
- Adapter flange, tensioning band
- Adapter flange with coupling and expanding shaft adaption
- Flange socket with cable tree and connector to the contact PC board[2]

1) *e.g. 2E9026 limit switch gear unit, Max Stegmann GmbH, Dürrheimer Str. 36, W-7710 Donaueschingen*
2) *Not included with the motor prepared for mounting*
3) *Connecting points for the limit switch gear unit, detailed technical documentation from Messrs. Stegmann*

- **Flange for 1FT506☐ to 1FT513☐ motors for mounting standard modular encoder systems (option G54)**



Mounting standard absolute shaft angle encoders with profiled mounting flange on 1FT506☐ to 1FT513☐ motors.

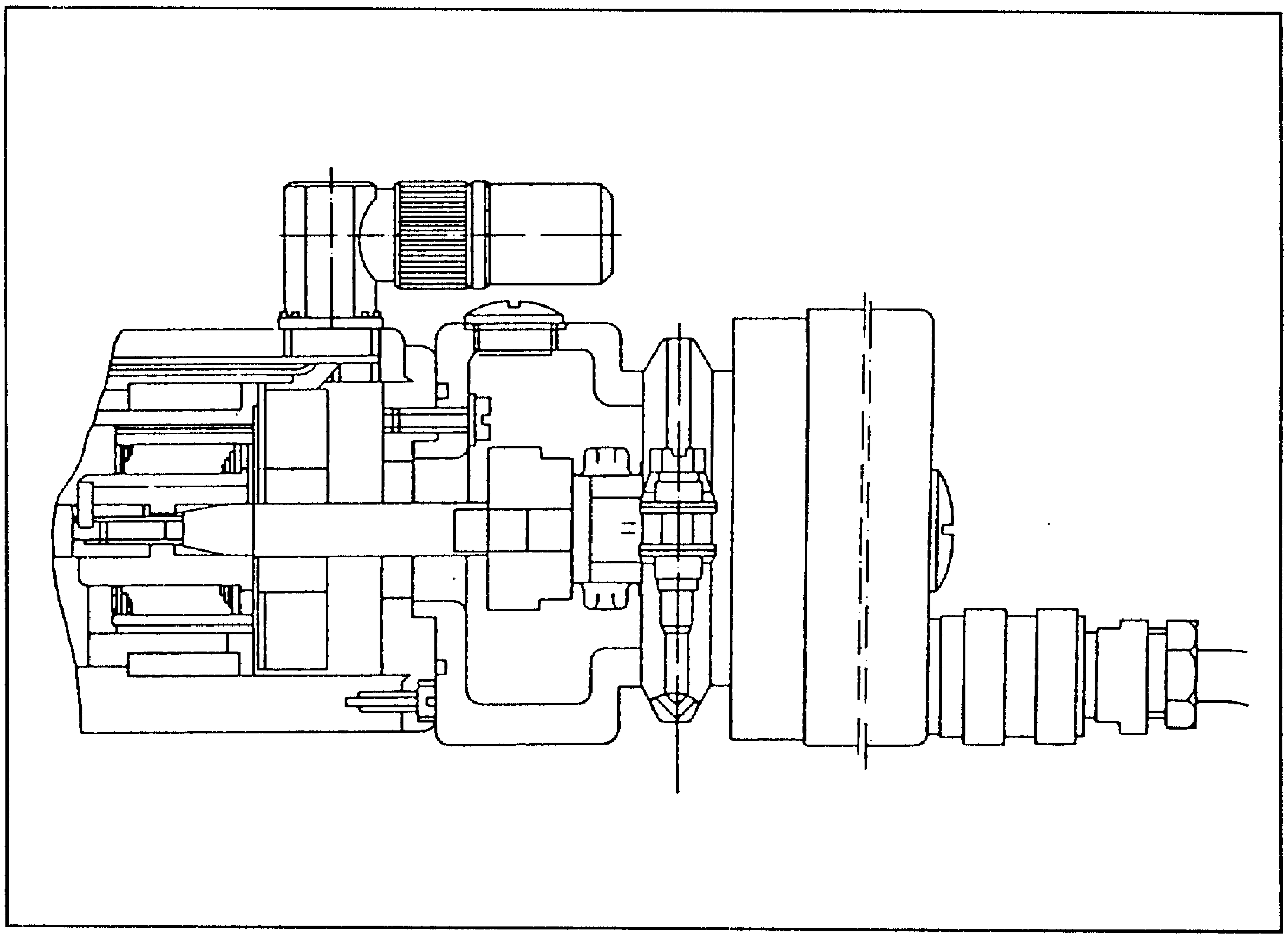
Standard encoders using modular system technology, which can be mounted on the profiled flange, can also be mounted on 1FT506☐ to 1FT513☐ motors, e.g.:

AG 101/4J1Y☐☐☐, Messrs. Stegmann;
CE 100M/04-732-017 Messrs. T&R.

Adapter flange, tensioning band and adapter shaft with coupling belong to the scope of supply.

- **Flange for 1FT503□ to 1FT504□ motors for using AG66[1] [2] [3] absolute shaft angle encoders (not for new designs)**

Mounted through an intermediate adapter with profiled clamping clip centering. The encoder is mounted on the motor using the expanding shaft and the profiled clamping clip. The connector is located on the encoder.



Mounting AG66[3] absolute shaft angle encoder with profiled clamping clip onto 1FT503□ to 1FT504□ motors

When using standard pulse encoder flanges (refer to Section 2.5.1), the absolute shaft angle encoders from the manufacturers specified below can be mounted (prepared for mounting, with code Z = G51) e.g. ROC 424 Messrs. Heidenhain[4]; CE 65/04-418-031 Messrs. T&R[5], CR 58 Messrs. TWK, AG661-21...26 Messrs. Stegmann

1) *Not included in the scope of supply.*
2) *Encoder system from Stegmann GmbH Dürrheimer Str. 36 W-7710 Donaueschingen*
3) *Tension band version will be discontinued; replacement type: AG661-21...26 (Messrs. Stegmann) also refer to Section 2.5.4.1*
4) *Dr. Johannes Heidenhain GmbH, Dr. Johannes-Heidenhain-Straße 5, W-8225 Traunreut*
5) *T&R Electronic GmbH, Eglishalde 6, W-7218 Trossingen*

2.5.5 Motor connection

For 1FT503□, 1FT504□ servomotors, only connection type 1 is available as standard (connector version)[1].

For all 1FT503□ to 1FT5013□ servomotors up to a rated motor current of 120 A (I_{RMS} = 98 A), connection type 1 is available as standard (connector version)[1][2]. Connection type 2 (terminal box version) is alternatively available for 1FT506□, 1FT507□, 1FT510□ and 1FT513□ servomotors.

The power and rotor position encoder connections are combined in a flange-mounted socket connector unit with the terminal box with a common cable outlet. The cable outlet direction can be rotated through 90° steps.

The required cable outlet direction must be specified when ordering, as it cannot be subsequently changed after the motor has been supplied.

The power connector - and signal connector flange-mounted sockets on the motor comply with degree of protection IP 67 when open with the connectors not inserted.

Flange-mounted angled connbectors are generally used for the servomotors so that when mounted the connector does not appreciably exceed the terminal box height. This means that it is possible to use straight connectors which make it easier to fit the cable to the mating connector and easier to handle the pre-assembled cable with connector in cable ducts. The mating connectors have socket contacts.

Appropriate connectors with the necessary crimped contacts are available for cable cross-sections in accordance with DIN VDE 0113/EN 60204, Part 1, Table BII, column 4 at 40 °C. The power connection contacts are dimensioned for the motor starting current. The brake feeder cables are also fed through the power connector. All connectors are designed for 1.5 mm^2 cables.

Further inormation regarding connector types and cables is provided in Section 2.11.

---

1) Mating power connectors must be separately ordered.

2) Not provided for 1FT4 AC servomotors.

2.6 Type designation

2.6.1 Type designation of 1FT5 AC servomotors

The type designation (which is also the Order No.) consists of a combination of digits and letters. It is subdivided into 4 blocks, which are hyphenated.

The first block comprises seven characters and identifies the motor type. The second block contains codes for other design features. The third and fourth blocks are provided for additional information.

1 F T 5 0 6 2 - 0 A C 7 1 - 1 - Z

Electric motor

Synchronous motor

AC servomotor

Series

Frame size

Overall length

Operating principle

Cooling type
A = Natural cooling
S = Forced cooling with externally mounted driven fan

Rated speeds
A = 1200 RPM
C = 2000 RPM
F = 3000 RPM
G = 4000 RPM
H = 4500 RPM
K = 6000 RPM

DC link voltage
0 = 210 V[1)]
7 = 600 V

Type of construction
1 = IM B5 (standard)
4 = IM V1
9 = Special design with plain text information, e.g. IM V3

Connection type
1 = Power connector + flange socket connection for signal connector 6FC9348-7AD
2 = Terminal box + flange socket connection for signal connector 6FC9348-7AD[2)]
9 = Other connecting types with plain text information

Supplementary information
specify with order code or plain text

1) *Motor data, refer to the Descriptions Order No.* 6ZB5 420-0AC02-0BA1

2) *Not possible for 1FT503□ and 1FT504□ motors*

Supplementary information for the standard design and options

Plain text information				Code
Degree of protection IP67				K93
Special paint finish, anthracite for tropical climates				L53
Second rating plate				K31
Terminal box/connector cable outlet direction[1) rotated through 90°	cable entry from the drive side			K83
	cable entry from the non-drive side			K84
Terminal box/connector cable outlet direction[1) rotated through 180°				K85
Rotary shaft sealing ring according to DIN 3760				K18
Drive shaft end	version b[3)			K42
	version c[4)			K43
	non-standard cylindrical shaft end			Y55[2)
Vibration severity grade (ISO 2373) Grade R (reduced)	600 to 1800 RPM	≤ 0.71 mm/s		K01
	>1800 to 3600 RPM	≤ 1.12 mm/s		
Radial eccentricity of the motor shaft end with tolerance R (reduced) according to DIN 42955-R				K04
Motor prepared for mounting a ROD 426[5) or a compatible absolute shaft angle encoder[6)				G51
Motor without encoder system				H30
Motor with mounted ROD 426[5) integrated pulse encoder				
5000 pulses/revolution				H28
2500 pulses/revolution				H27
2000 pulses/revolution				H26
1500 pulses/revolution				H25
1250 pulses/revolution				H24
1024 pulses/revolution				H23
1000 pulses/revolution				H22
720 pulses/revolution				H21
500 pulses/revolution				H20
400 pulses/revolution				H19
250 pulses/revolution				H18
Motor prepared for mounting a ROD 426[5) pulse encoder and the following absolute shaft angle encoders[6): • ROC 424 Messrs. Heidenhain • CE 65/04-418-031 Messrs.T&R • CR 58 Messrs. TWK • AG 661-21-24 Messrs. Stegmann				G51

1) *Standard version corresponds to dimension sheets (Section 2.10)*
2) *Additionally specify in plain text:* ***Non-standard cylindrical shaft end with ... mm diameter and ... mm length.***
3) *Standard cylindrical shaft end acc. to DIN 748 without key and keyway tolerance zone k6*
4) *Standard cylindrical shaft end acc. to DIN 748 without key and keyway tolerance zone k5*
5) *Encoder system from Messrs. Heidenhain Traunreut*
6) *Additional plain text required: "spring plate coupling", for 1FT503□, 1FT504□ only on request.*

Plain text information	Code
Motor with mounted pulse encoder - ROD 320[1]	
5000 pulses/revolution	H04
2500 pulses/revolution	G44
2000 pulses/revolution	G42
1250 pulses/revolution	H01
1024 pulses/revolution	H02
1000 pulses/revolution	H00
Mounting prepared for absolute shaft angle encoder with profiled clamping clip ● only 1FT506□ to 1FT513□ - (coupling, plug-in cable to the contact PC board, connector and flange-mounted socket included)	G53
Mounting prepared for standard absolute shaft angle encoder with profiled clamping clip - only 1FT506□ to 1FT513□	G54
Mounting prepared for standard absolute shaft angle encoder with profiled clamping clip[2] ● only 1FT503□ to1FT504□ - (coupling included)	Plain text
Holding brake (integrated)	G45
Motor with planetary gearbox	G93
Motor prepared for mounting a cyclo-gearbox	G94
Increased temperature range (e.g. –40°C)	Plain text

When ordering a 1FT5 AC servomotor, for options, it is necessary to add a suffix "-Z" to the basic Order No. and also the code or plain text description.

Example: 1FT5066-0AC71-Z
Z = K18 + G45 + pulse encoder 6FC9320 2000 pulses/revolution

The codes are also specified on the motor rating plate.

1) *Not possible for 1FT503□ and 1FT504□ motors*

2) *Not for new designs*

2.6.2 Type designation of 1FT4 AC servomotors

The type designation (which is also the Order No.) consists of a combination of digits and letters. It is subdivided into four blocks, which are joined by hyphens.

The first block comprises 7 positions and identifies the motor type. Additional design features are coded in the second block, and the third and fourth blocks are provided for additional information.

1 F T 4 1 0 1 - 0 S G 7 1 - 0 - Z

- Electric motor (1)
- Synchronous motor (F)
- AC servomotor (T)
- Series (4)
- Frame size (10)
- Overall length (1)
- Operating principle (0)
- Cooling type (S)
  S = Separately-ventilated with mounted fan
- Rated speed (G)
  G = 4000 RPM
  K = 6000 RPM
  N = 8000 RPM
- DC link voltage (7)
  7 = 600 V
- Type of construction (1)
  1 = IM B5 (standard)
  4 = IM V1
  9 = Special version with plain text information, e.g. IM V3
- Connecting type (0)
  2 = Terminal box - + signal connector connection for connector 6FC 9348-7AD
- Supplementary information (Z)
  with code, or specify in plain text
  (refer to Catalog SD 12)

Additional information for the standard version and options (1FT4 AC servomotors)

Plain text information			Code
Second rating plate			K31
Reinforced bearing (double bearing-design up to 6000 RPM)			K20
Rotary shaft seal on the drive end			K18
Drive shaft end	version b		K42
	non-standard cylindrical shaft end		Y66[1]
Radial eccentricity tolerance R acc. to DIN 42-955R			K04
Vibration severity grade S (special)			K02
Terminal box/connector outlet direction[2]			
rotated through 90°		cable entry from the drive end	K83
		cable entry from the non-drive end	K84[3]
Terminal box/connector outlet direction[2] rotated through 180°			K85
Motor with mounted pulse encoder[4]			
	6FC9320-3MS00	5000 pulses/revolution	H28
	6FC9320-3MN00	2500 pulses/revolution	H27
	6FC9320-3MK00	2000 pulses/revolution	H26
	6FC9320-3MG00	1500 pulses/revolution	H25
	6FC9320-3ME00	1250 pulses/revolution	H24
	6FC9320-3MB00	1024 pulses/revolution	H23
	6FC9320-3MA00	1000 pulses/revolution	H22
	6FC9320-3LX00	720 pulses/revolution	H21
	6FC9320-3LS00	500 pulses/revolution	H20
	6FC9320-300	400 pulses/revolution	H19
	6FC9320-3LL00	250 pulses/revolution	H18

1) *Additionally specify in plain text: Non-standard shaft end with diameter (mm) and length (mm).*
2) *Standard design according to the dimension sheets in Section 2.10*
3) *The terminal box for connecting the fan and terminals for mounted components are mounted on the righthand side of the motor when viewing the motor from the drive end.*
4) *Pulse encoders mounted on the motor have a radial cable outlet. Pulse encoders with different numbers of pulses per revolution on request.*

Plain text information		Code
ROD 320[1] integrated pulse encoder	5000 pulses/revolution	H04
	2500 pulses/revolution	G44
	2000 pulses/revolution	G42
	1250 pulses/revolution	H01
	1000 pulses/revolution	H00
Motor with mounted planetary gearbox		G93/Y55[2]
Motor prepared for mounting a cyclo-gearbox		G94 [3]

When ordering a 1FT4 AC servomotor, it is necessary to add a "-Z" suffix to the basic Order No. followed by the code or plain text description.

Example: 1FT4102-0SK71-1-Z
Z = K18 + pulse encoder 6FC9320 2000 pulses/revolution

The codes are also specified on the motor rating plate.

1) *Please note when engineering the drive, the limiting frequency of the pulse encoder ($f = 250$ kHz). Motors can only be dimensioned for a winding temperature rise of $\Delta T = 60K$.*

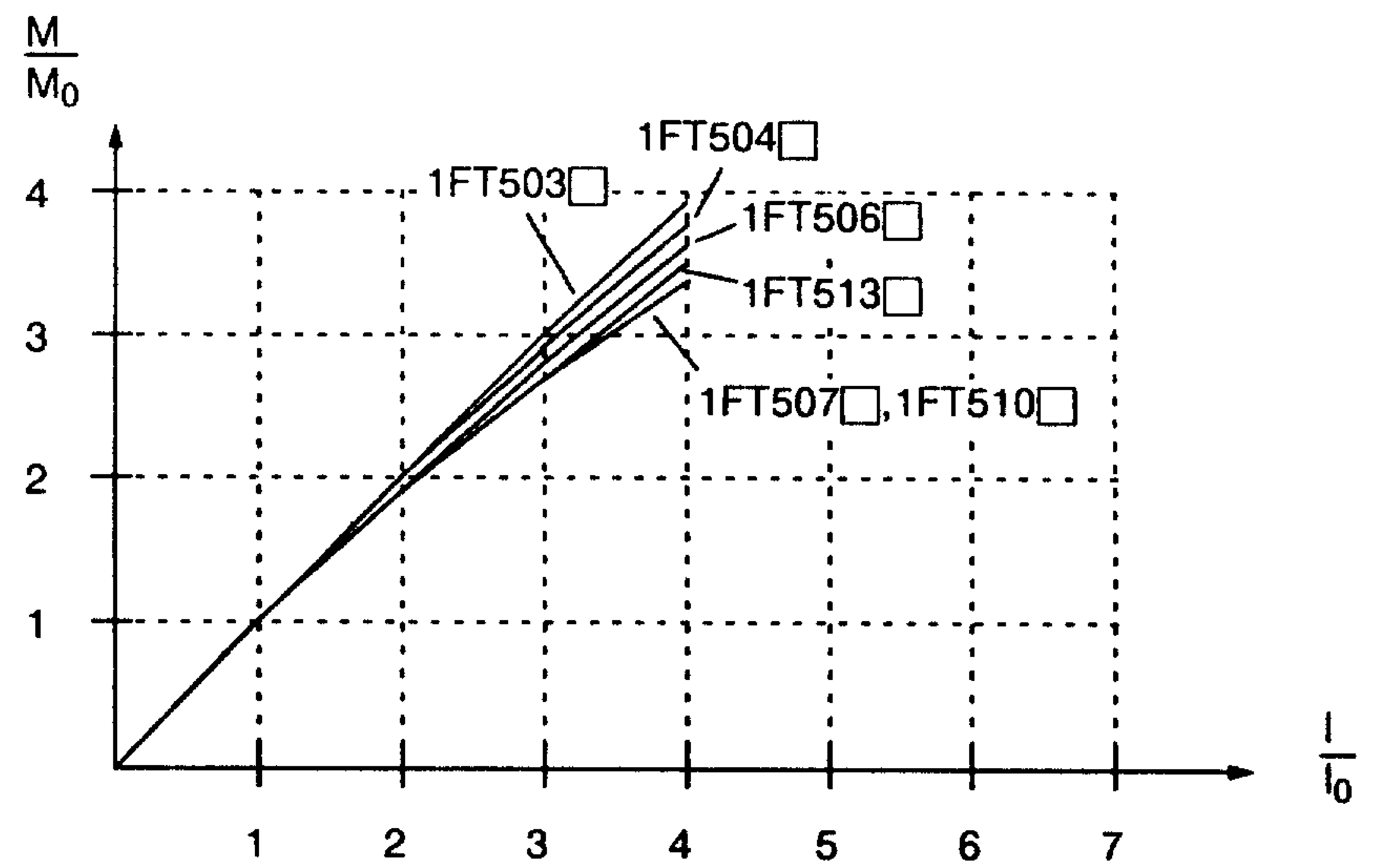
2) *G93 is only possible in conjunction with a non-standard shaft end (option Y55). When ordering, also specify the gearbox ratio.*

3) *Also specify in plain text: Motor shaft according to the cyclo-gearbox drawing number.*

2.7 Terminology

1FT5 and 1FT4 AC servomotors

- Stall torque M_0 (also known as standstill torque)
  The stall torque M_0 is available at n = 0 for any length of time. The servomotor draws the following current I_0.
  - Stall torque (60 K) for a winding temperature rise of $\Delta T = 60$ K
  - Stall torque (100 K) for a winding temperature rise of $\Delta T = 100$ K
- Rated torque M_{rated}
  The servomotor can provide rated torque M_{rated} at the shaft, corresponding to the specified duty type (S1 or S3) and switch-on duration for a duty cycle time of 10 minutes (DIN VDE 0530) and at rated speed n_{rated}. This is base on a winding temperature rise of $\Delta T = 100$ K.
- Peak current I_{max}
  The peak current I_{max} is the maximum current, at which irreversible demagnetization still does not occur. The maximum accelerating current should not exceed 450 % of the rated current. The actual accelerating current is defined by the maximum current of the assigned PWM converter. A peak torque of 4 · M_0 (100 K) should not be exceeded in order to protect the motor mechanical system. Duty types S1 (continuous operation at rated torque) or S3 (intermittent periodic duty with relative switch-on duration of 25% or 40% with a duty cycle time of 10 minutes) according to VDE 0530 should be taken into account.
- Maximum speed n_{max}
  The maximum speed n_{max} is the limiting speed, at which the servomotor can be operated under no load conditions (M = 0) as a result of the specified PWM converter DC link voltage. No additional current can be impressed in the motor when this speed is exceeded at the specified rated DC link voltage. Further, these values take into account the maximum speed limit determined by the motor mechanical system.
- Torque constant K_T
  The torque constant K_T is the quotient of the stall torque and the associated current for a DC current supply (form factor 1). A reduction of the torque constants as a result of frictional torque, iron and stray losses have been neglected. These corrections are not required at standstill.



Torque/current characteristic for the various shaft heights

- Voltage constant K_E
  The voltage constant K_E is the peak value of the phase-to-phase induced voltage referred to 1000 RPM.
- Electrical time constant T_{el}
  The electrical time constant T_{el} is the quotient of the stator winding inductance and stator winding resistance. It is an almost constant quantity for every servomotor, independent of the armature circuit. It specifies the time, which the armature current requires to reach 63% of its final value when a step voltage is applied and the rotor is locked.
- Thermal time constant T_{th}
  Average housing time constant τ in which the housing reaches 63% of its final temperature rise.
- Mechanical time constant T_{mech}
  The mechanical time constant T_{mech} is obtained from the tangent starting at the origin along a theoretical ramp-up function. It is calculated by:

$$T_{mech} = \frac{J_{mot} \cdot R_{U\text{-}V}}{K_T \cdot K_E} \cdot 2\pi \cdot \frac{1000}{60} \quad [s]$$

  Meanings:

  J_{mot} Servomotor moment of inertia [kgm2]
  $R_{U\text{-}V}$ Resistance of two stator winding phases [Ω]
  K_T Torque constant [Nm/A]
  K_E Voltage constant [V/1000 RPM]

- Braking resistor $R_{a\ opt}$
  $R_{a\ opt}$ corresponds to the resistance value for each phase connected in series externally with the motor winding during armature short-circuit braking. For a specified resistance value of zero, optimal braking is achieved without external resistors, i.e. direct short-circuit at the terminals.
- Braking torque $M_{B\ opt}$
  $M_{B\ opt}$ corresponds to the average, optimum braking torque, which is achieved by adapting the resistor
- Winding inductance L_A phase value
- Winding resistance R phase value (two phases in each motor)
- Tolerance information of the motor list data
  (additional data is subject to measuring accuracy)

Motor list data		Typ. value	Theoretical value
Standstill current	I_0	± 3 %	± 7.5 %
Max. speed	n_{max}	± 3 %	± 7.5 %
Electrical time constant	T_{el}	± 5 %	± 10 %
Torque constant	K_T	± 3 %	± 7.5 %
Voltage constant	K_E	± 3 %	± 7.5 %
WInding resistance	R	± 5 %	± 10 %
Moment of inertia	J_{Mot}	± 2 %	± 10 %

2.8 Torque-speed diagrams

The torque-speed diagrams for S1 and S3 duty, as a function of the speed are illustrated in the following pages. The speed-torque diagrams are valid for a motor utilization according to $\Delta T = 100$ K winding temperature rise.

Speed-power diagrams are also illustrated for 1FT4 servomotors.

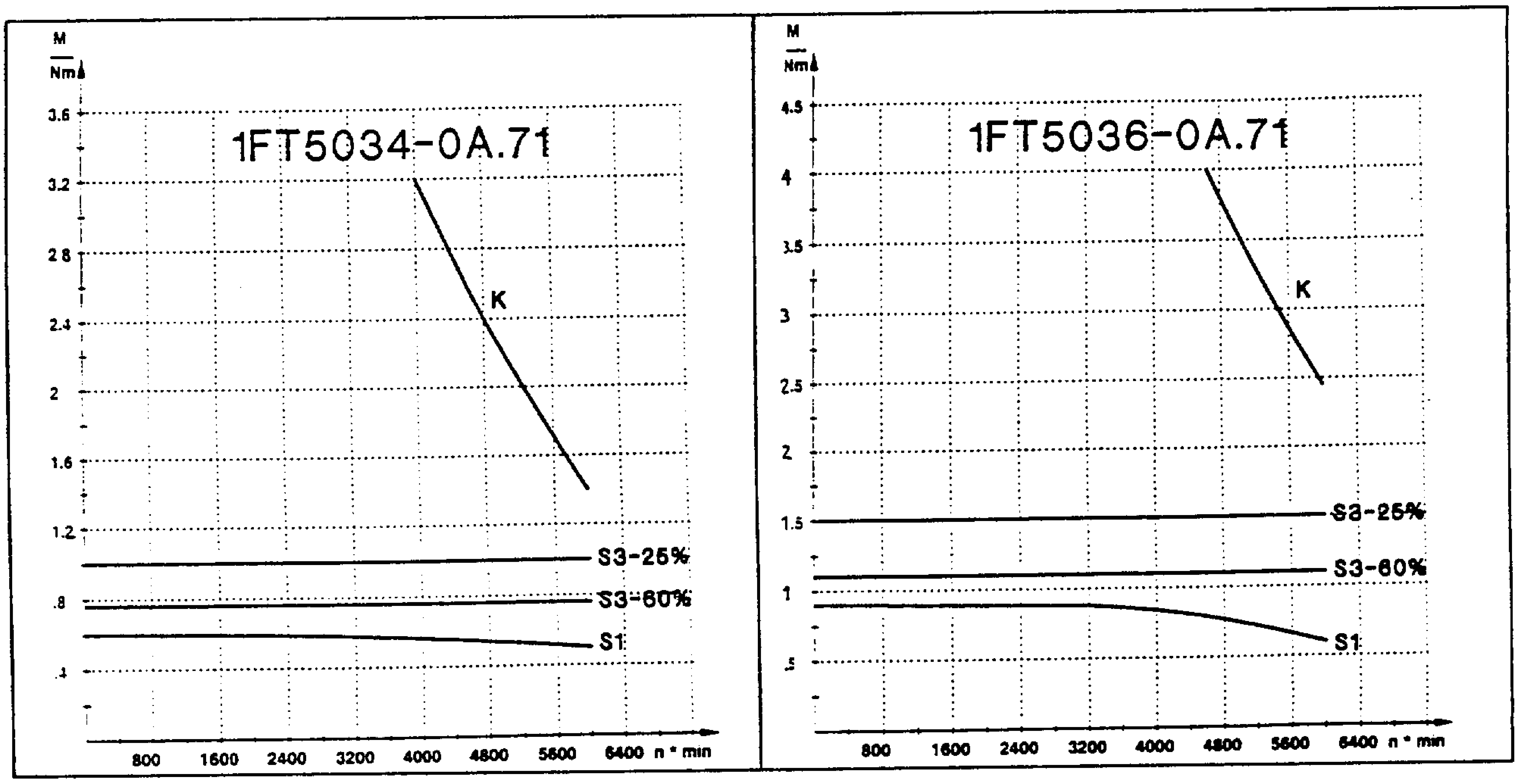
When dimensioning or engineering a drive using these characteristics, it should be ensured that the PWM converter can provide the appropriate rated motor current (e.g. dimensioning for S3 duty) as continuous current.

400% of the motor rated torque should not be exceeded when accelerating.

The transistor PWM converter supply voltage is 3-ph. AC 380V (400V) 50/60 Hz. A DC link voltage is derived from this supply voltage, which is controlled to 600 V DC, independent of the supply voltage tolerance. The thus obtained torque limit curves can result in a reduction of the accelerating torque during acceleration with increasing speed.

For editing reasons, a voltage limiting curve of 575 V is shown in the following diagrams. For the 600 V DC link voltage in SIMODRIVE 611, the voltage limiting curve is shifted slightly upwards. Thus, at higher speeds, somewhat higher overload capabilities are obtained.

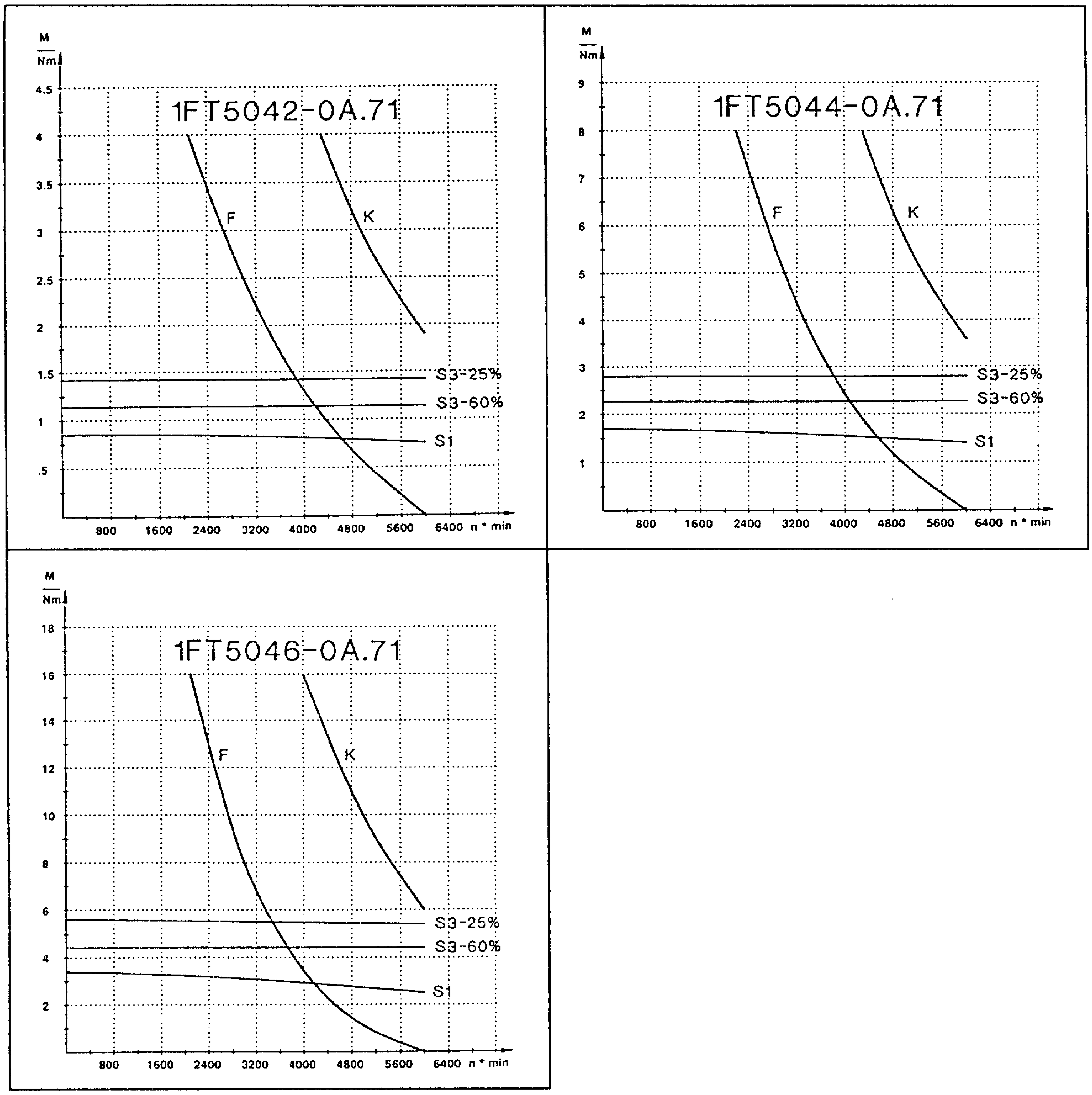
2.8.1 1FT5 AC servomotors, standard type of construction



Speed-torque diagram: 1FT5034-0A.71, 1FT5036-0A.71 servomotors
winding temperature rise ΔT = 100 K

1FT5□□□-0A□71

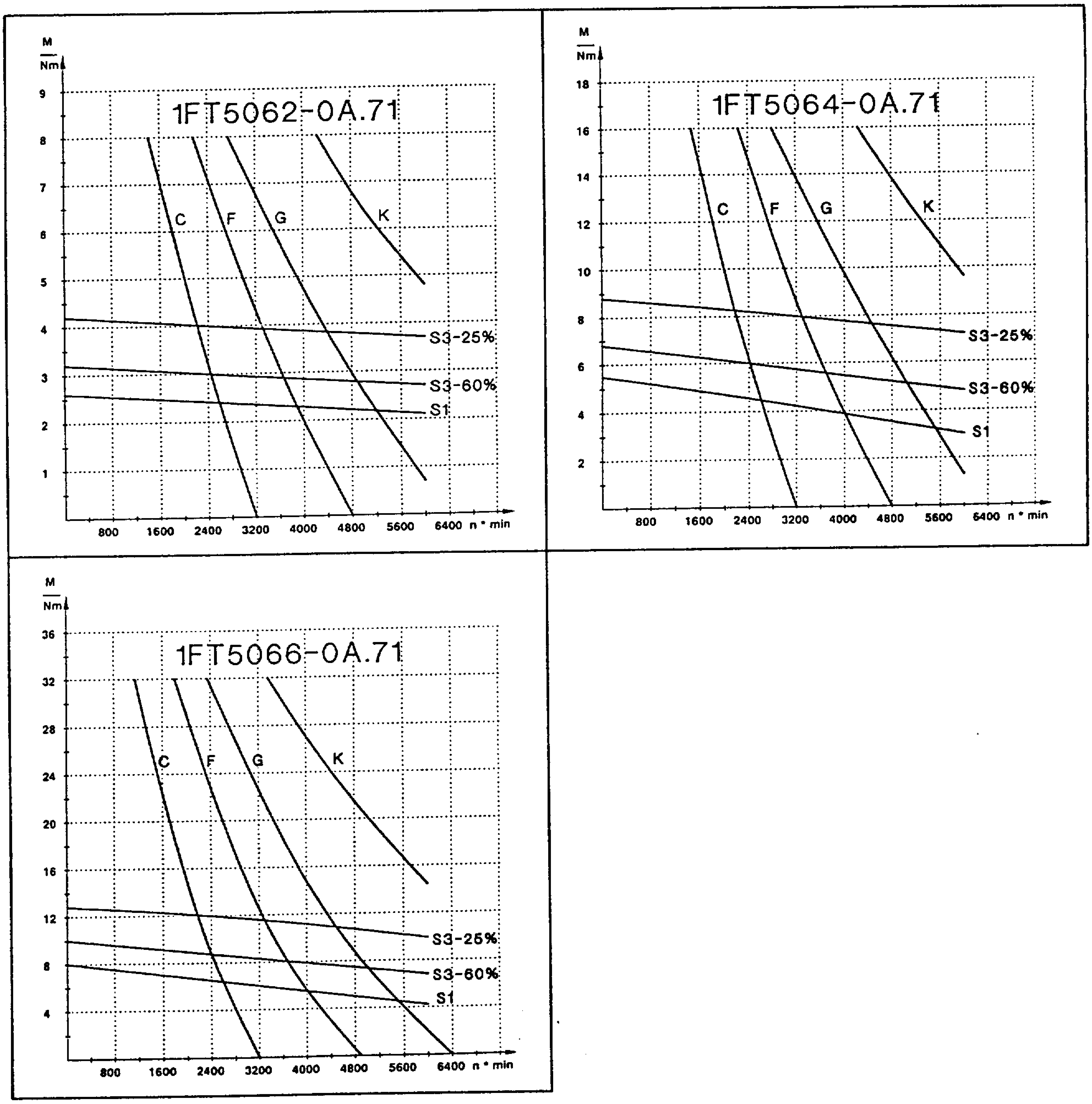
Armature circuit	C	Rated speed	2 000 RPM
	F		3 000 RPM
	H		4 500 RPM
	K		6 000 RPM



Speed-torque diagram: 1FT5042-0A.71, 1FT5044-0A.71, 1FT5046-0A.71 servomotors
winding temperature rise $\Delta T = 100$ K

1FT5□□□-0A□71

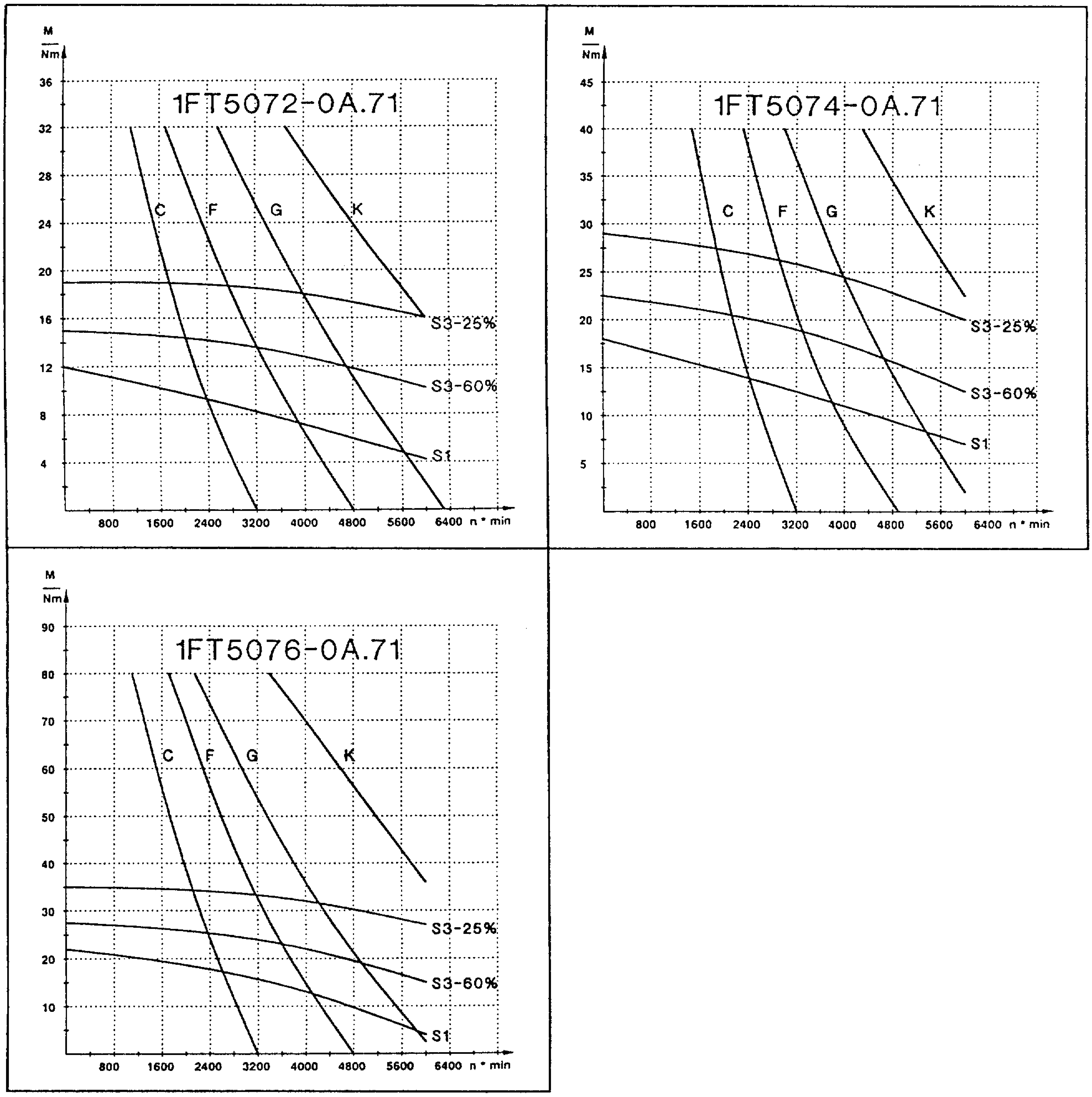
Armature circuit	C	Rated speed	2 000 RPM
	F		3 000 RPM
	H		4 500 RPM
	K		6 000 RPM



Speed-torque diagram: 1FT5062-0A.71, 1FT5064-0A.71, 1FT5066-0A.71 servomotors, winding temperature rise $\Delta T = 100$ K

1FT5☐☐☐-0A☐71

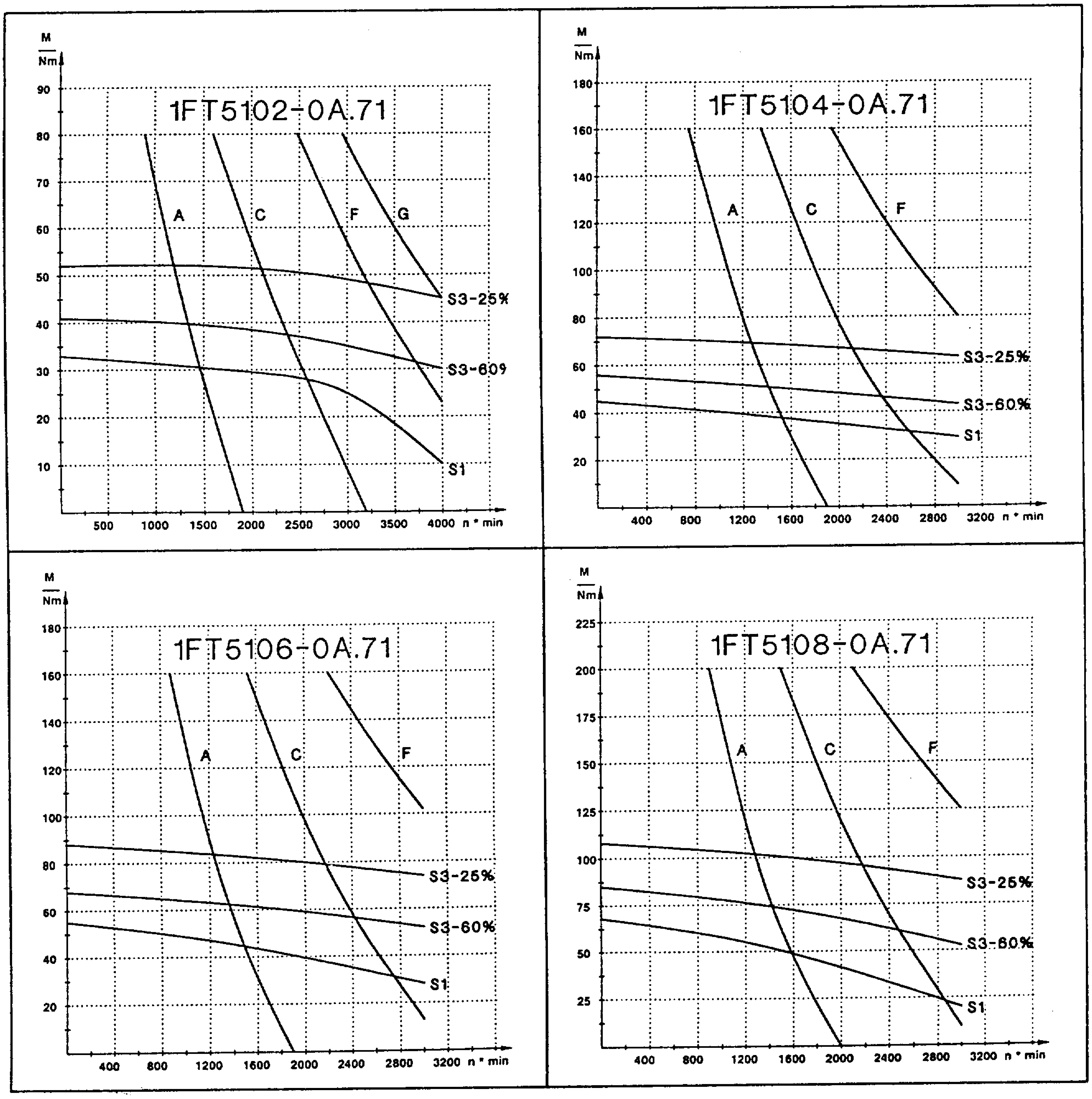
Armature circuit	C	Rated speed	2 000 RPM
	F		3 000 RPM
	G		4 000 RPM
	K		6 000 RPM



Speed-torque diagram: 1FT5072-0A.71, 1FT5074-0A.71, 1FT5076-0A.71 servomotors, winding temperature rise $\Delta T = 100$ K

1FT5□□□-0A□71

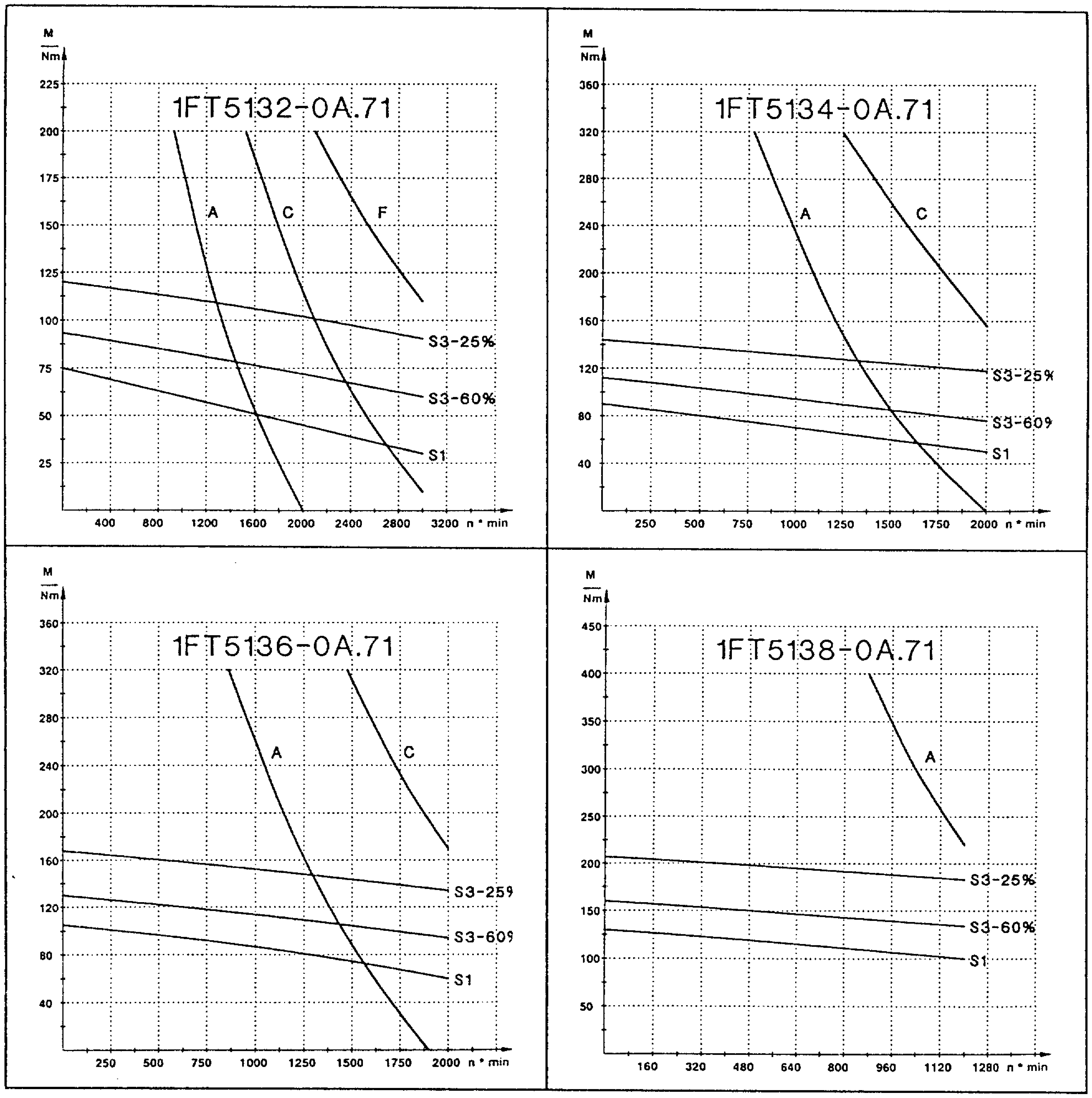
Armature circuit	C	Rated speed	2 000 RPM
	F		3 000 RPM
	G		4 000 RPM
	K		6 000 RPM



Speed-torque diagram: 1FT5102-0A.71, 1FT5104-0A.71, 1FT5106-0A.71, 1FT5108-0A.71 servomotors, winding temperature rise ΔT = 100 K

1FT5□□□-0A□71

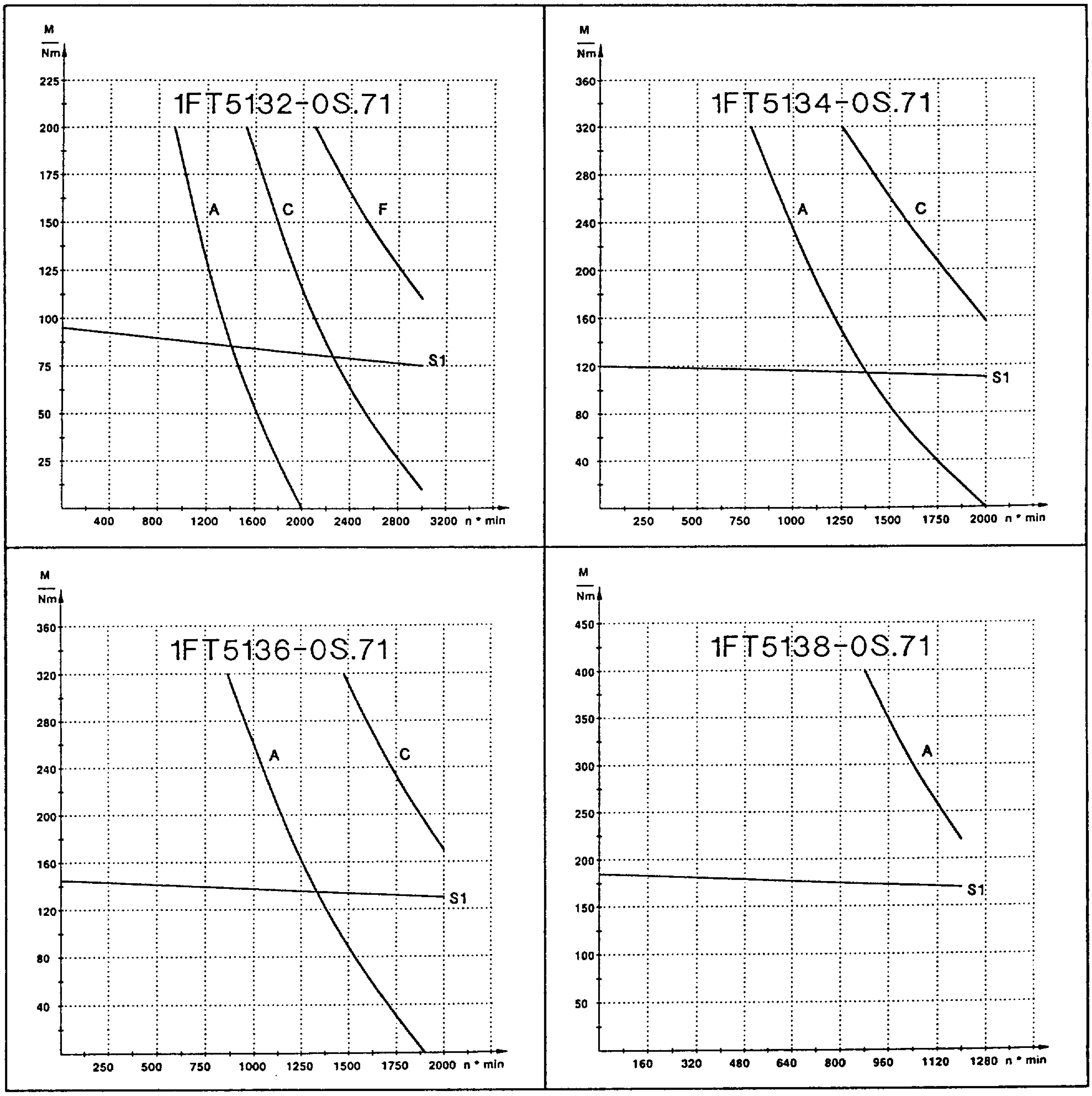
Armature circuit	A	Rated speed	1 200 RPM
	C		2 000 RPM
	F		3 000 RPM
	G		4 000 RPM



Speed-torque diagram: Force-ventilated 1FT5132-0A.71, 1FT5134-0A.71, 1FT5136-0A.71, 1FT5138-0A.71 servomotors, winding temperature rise $\Delta T = 100$ K

1FT5□□□□-0A□71

Armature circuit	A	Rated speed	1 200 RPM
	C		2 000 RPM
	F		3 000 RPM



Speed-torque diagram: Force-ventilated 1FT5132-0S.71, 1FT5134-0S.71, 1FT5136-0S.71, 1FT5138-0S.71, servomotors, winding temperature rise $\Delta T = 100$ K

1FT5□□□-0S□71

Armature circuit	A	Rated speed	1 200 RPM
	C		2 000 RPM
	F		3 000 RPM

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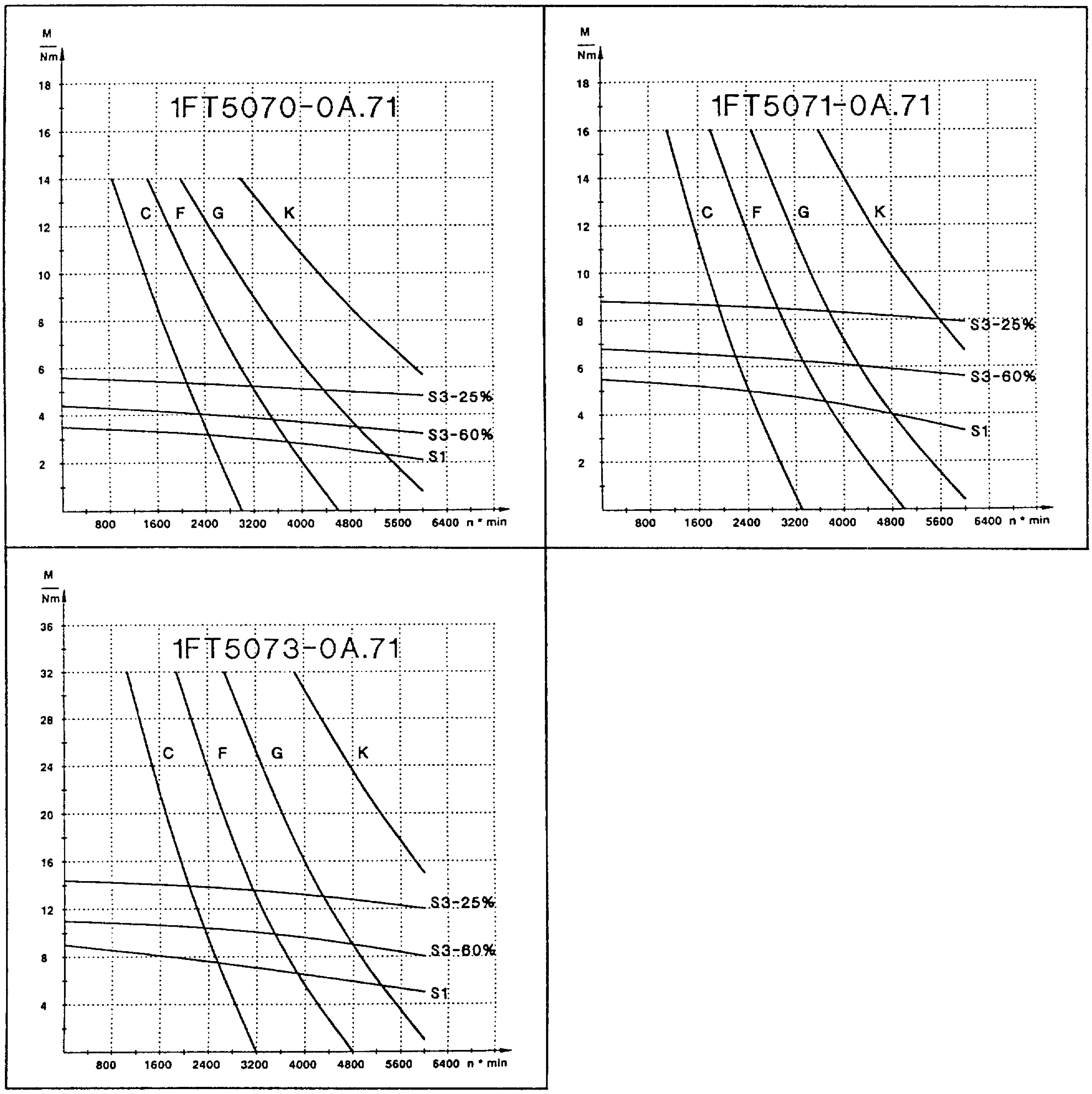
SIMODRIVE 611 (PJ)

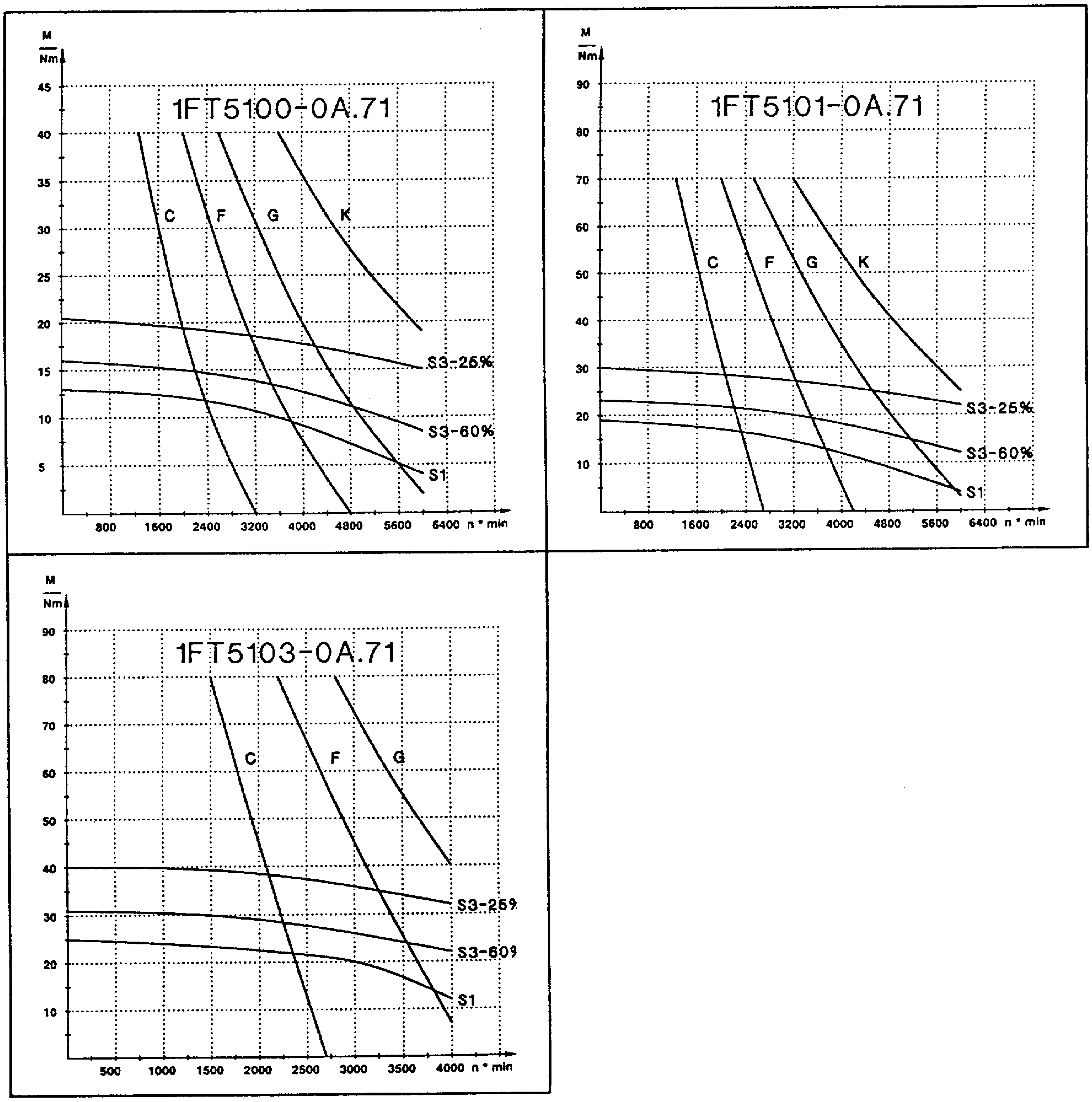
2.8.2 1FT5 AC servomotors, short type of construction



Speed-torque diagram: 1FT5070-0A.71, 1FT5071-0A.71, 1FT5073-0A.71 servomotors, winding temperature rise ΔT = 100 K

1FT5□□□-0A□71

Armature circuit	C	Rated speed	2 000 RPM
	F		3 000 RPM
	G		4 000 RPM
	K		6 000 RPM

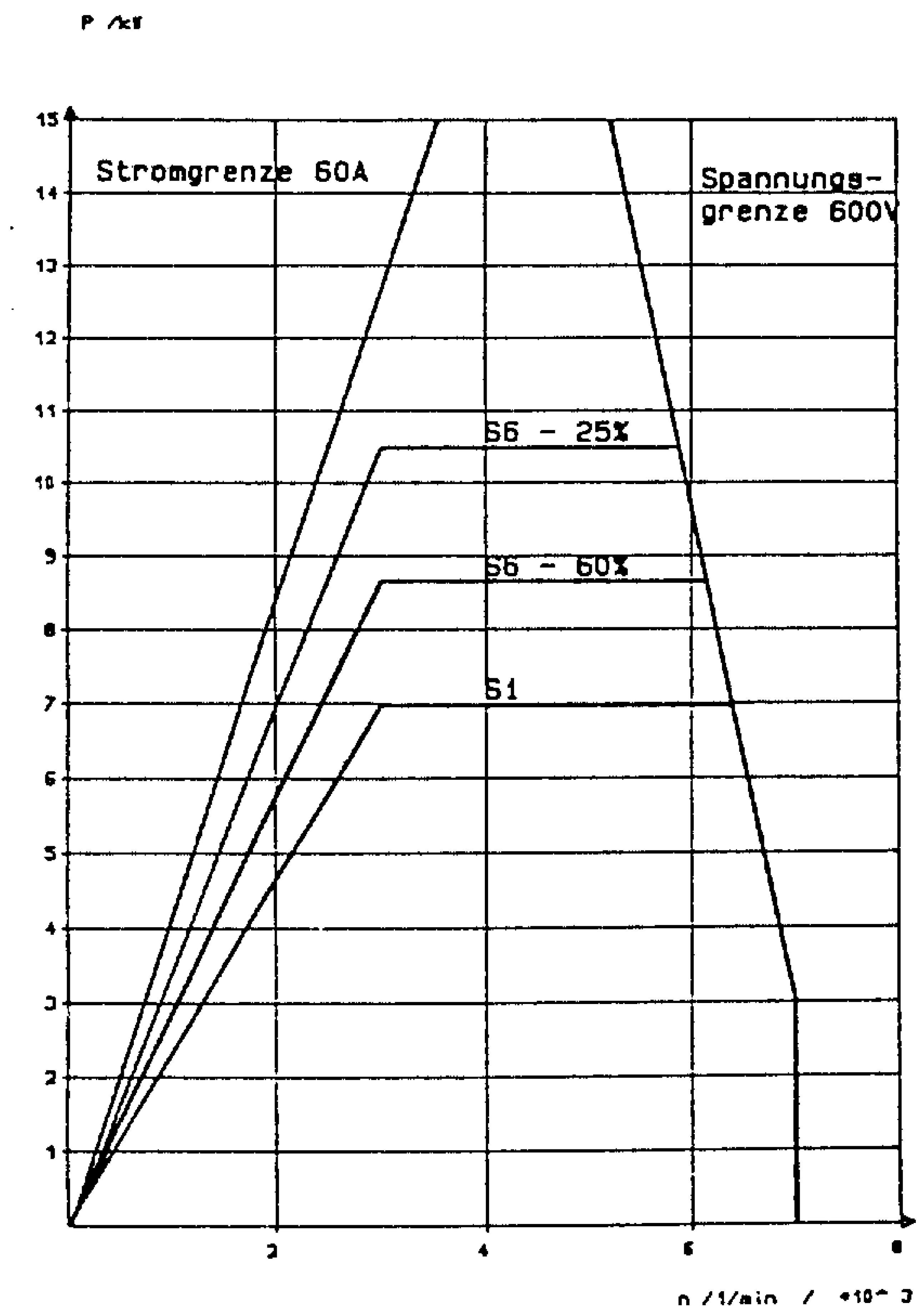


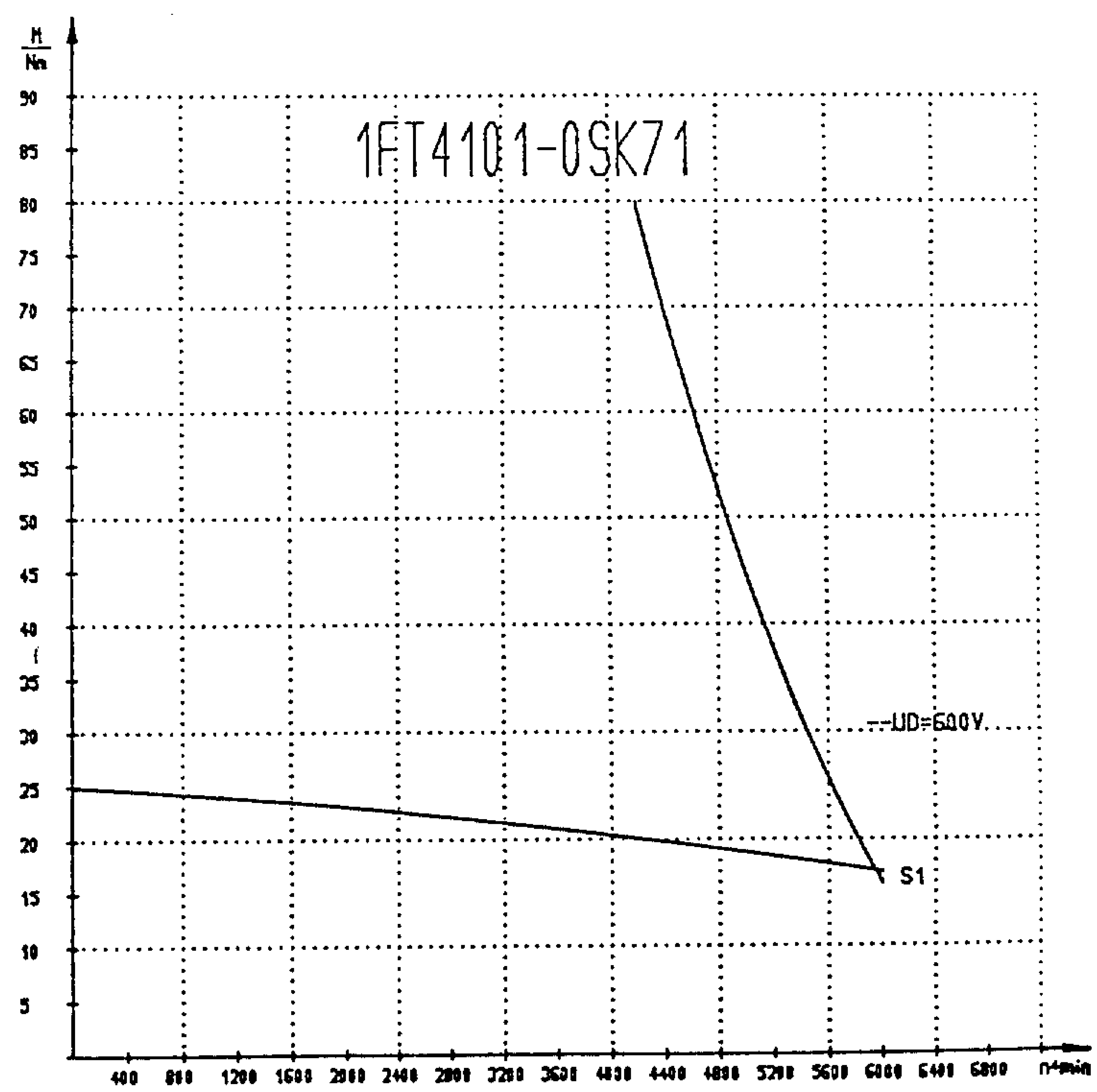
Speed-torque diagram: 1FT5100-0A.71, 1FT5101-0A.71, 1FT5103-0A.71 servomotors, winding temperature rise ΔT = 100 K

1FT5□□□-0A□71

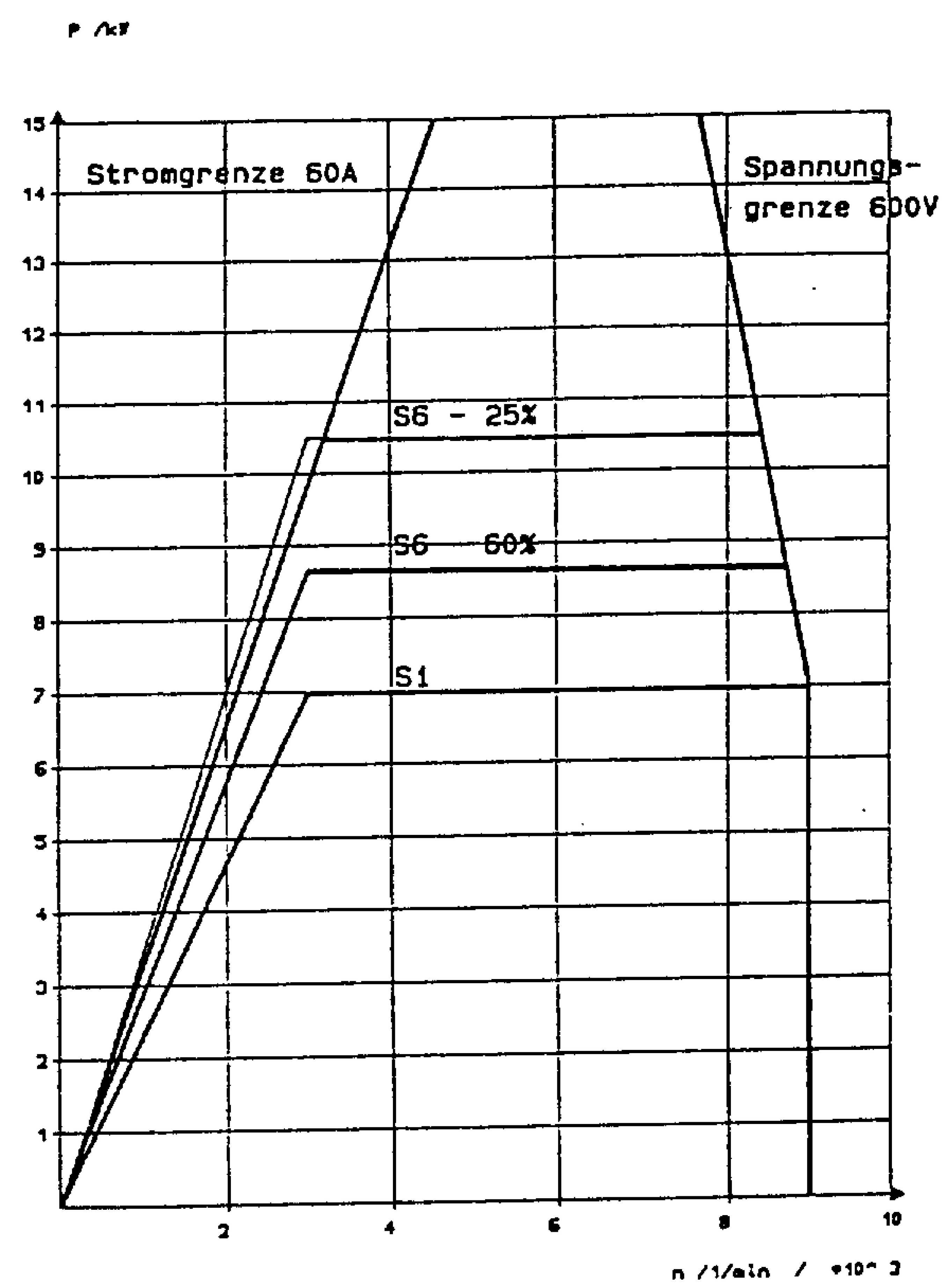
Armature circuit	C	Rated speed	2 000 RPM
	F		3 000 RPM
	G		4 000 RPM
	K		6 000 RPM

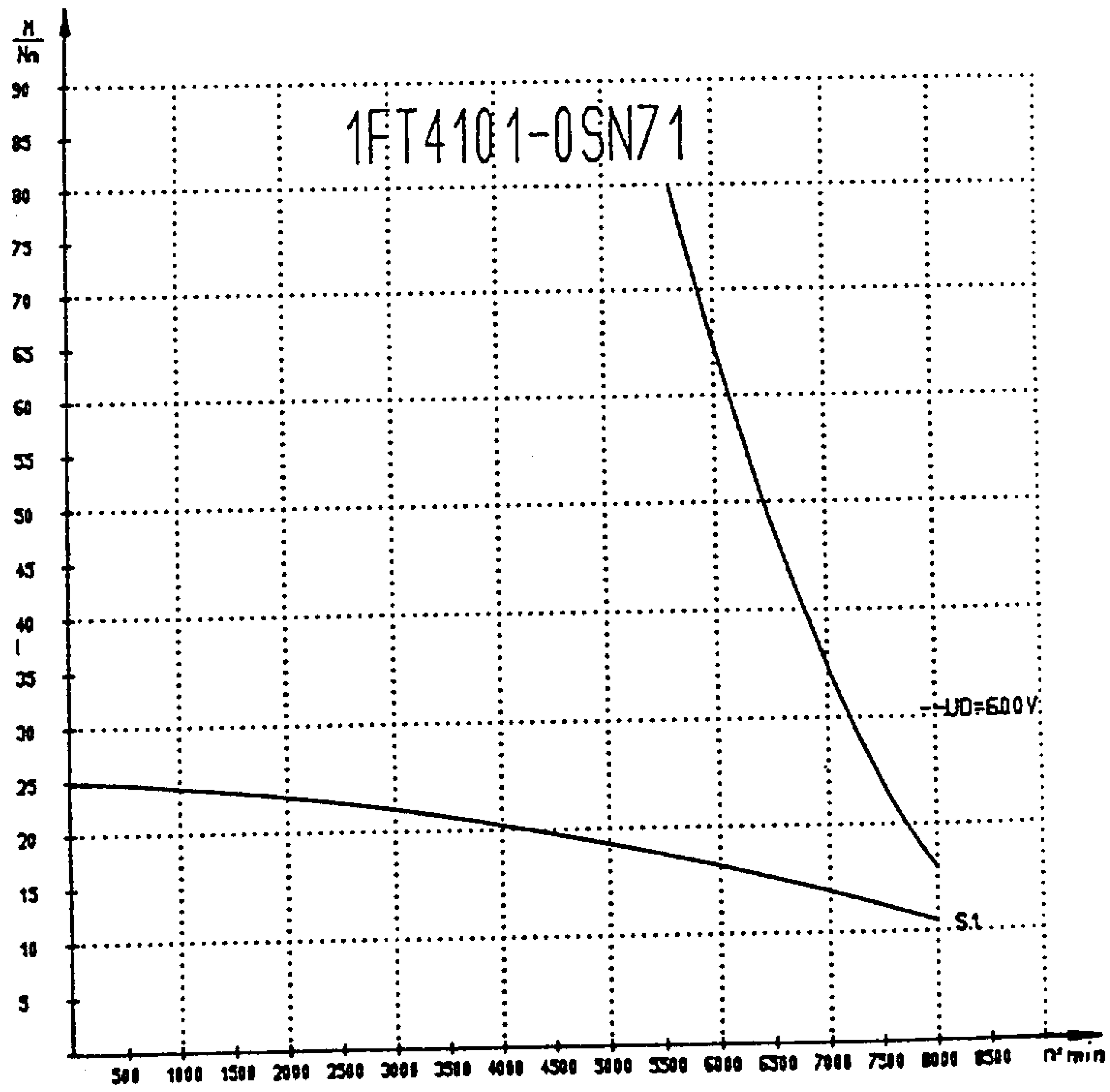
2.8.3 Torque and output vs speed diagrams for 1FT4 servomotors



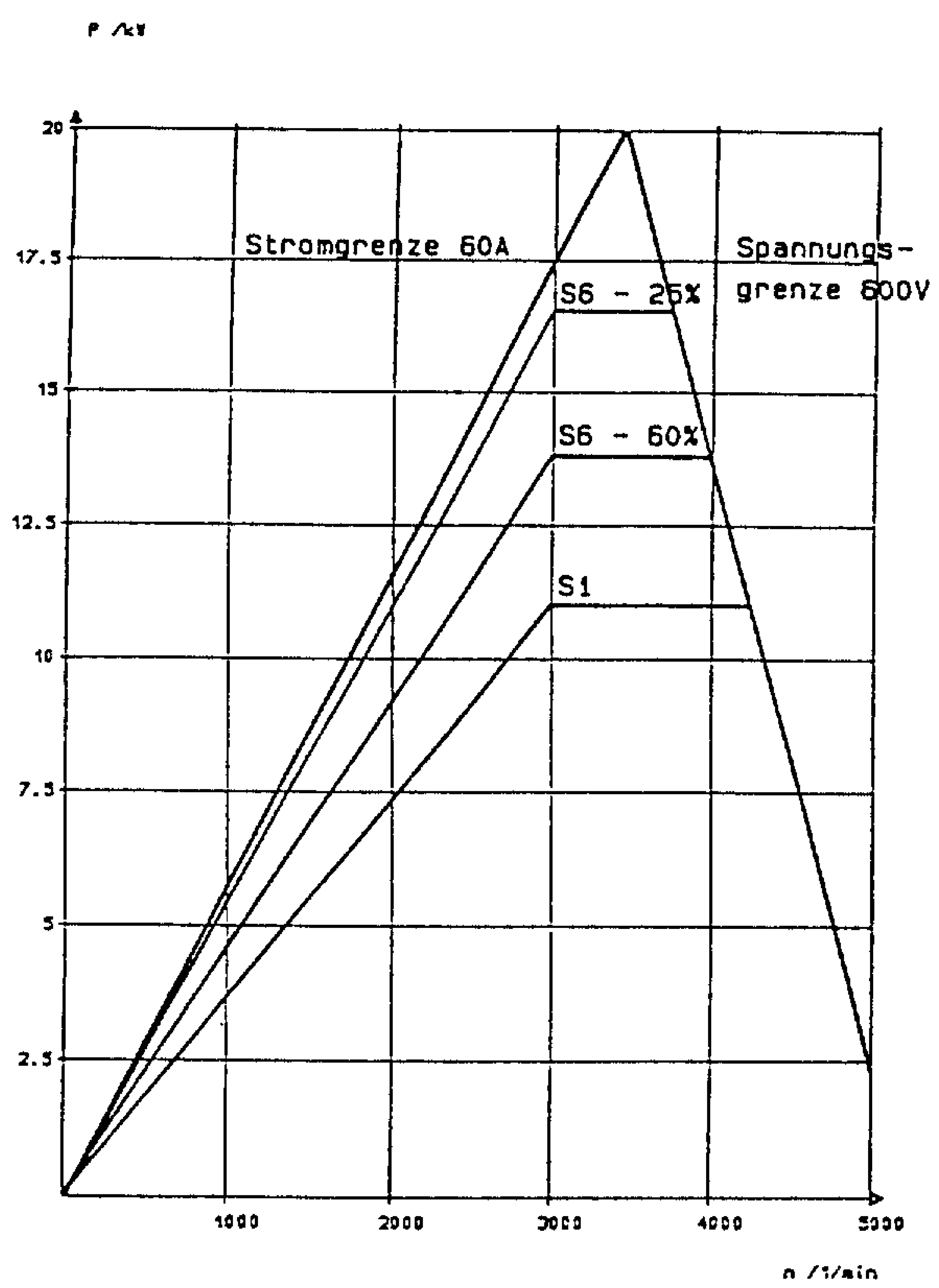


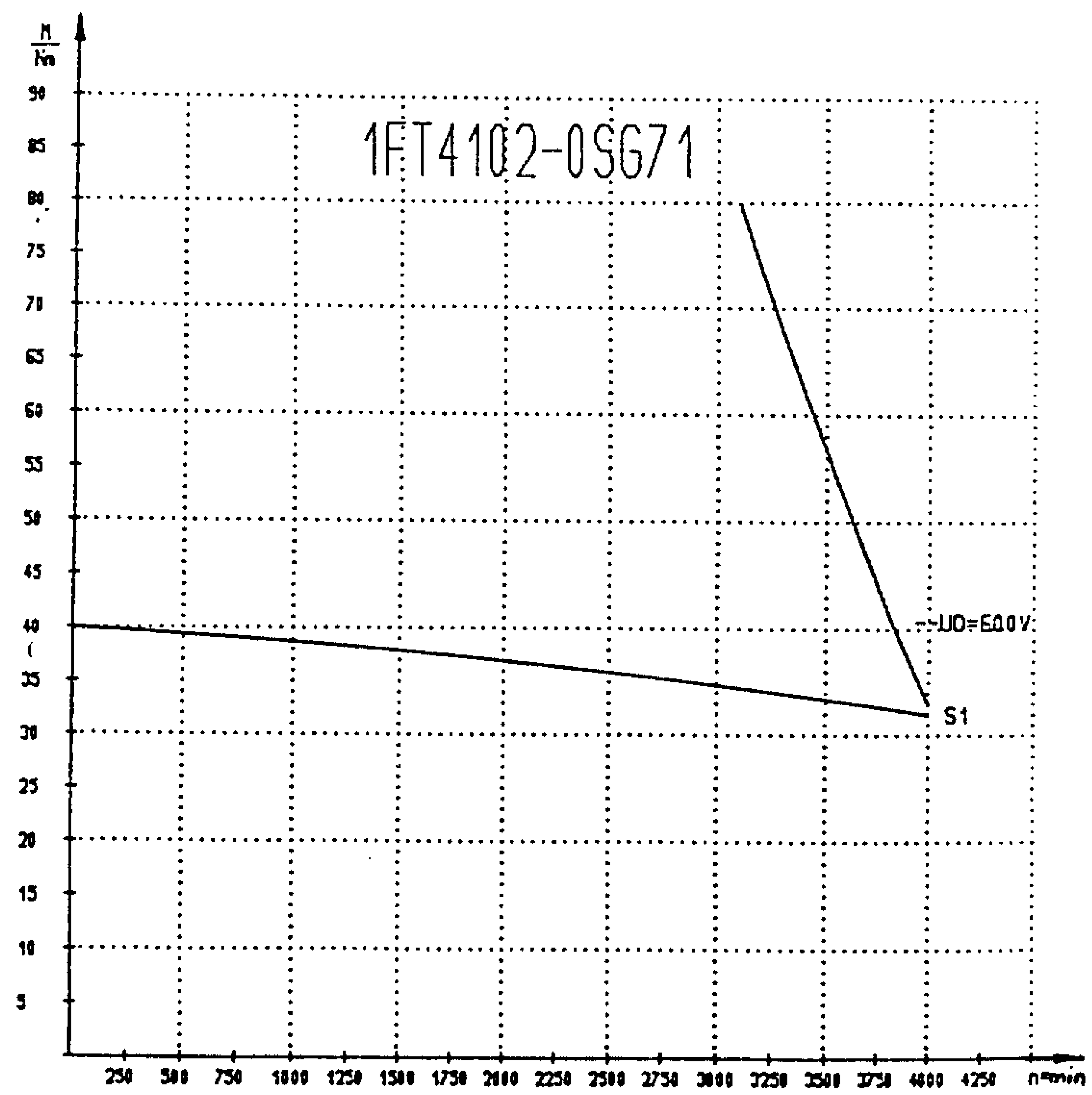
1FT4101-0SK71 servomotor, winding temperature rise $\Delta T = 100$ K



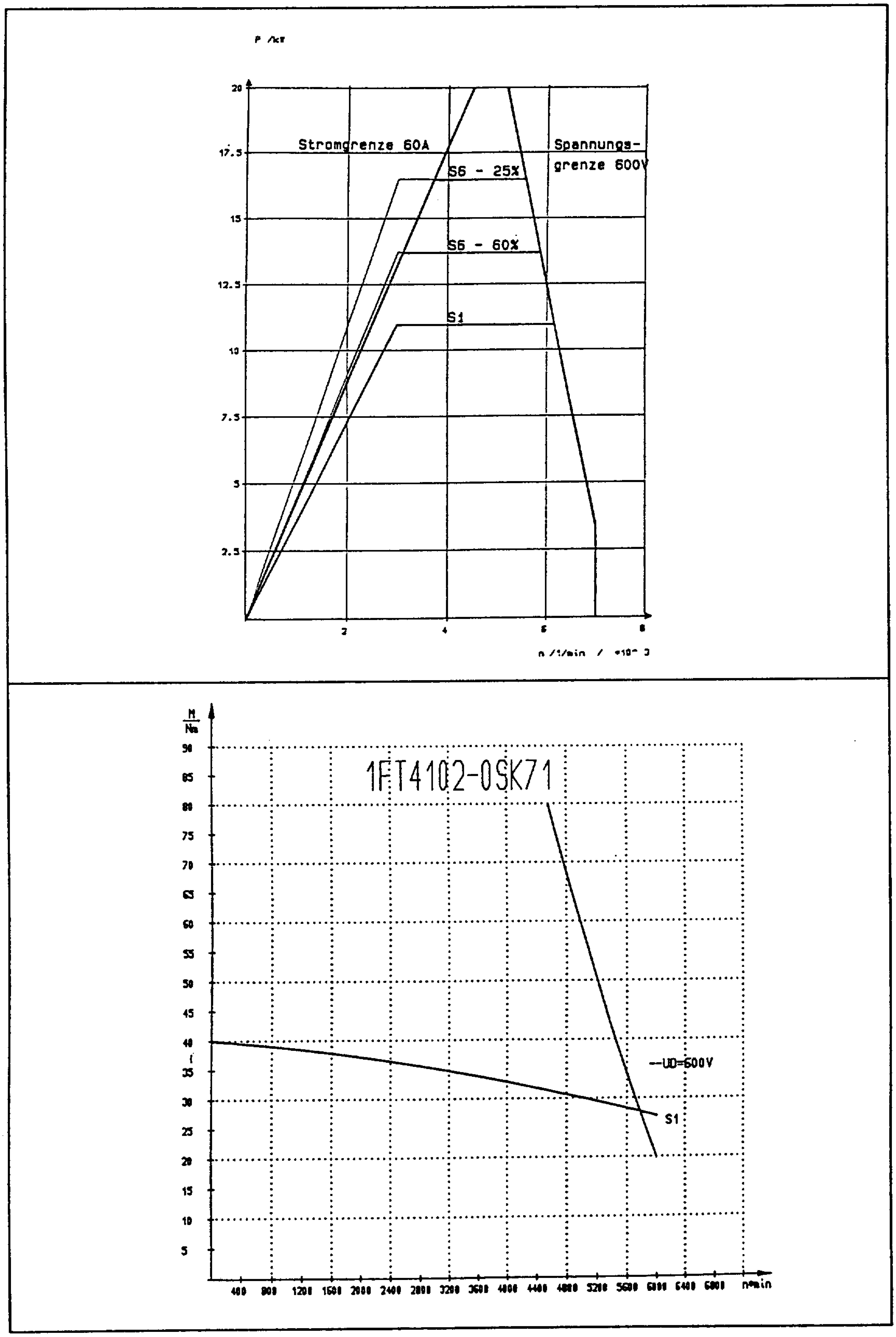


1FT4101-0SN71 servomotor, winding temperature rise $\Delta T = 100$ *K*



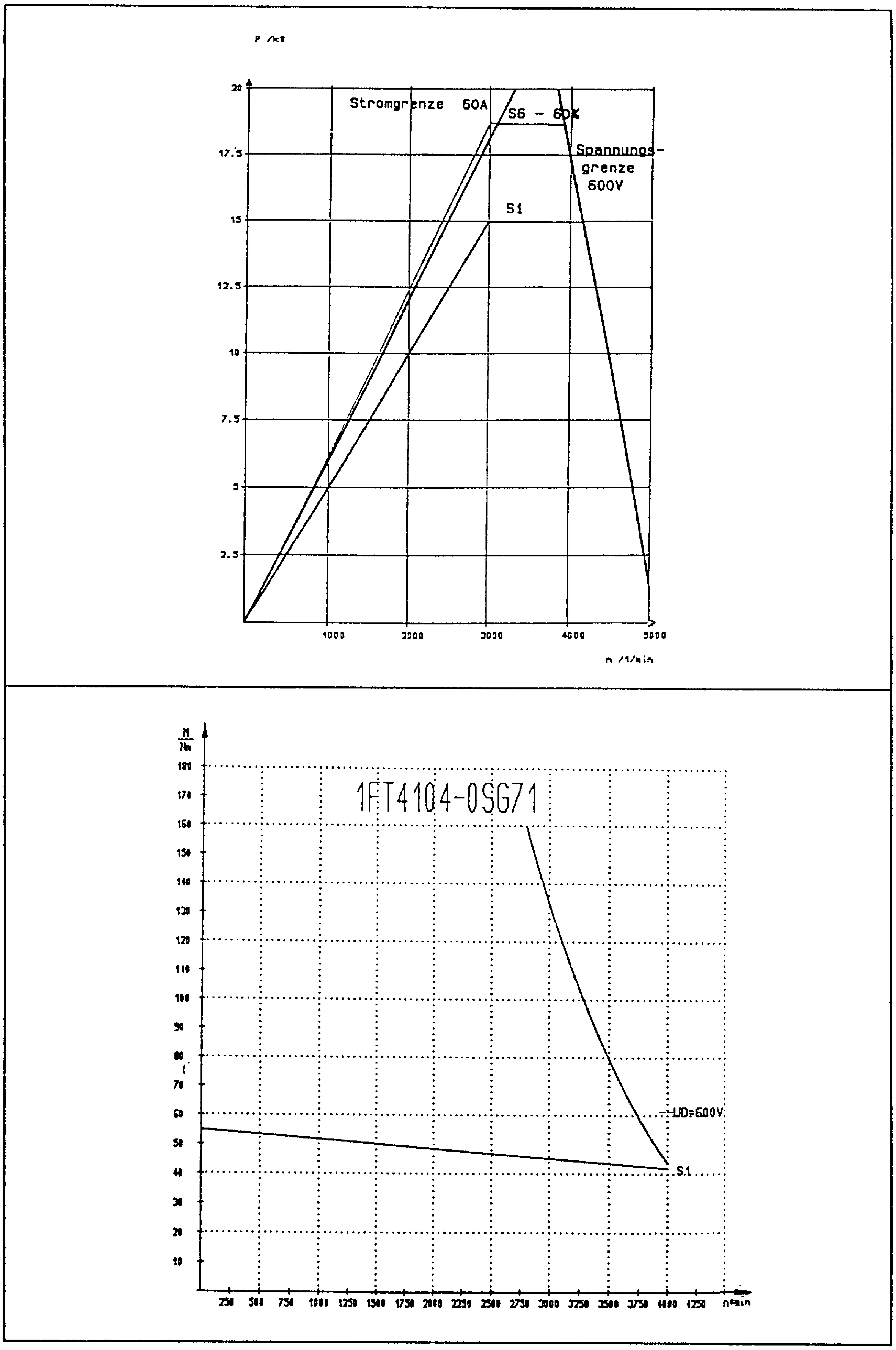


1FT4102-0SG71 servomotor, winding temperature rise $\Delta T = 100$ *K*

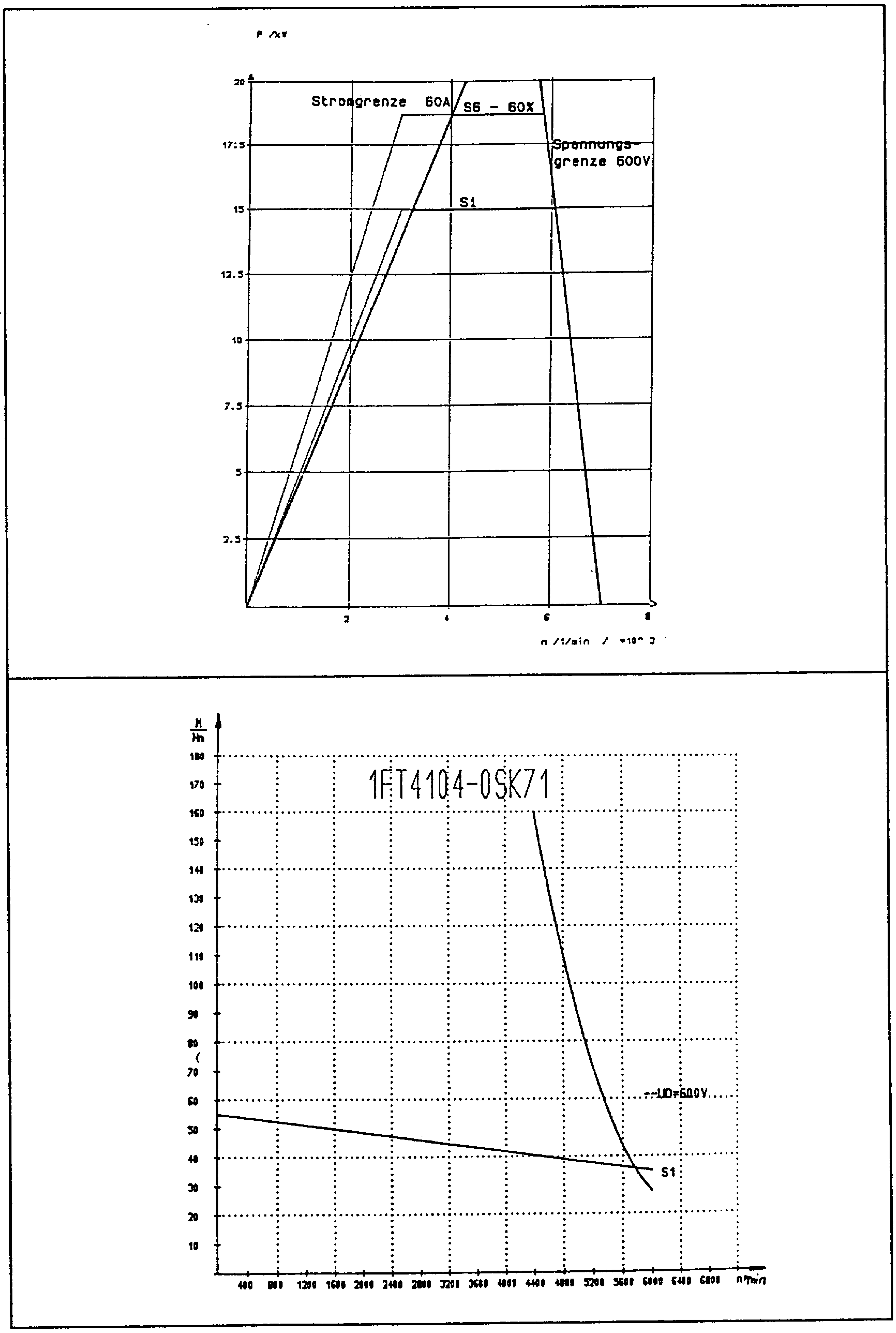


1FT4102-0SK71 servomotor, winding temperature rise $\Delta T = 100$ K

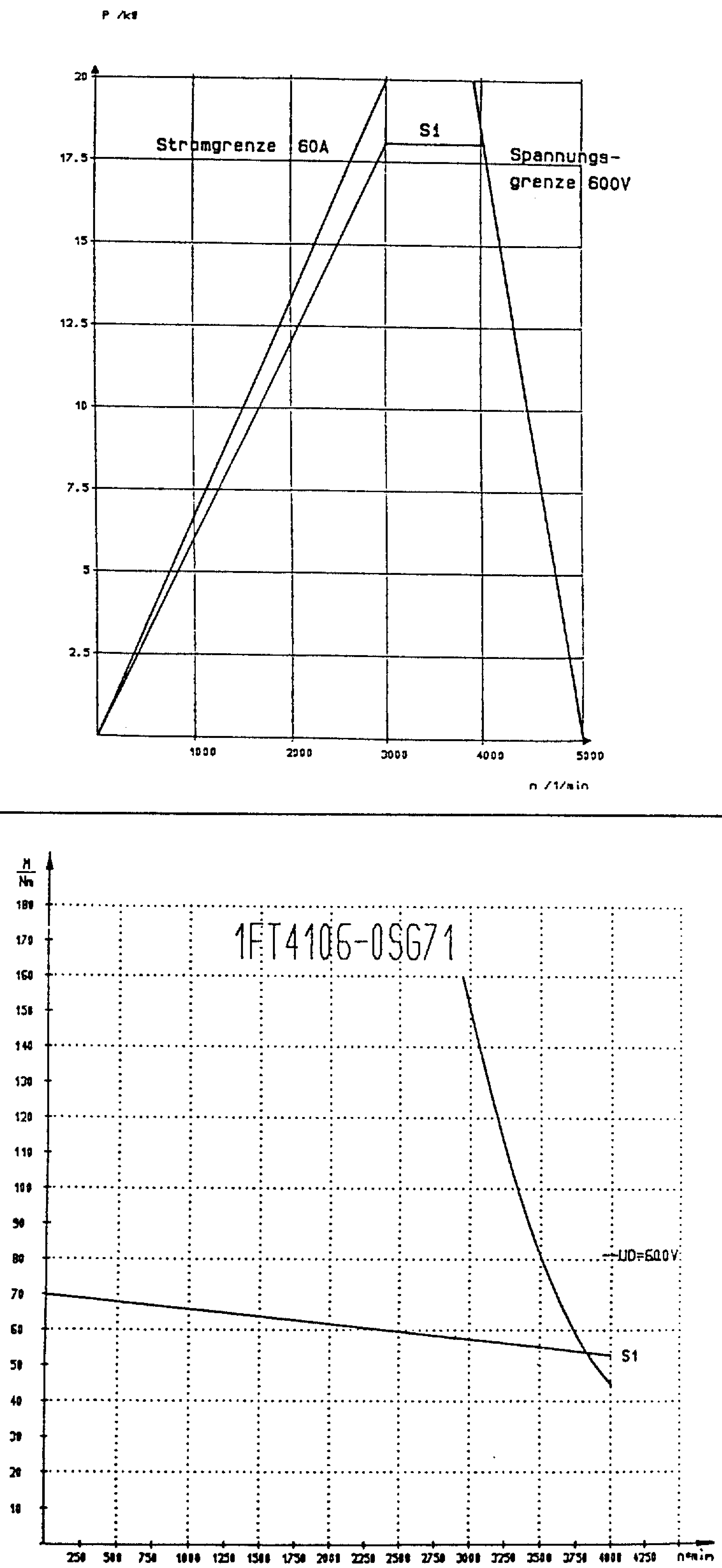
 6ZB5 420-0AS02
SIMODRIVE 611 (PJ)



1FT4104-0SG71 servomotor, winding temperature rise $\Delta T = 100$ K



1FT4104-0SK71 servomotor, winding temperature rise $\Delta T = 100$ K



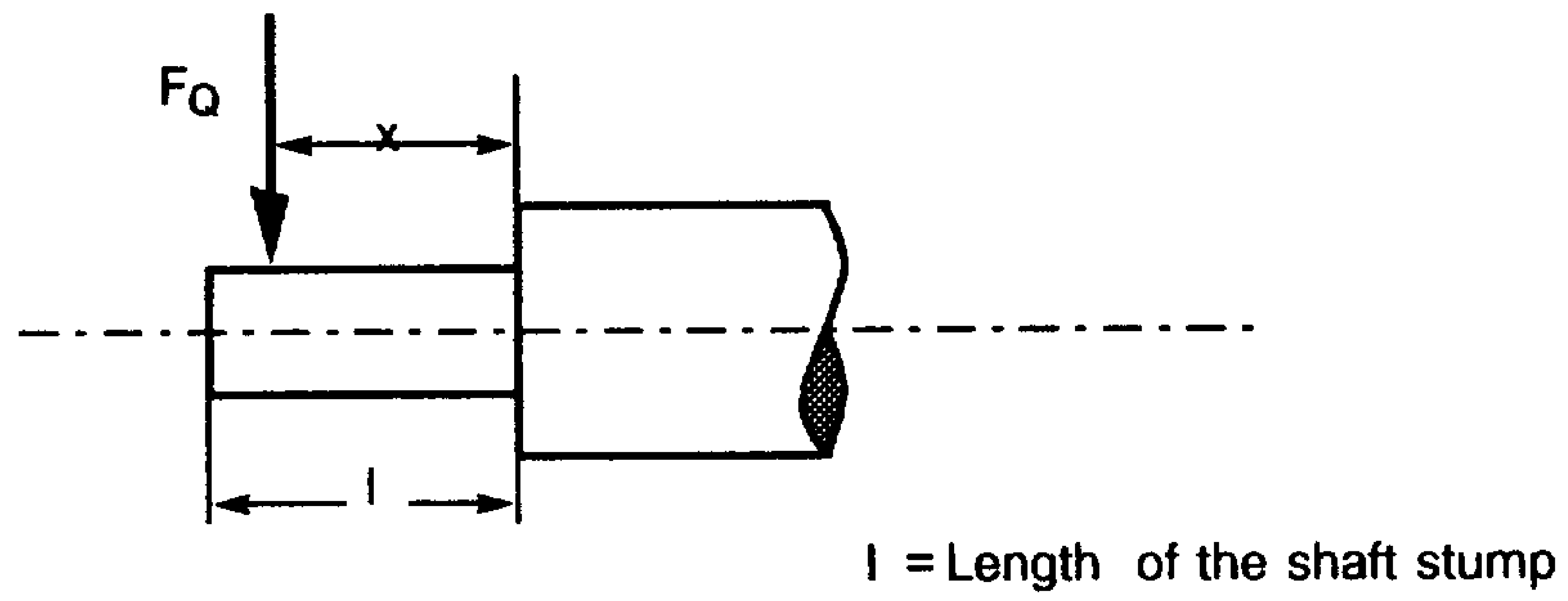
1FT4106-0SG71 servomotor, winding temperature rise $\Delta T = 100$ K

2.9 Cantilever force diagrams

The cantilever force diagrams show the cantilever force F_Q

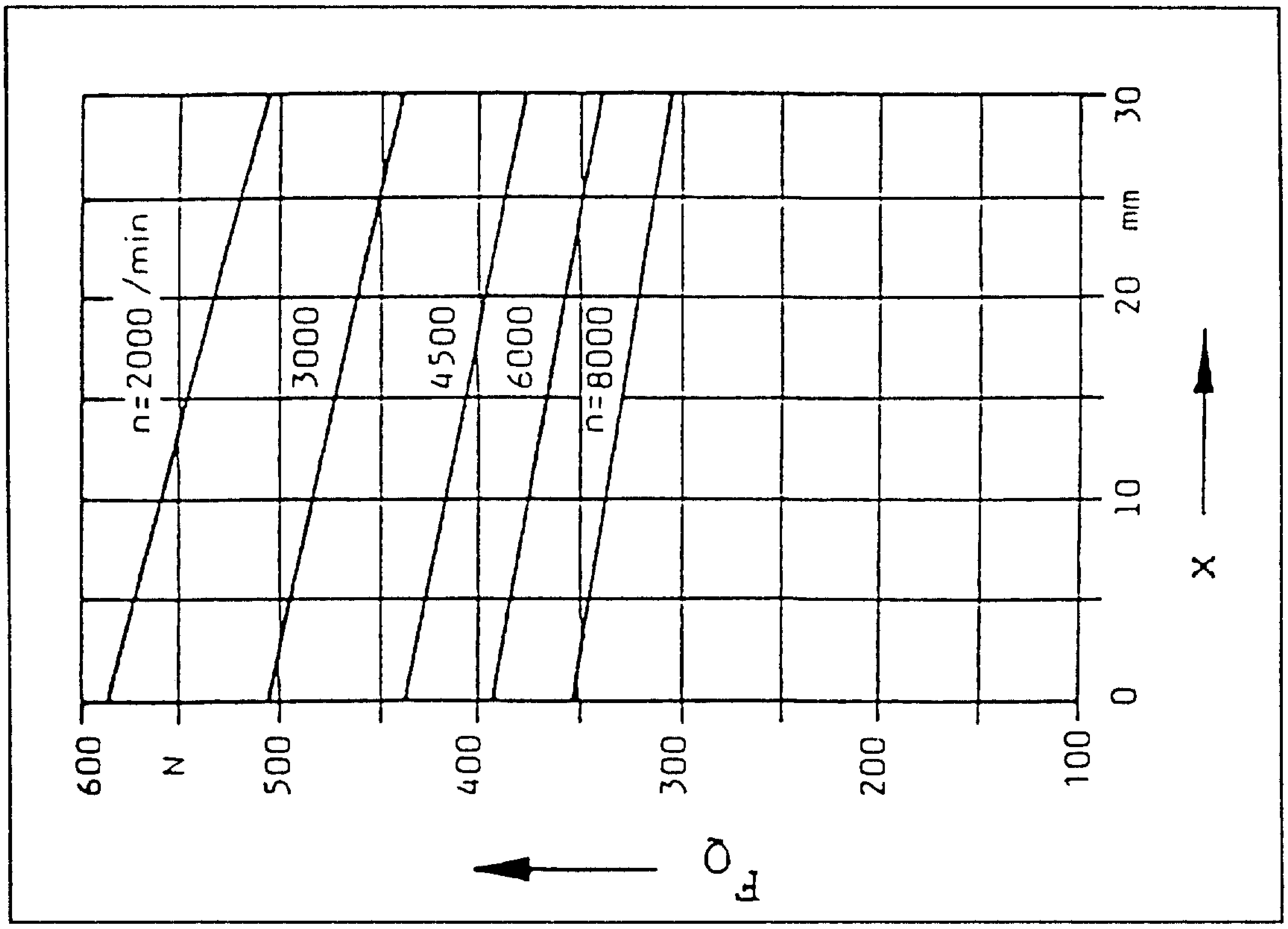
- at a distance x from the shaft shoulder
- at average operating speeds

for a nominal bearing service life of 20 000 hours.

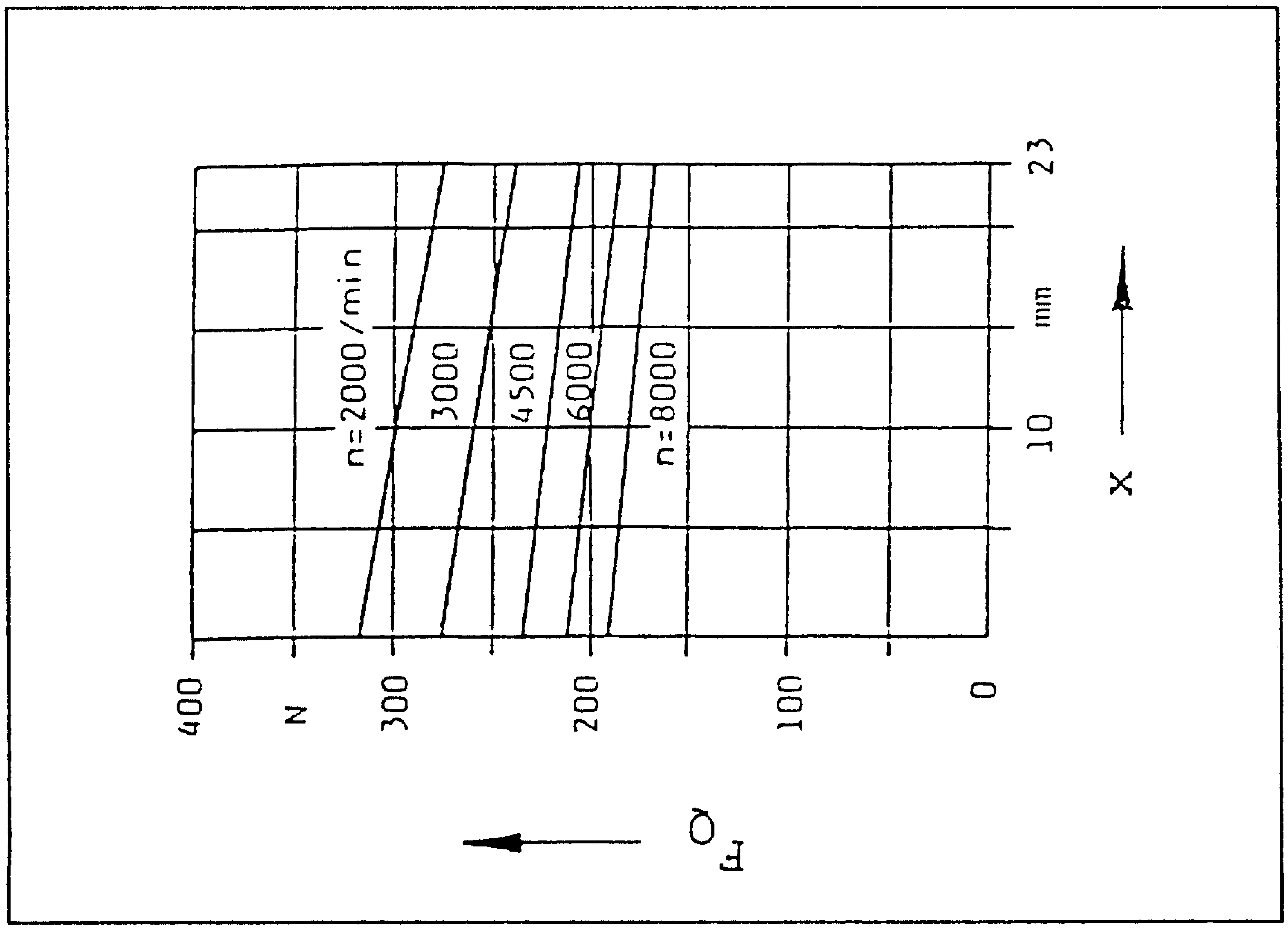


Point of application of cantilever forces on motor shaft ends

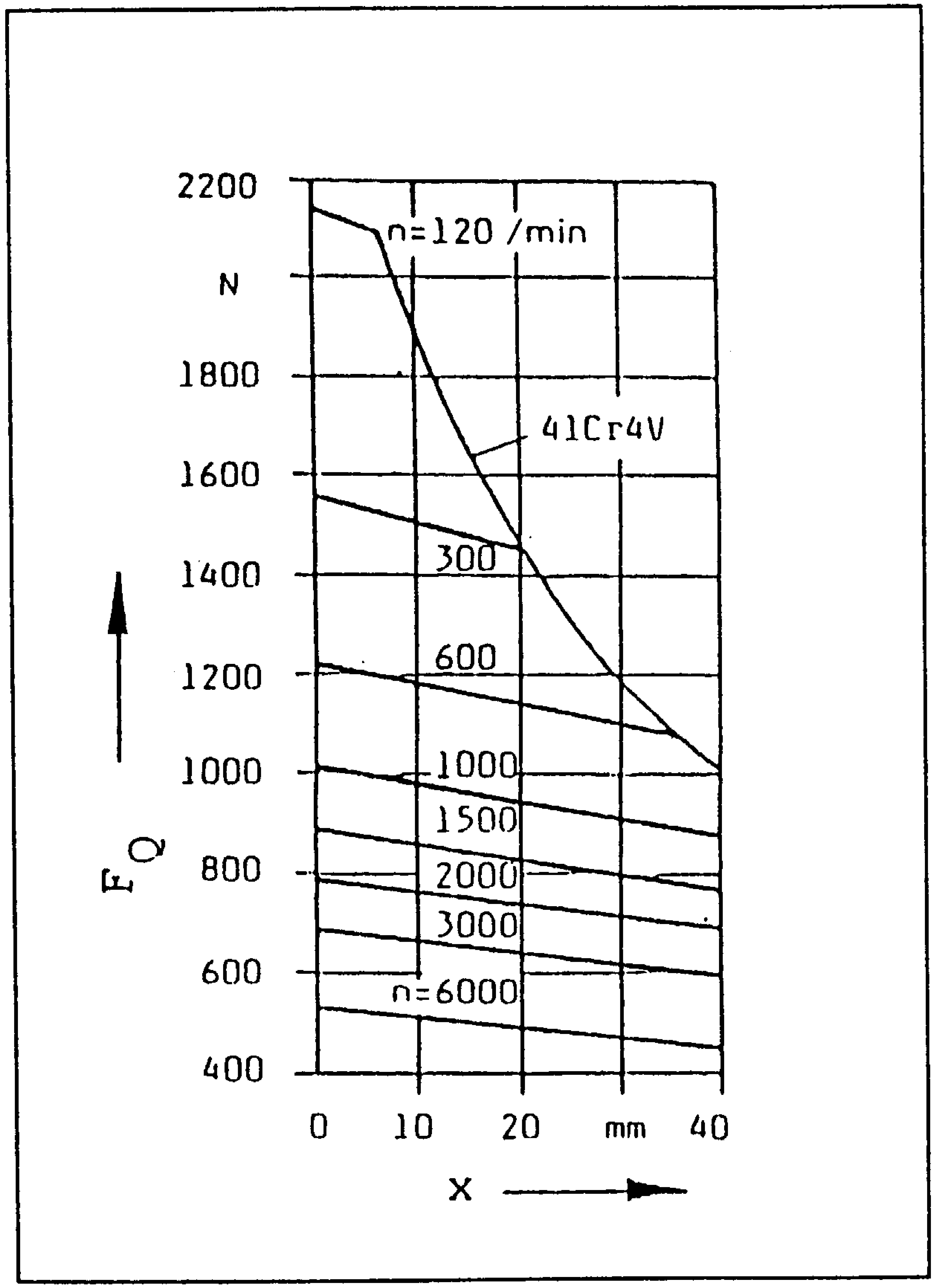
2.9.1 1FT5 AC servomotors, standard type of construction



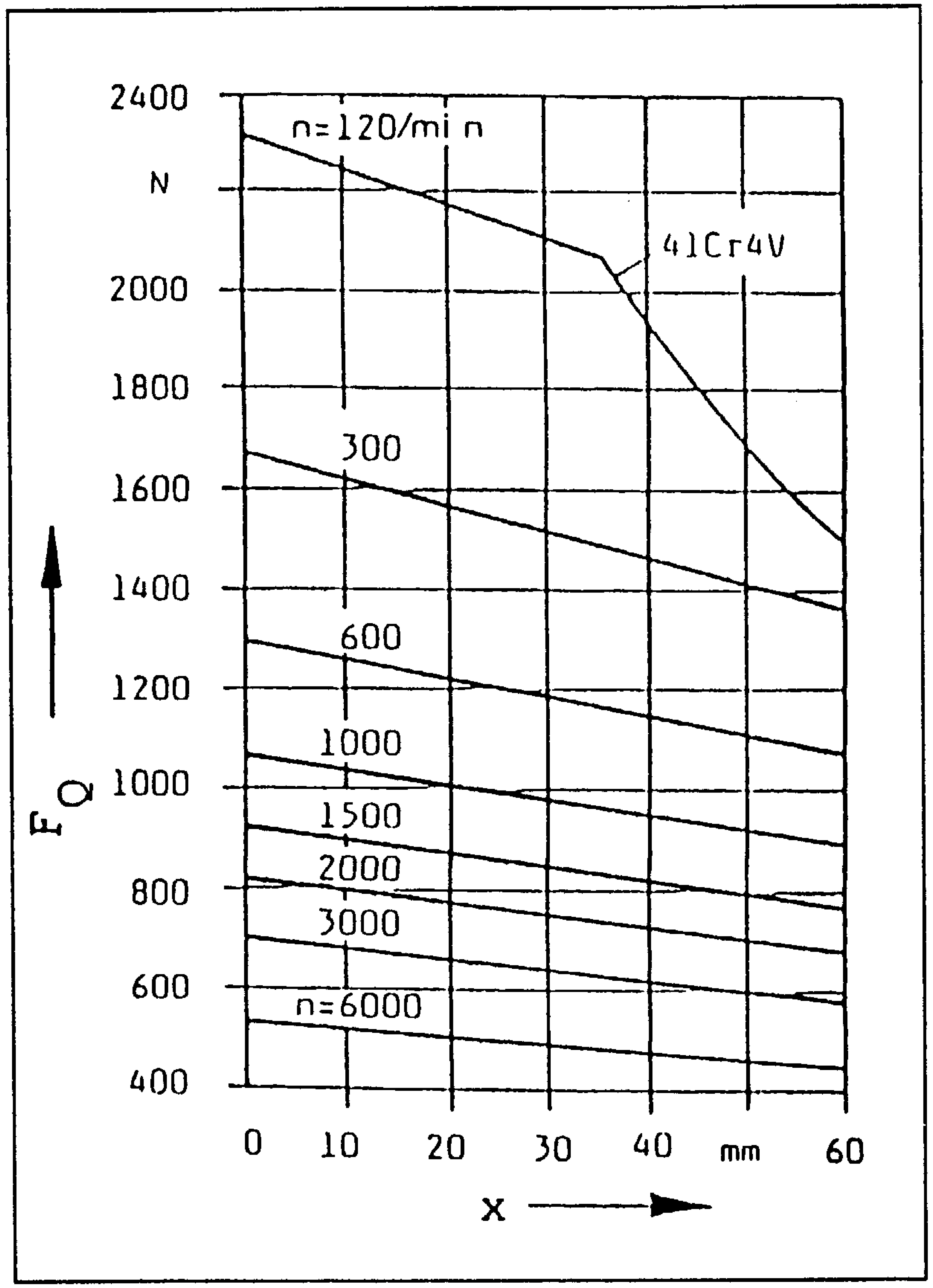
Permissible cantilever forces: Servomotors 1FT5042 to 1FT5046



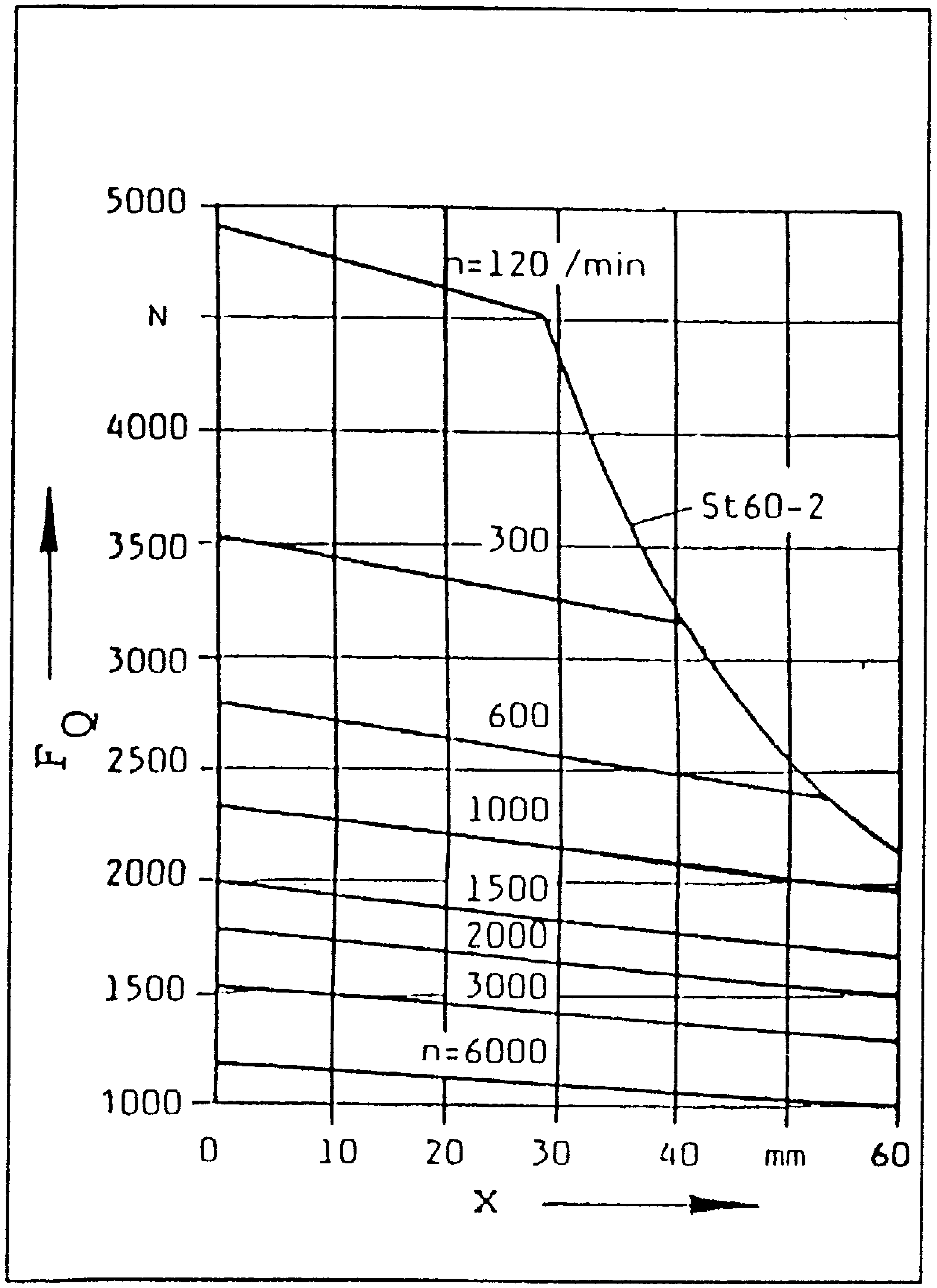
Permissible cantilever forces: Servomotors 1FT5034 to 1FT5036



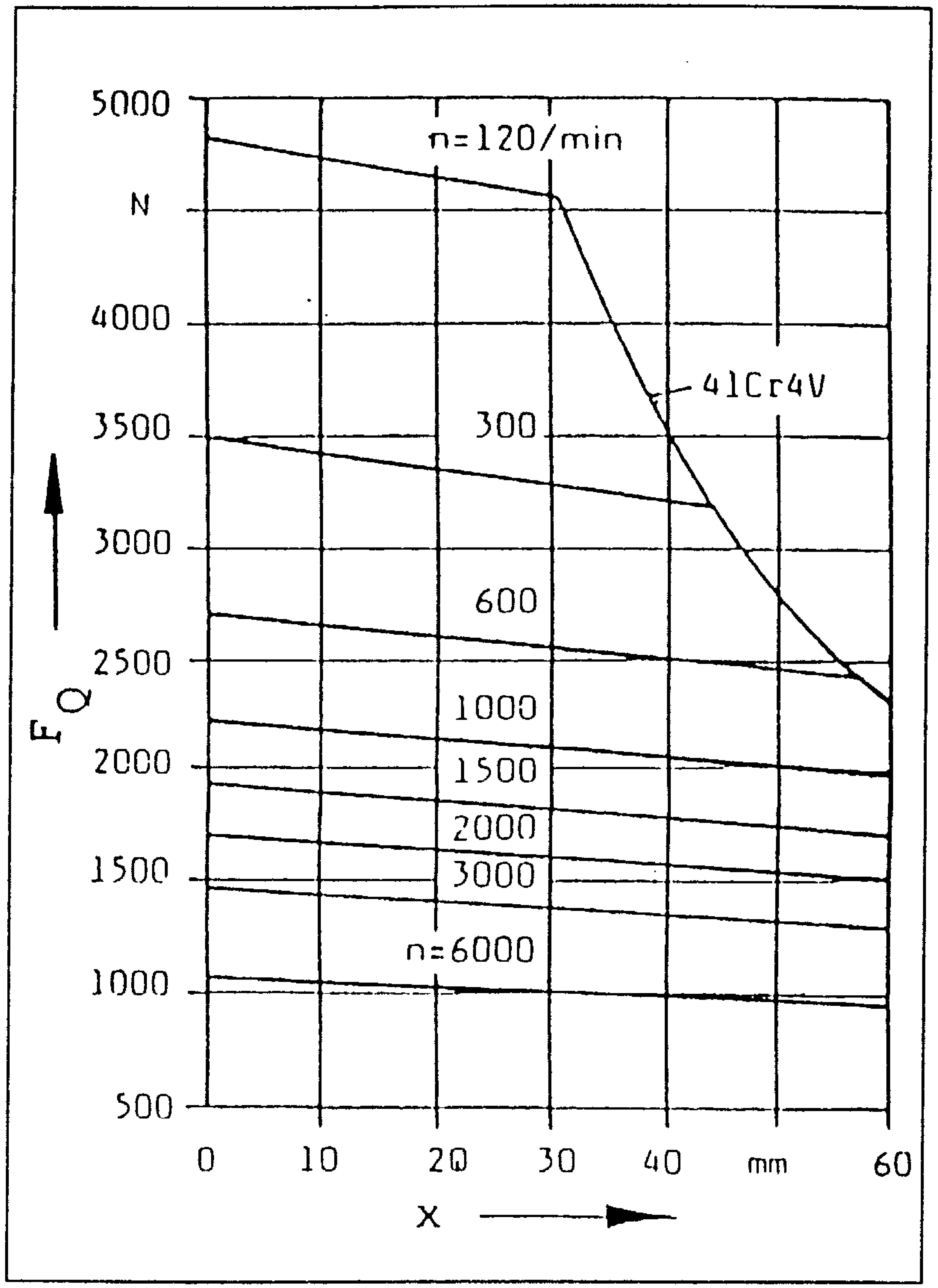
Permissible cantilever forces: Servomotors 1FT5062 to 1FT5066



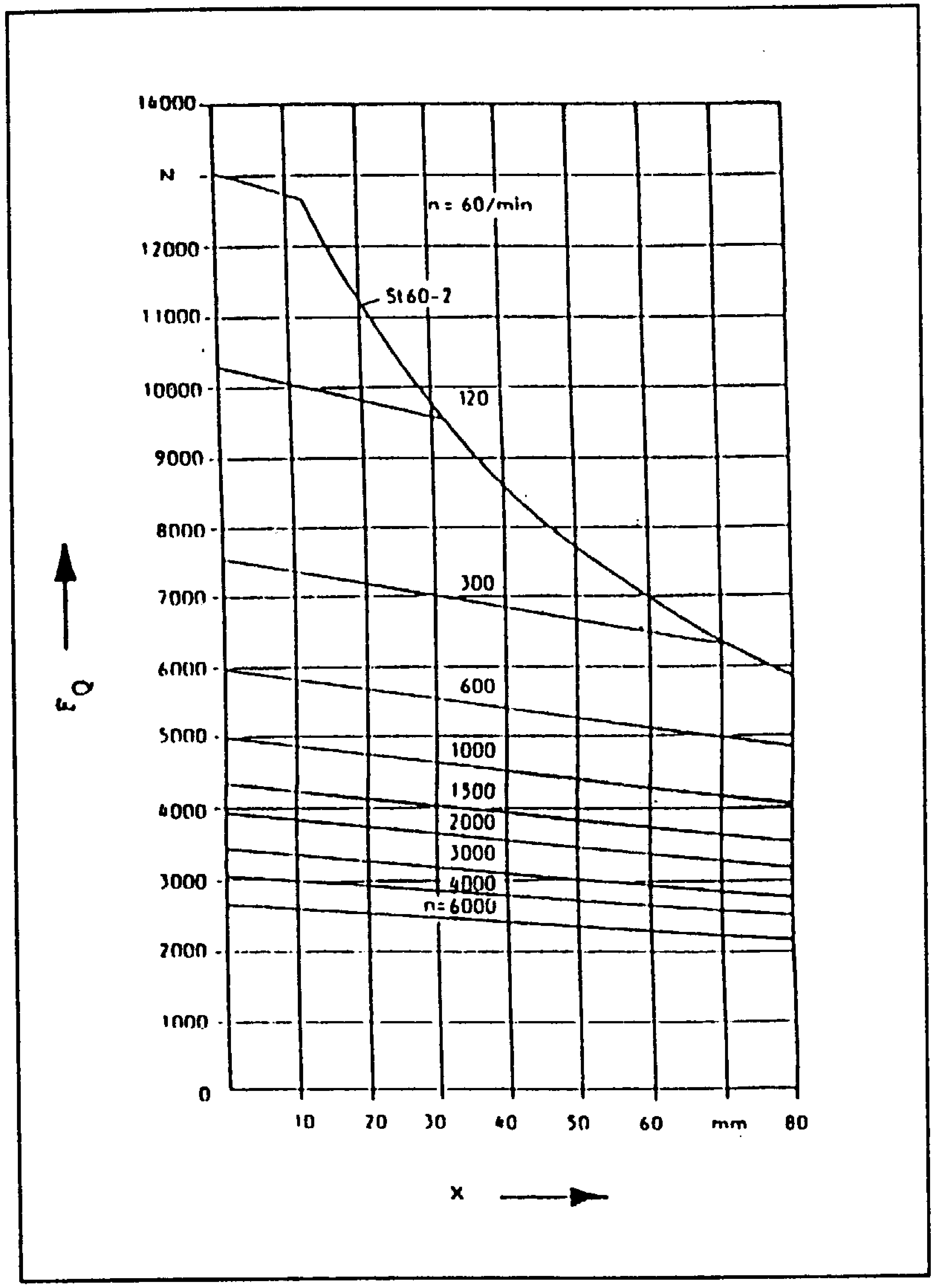
Permissible cantilever forces: Servomotors 1FT5072, 1FT5074 and 1FT5076



Permissible cantilever forces: Motors 1FT5102 and 1FT5104

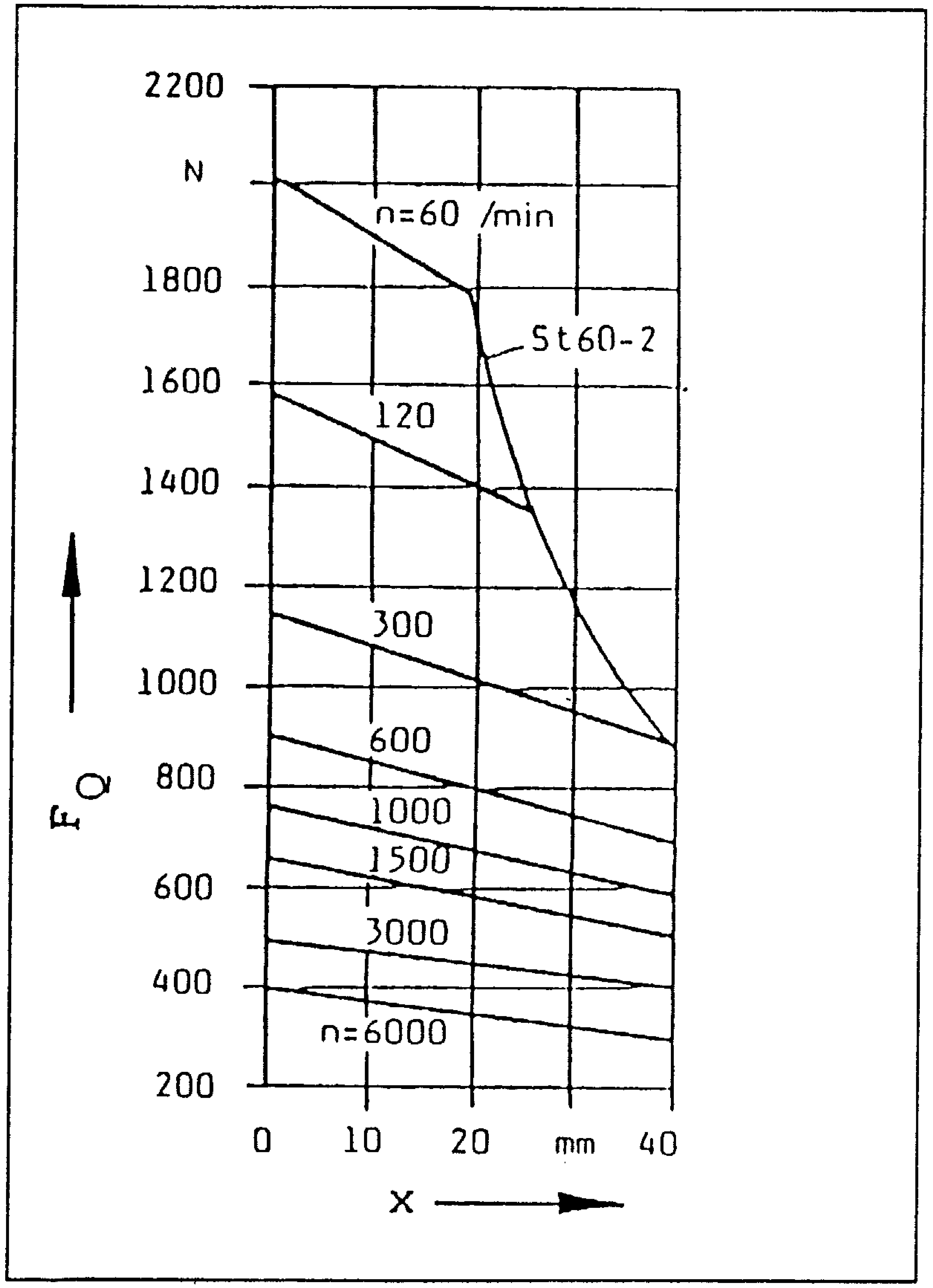


Permissible cantilever forces: Motors 1FT5106 and 1FT5108

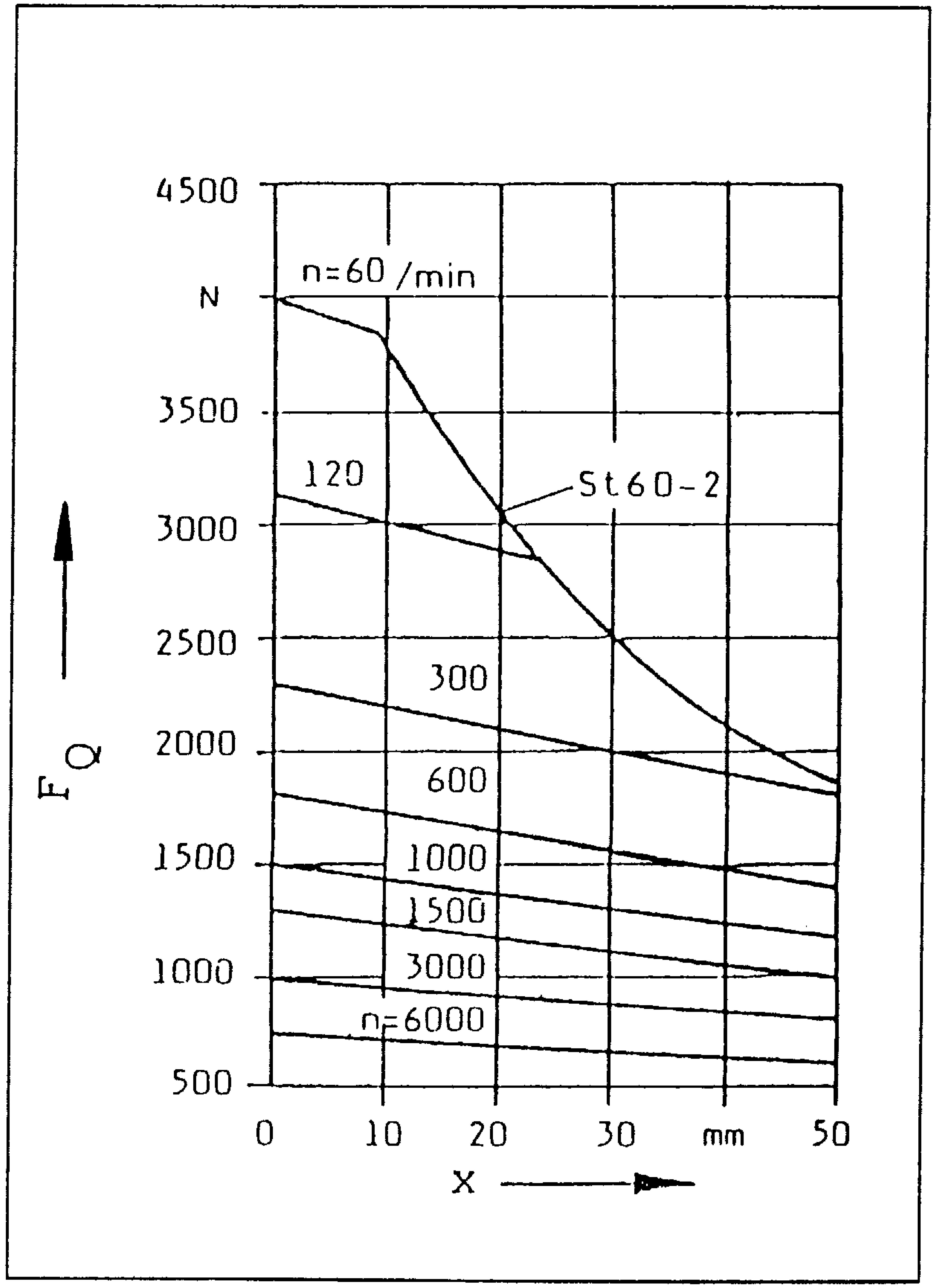


Permissible cantilever forces: Motors 1FT5132, 1FT5134 and 1FT5136

2.9.2 1FT5 AC servomotors, short type of construction

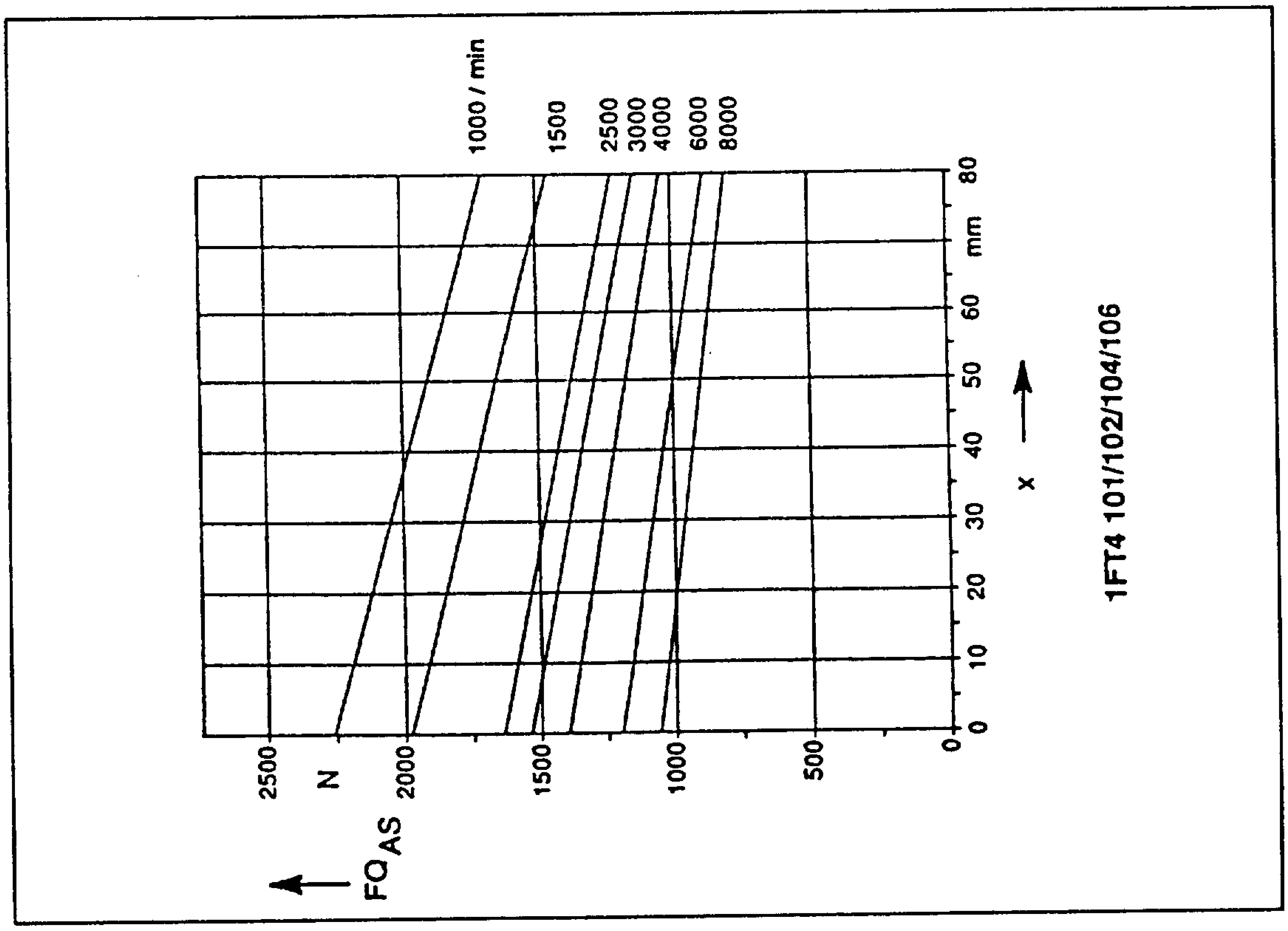


Permissible cantilever forces: Motors 1FT5070 and 1FT5071

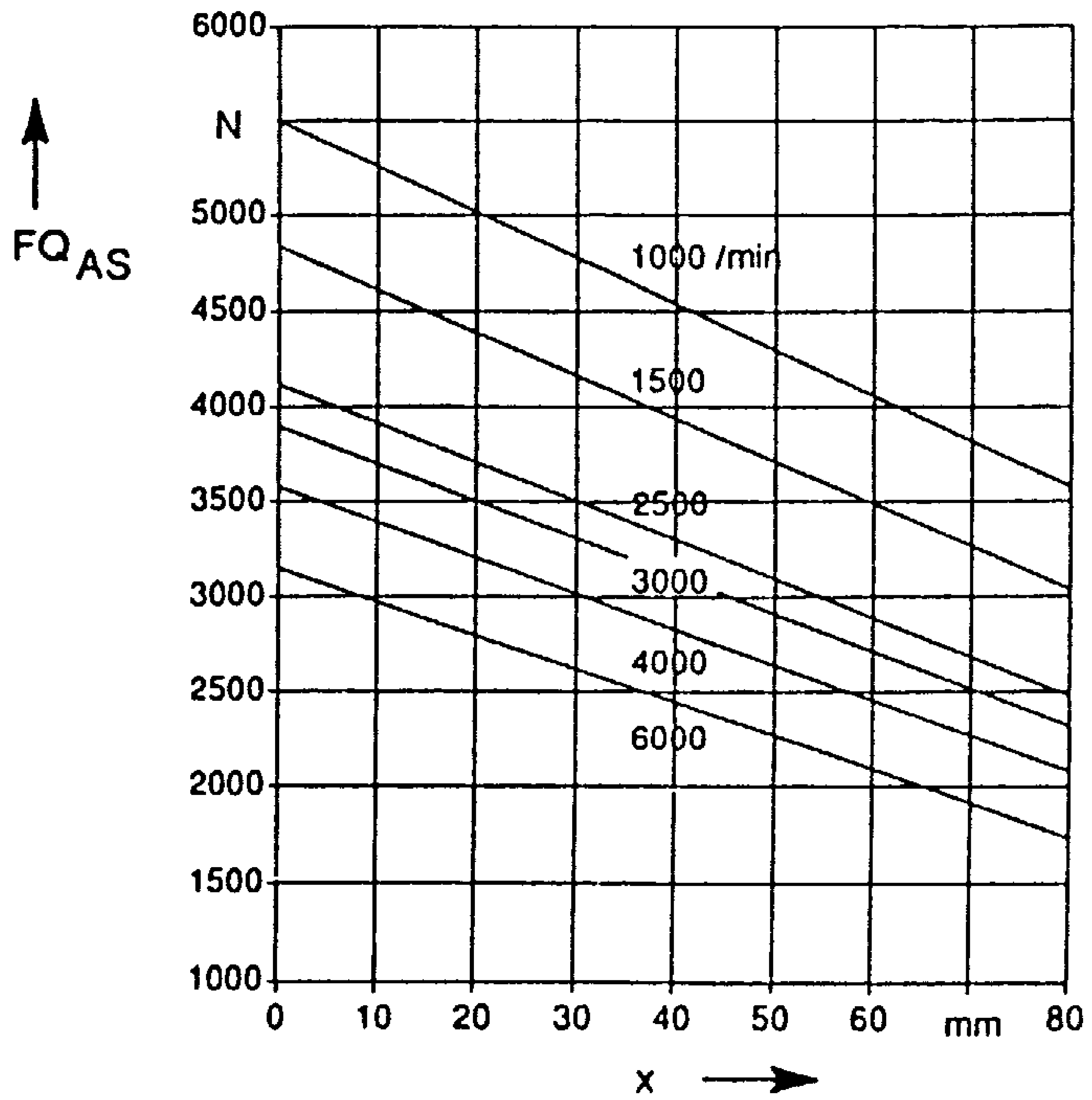


Permissible cantilever forces: Motors 1FT5100, 1FT5101 and 1FT5103

2.9.3 1FT4 AC servomotors

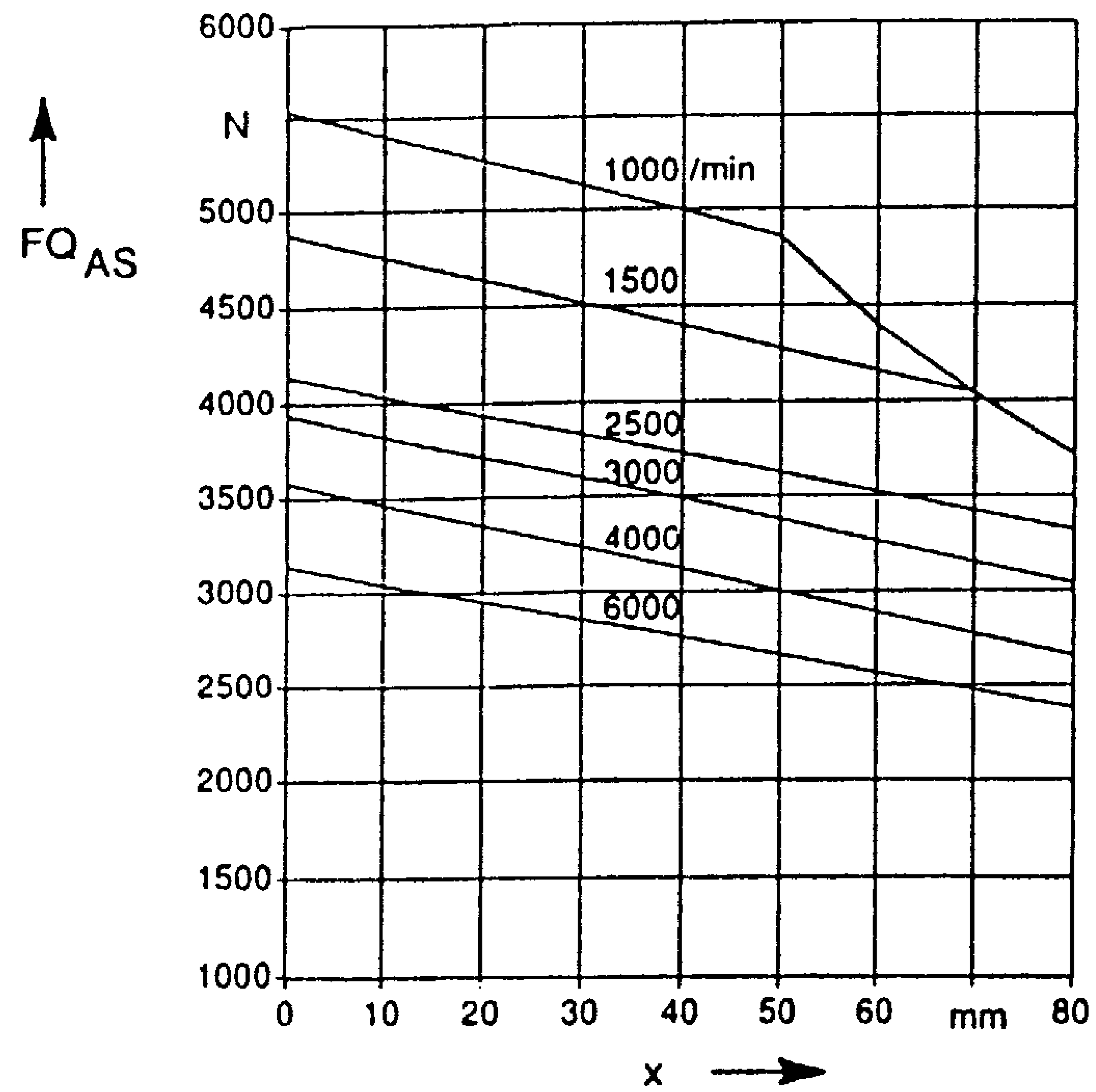


Permissible cantilever forces: Motors 1FT4101 to 1FT4106



1FT4 101/102

Permissible cantilever forces: Motors 1FT4101/102 ***double bearing design***



1FT4 104/106

Permissible cantilever forces: Motors 1FT4104/106 ***double bearing design***

2.10 Dimension drawings

Notes: All dimension drawings not to scale
All dimensions in mm.
Tolerance zones for shafts and flange acc. to DIN ISO 286.

2.10.1 1FT5 AC servomotors, standard type of construction

2.10.1.1 Basic version with connector

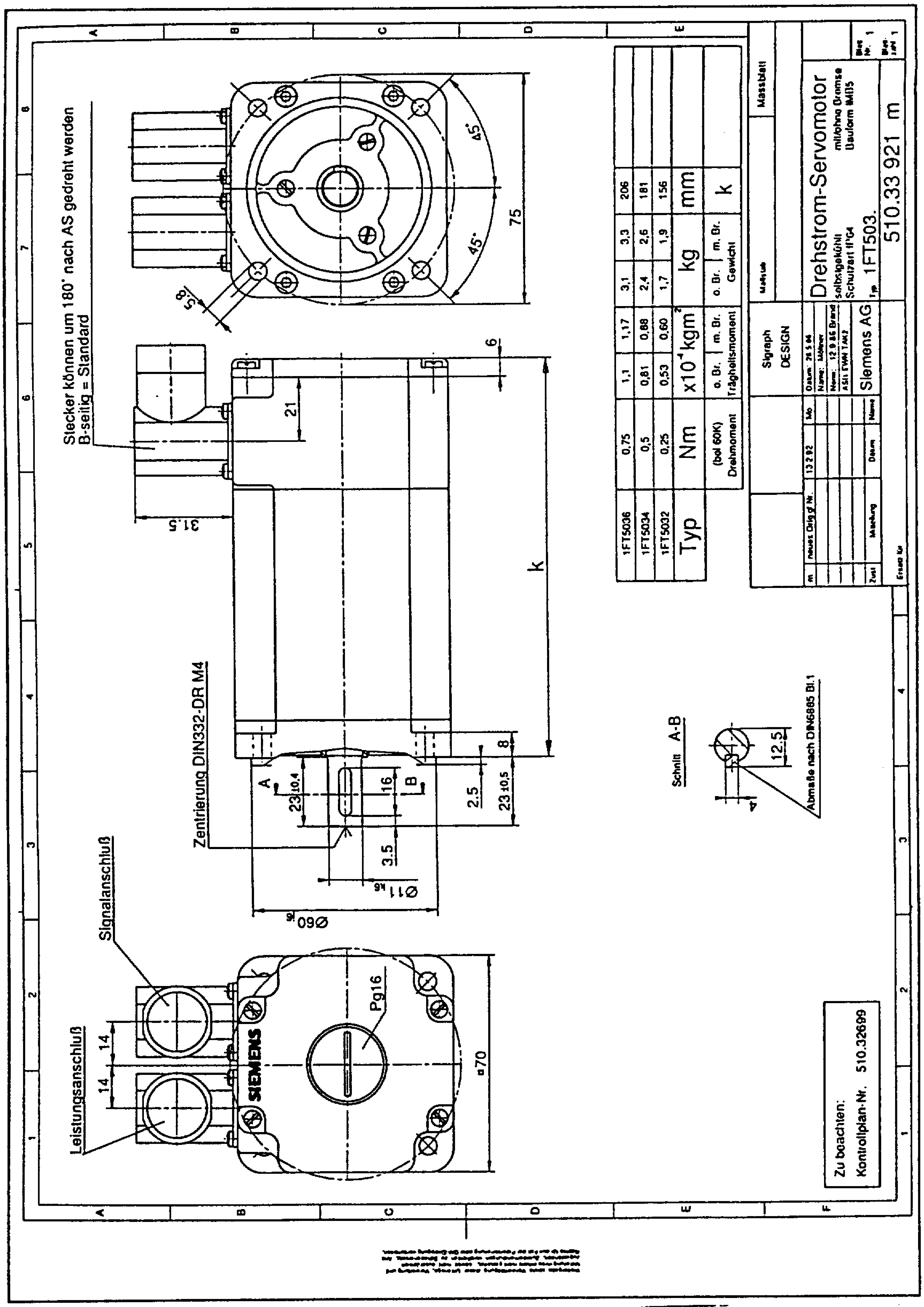
2.10.1.2 Basic version with terminal box

2.10.1.3 Options

2.10.2 1FT5 AC servomotors, short type of construction

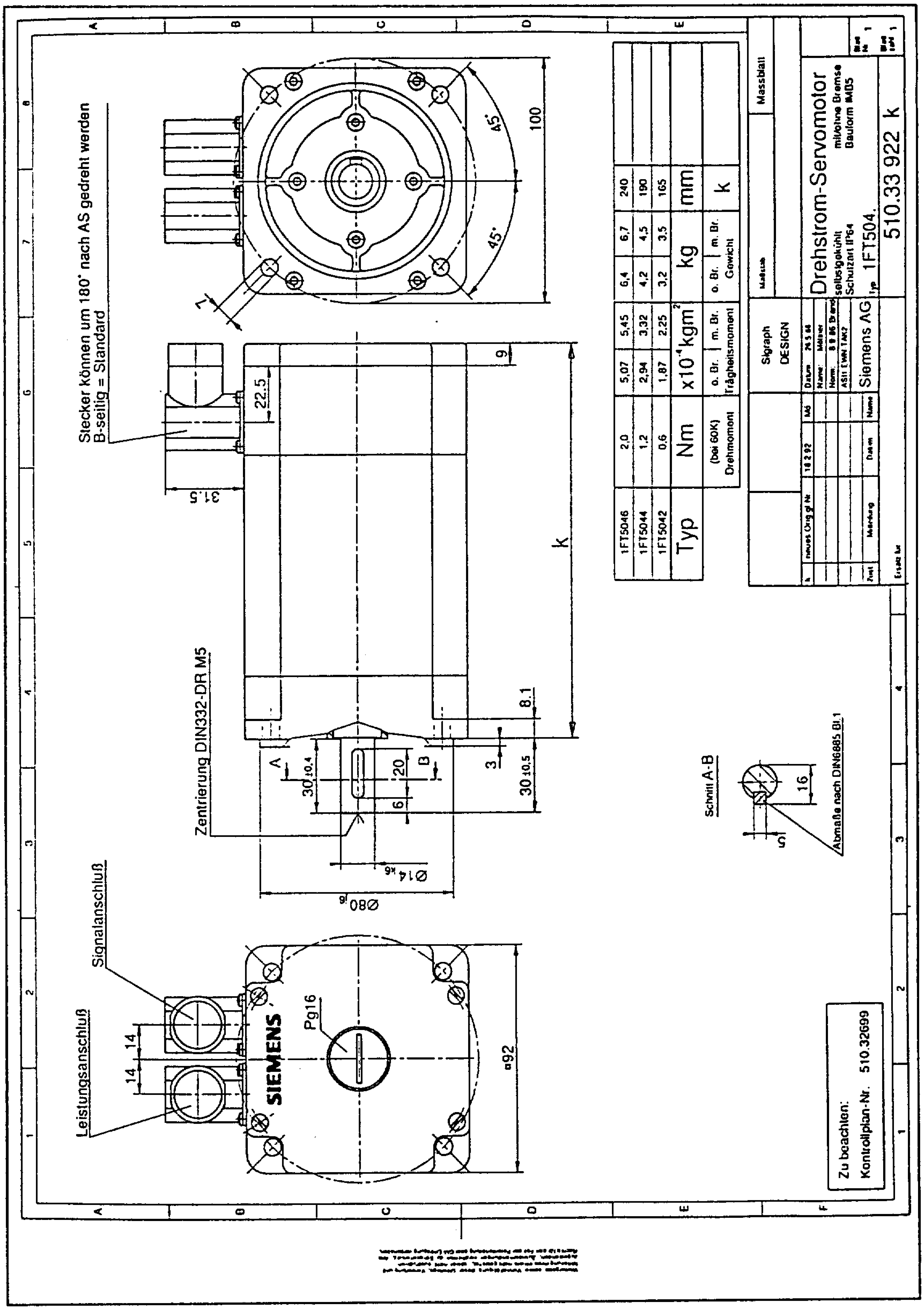
Dictionary

Abmaße nach	deviations to
Achtung! Bei Kabeleinführung von BS muß der Impulsgeberstecker von links, rechts oder unten erfolgen - dieses ist bei Bestellung anzugeben	Important! With cable entry from non-drive end, the shaft encoder plug must be connected from the left, rigt or below-details must be stated in order
Ansicht	view
äußere Schutzleiterklemme	external protective conductor terminal
B-seitig = standard	non-drive end = standard
bei 60K	at 60K
bei Impulsgeber	for shaft encoder
Bl.	sht.
Bremsenanschluß	brake connection
Die Stecker können jeweils um 90 Grad gedrehrt werden.	Plug entry can be turned in steps of 90o
Drehmoment	torque
Drehstrom-Servomotor	AC servomotor
explosionsgeschützt	explosion-protected
Gewicht	weight
gültig für	applies to
Impulsgeber	shaft encoder
Klemmenkasten	terminal box
Klemmkasten-/Ankerkreiszuordnung	terminal-box type graded according to armature circuit
Kontrollplan-Nr.	check list no.
Leistungsanschluß	power connection
m. Br.	with brake
Maß	size
Maßblatt	dimension drawing
Maße	dimensions
Maßstab	scale
mit Impulsgeber	with shaft encoder
mit/ohne Bremse	with/without holding brake
Motor- + Bremsenanschluß	motor and brake connection
Motoranschluß	motor connection
nach Kundenbestellung	according to customer order
o. Br.	without brake
Ringschraube nicht eingezeichnet	eye-bolt not included in drawing
Schnitt	section
Schutzart	degree of protection
Selbstgekühlt	self-ventilated
Signalanschluß	signal connection
Spannung	voltage
Standard	standard
Standardsteckerausführung	standard plug design
Steckdose für Rotorgeberanschluß	socket for connection of shaft encoder
Steckergröße-/Ankerkreiszuordnung	plug size according to armature circuit
Steckergrößen	plug size
Stromstärke	current
Tacho- und Kaltleiteranschluß	connection of tachogenerator and PTC thermistor
Trägheitsmoment	moment of inertia
Typ	type
Zentrierung	centering
Zu beachten	important



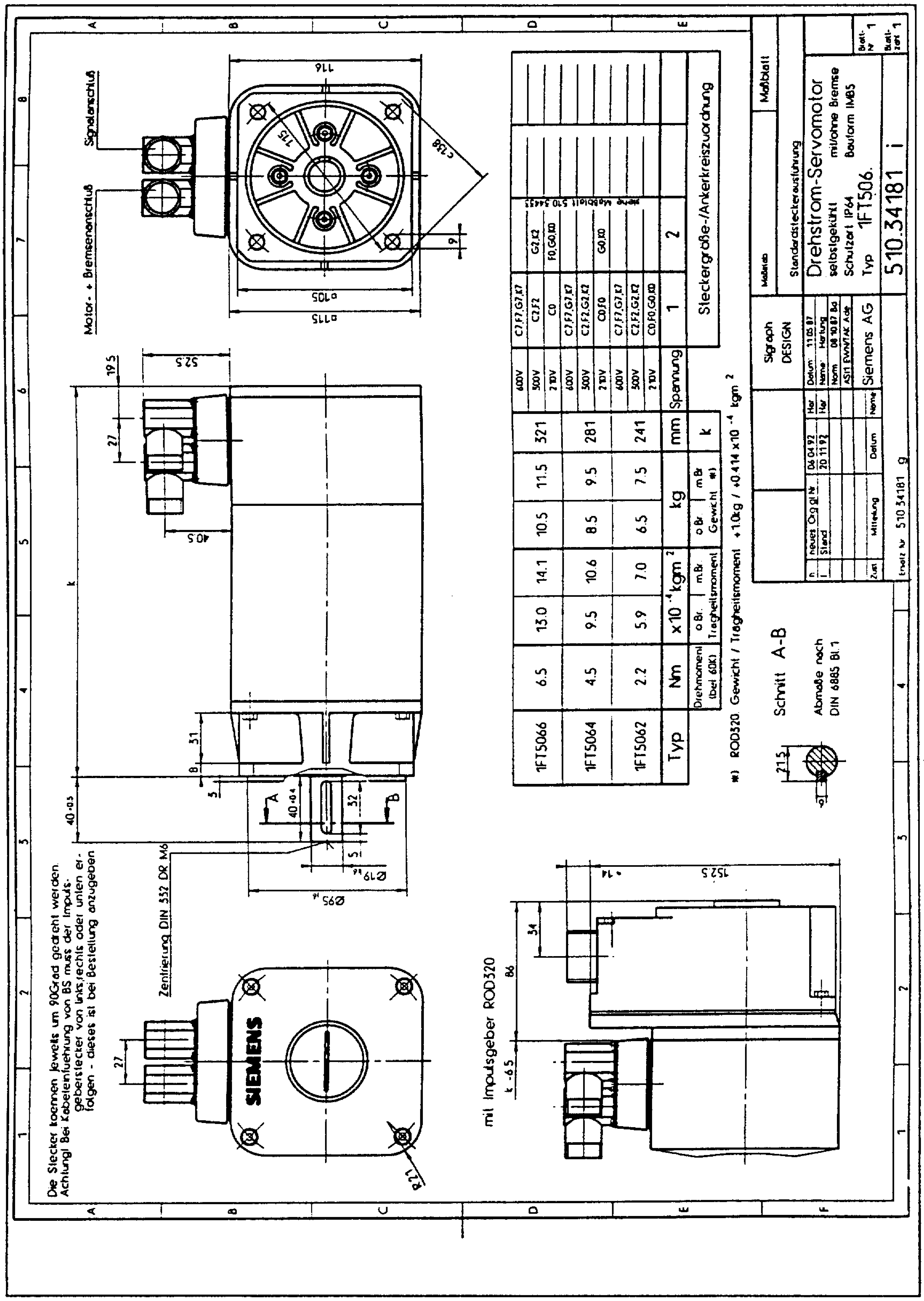
Typ	Nm (bei 60K) Drehmoment	x10⁻⁴kgm² o. Br. Trägheitsmoment	x10⁻⁴kgm² m. Br. Trägheitsmoment	kg o. Br. Gewicht	kg m. Br. Gewicht	mm k
1FT5036	0,75	1,1	1,17	3,1	3,3	206
1FT5034	0,5	0,81	0,88	2,4	2,6	181
1FT5032	0,25	0,53	0,60	1,7	1,9	156

Dimension drawing of 1FT5032 to 1FT5036 servomotors, type of construction IM B5
(motor type 1FT5032-□□□7□-□ is not available)



Typ	Nm (bei 60K) Drehmoment	x10⁻⁴kgm² o. Br. (Trägheitsmoment)	x10⁻⁴kgm² m. Br. (Trägheitsmoment)	kg o. Br. (Gewicht)	kg m. Br. (Gewicht)	mm k
1FT5046	2,0	5,07	5,45	6,4	6,7	240
1FT5044	1,2	2,94	3,32	4,2	4,5	190
1FT5042	0,6	1,87	2,25	3,2	3,5	165

Dimension drawing of 1FT5042 to 1FT5046 servomotors, type of construction IM B5

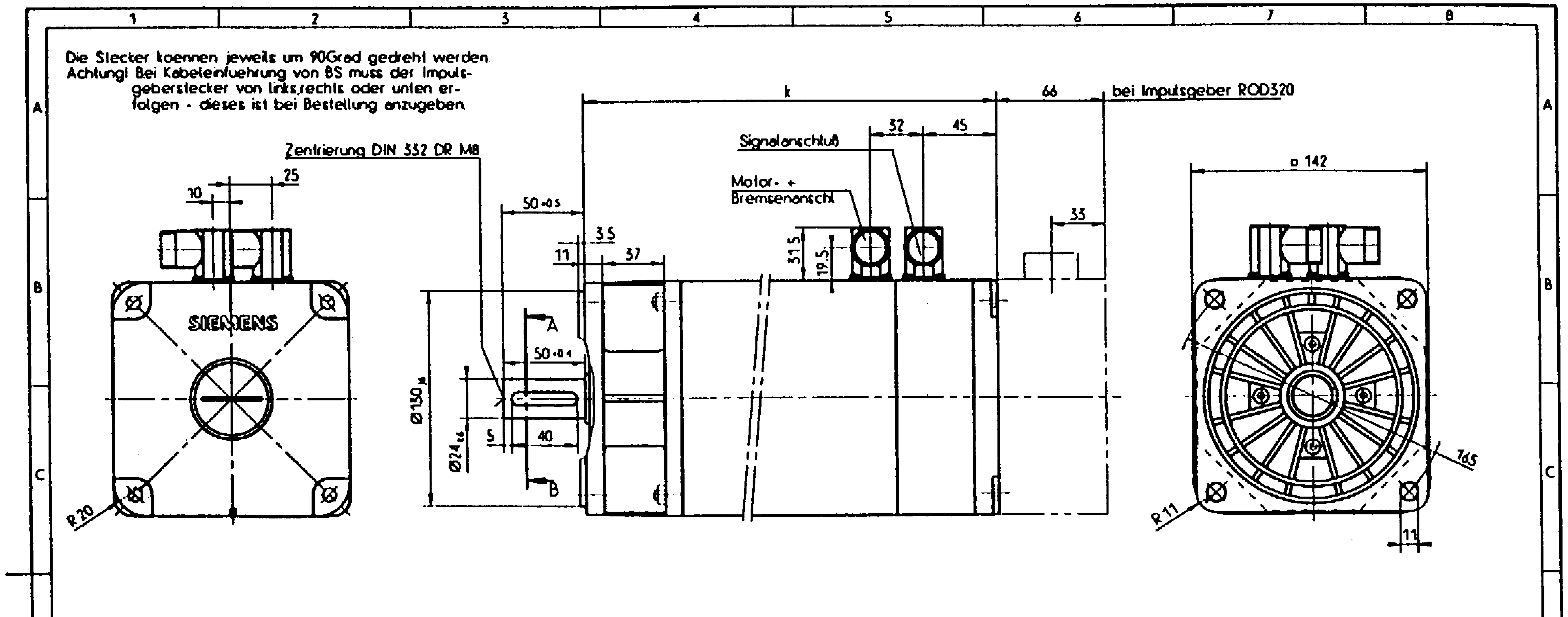


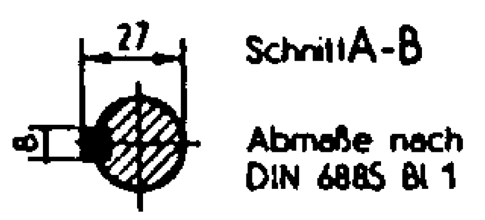
Typ	Nm Drehmoment (bei 60K)	$x10^{-4}$ kgm² Trägheitsmoment o.Br.	$x10^{-4}$ kgm² Trägheitsmoment m.Br.	kg Gewicht o.Br.	kg Gewicht m.Br. *)	mm k	Spannung	Steckergröße-/Ankerkreiszuordnung 1	2
1FT5066	6.5	13.0	14.1	10.5	11.5	321	600V	C7,F7,G7,K7	
							500V	C2,F2	G2,K2
							210V	C0	F0,G0,K0
1FT5064	4.5	9.5	10.6	8.5	9.5	281	600V	C7,F7,G7,K7	
							500V	C2,F2,G2,K2	
							210V	C0,F0	G0,K0
1FT5062	2.2	5.9	7.0	6.5	7.5	241	600V	C7,F7,G7,K7	
							500V	C2,F2,G2,K2	
							210V	C0,F0,G0,K0	

siehe Maßblatt 510.34455

*) ROD320 Gewicht / Trägheitsmoment +1.0kg / +0.414 x10^{-4} kgm²

Dimension drawing of 1FT5062 to 1FT5066 AC servomotors, with connectors (size 1), type of construction IM B5





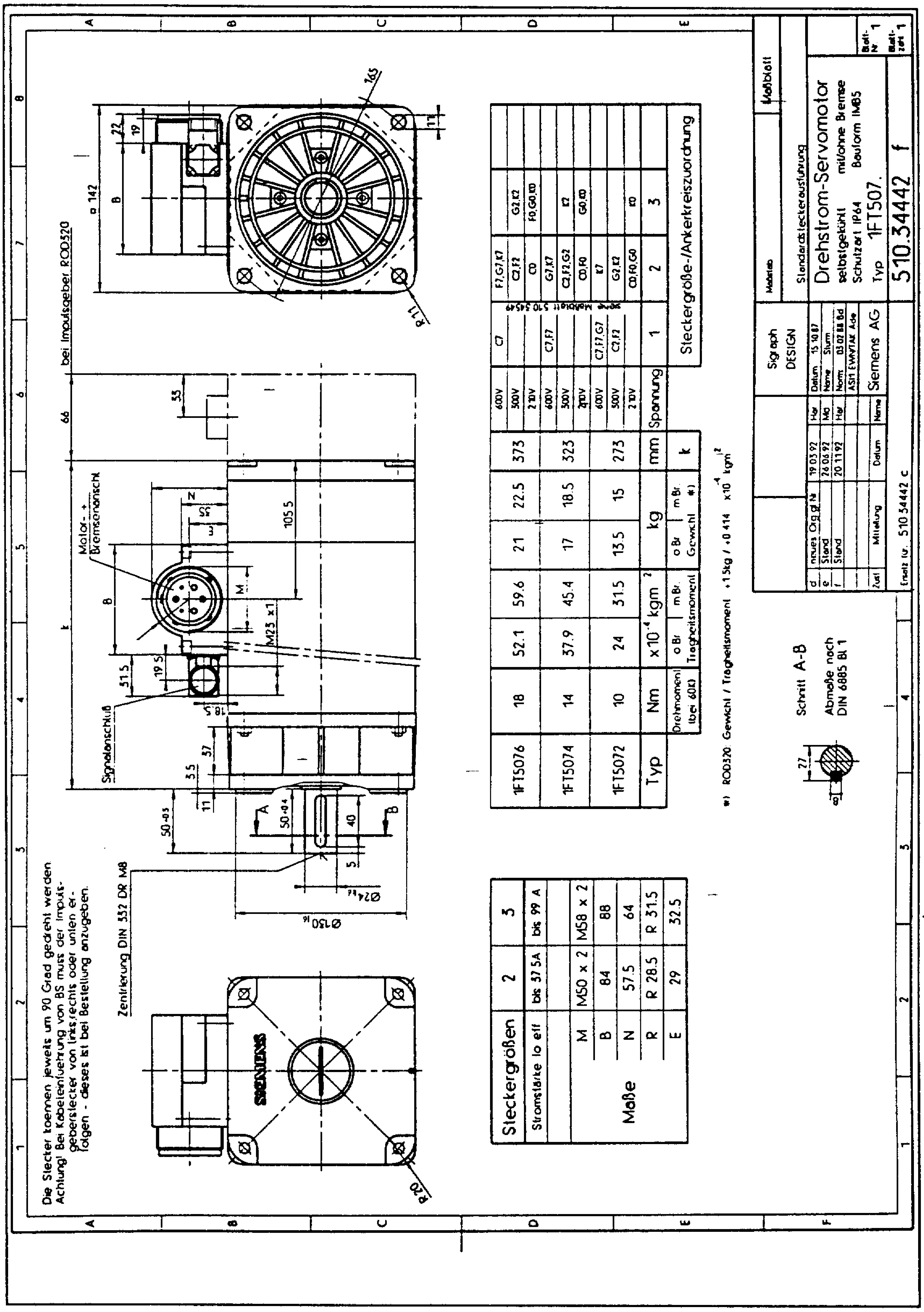
Typ	Nm Drehmoment (bei 60K)	x10⁻⁴ kgm² o Br Trägheitsmoment	x10⁻⁴ kgm² m Br Trägheitsmoment	kg o Br Gewicht	kg m Br Gewicht *)	mm k	Spannung	1	2	3
1FT5076	18	52.1	59.6	21	22.5	373	600V	C7	F7,G7,K7	
							300V		C2,F2	G2,K2
							210V		C0	F0,G0,K0
1FT5074	14	37.9	45.4	17	18.5	323	600V	C7,F7	G7,K7	
							300V		C2,F2,G2	K2
							210V		C0,F0	G0,K0
1FT5072	10	24	31.5	13.5	15	273	600V	C7,F7,G7	K7	
							300V	C2,F2	G2,K2	
							210V		C0,F0,G0	K0

Steckergröße-/Ankerkreiszuordnung (siehe Maßblatt 510.34442)

*) ROD320: Gewicht / Trägheitsmoment +1.5kg / +0.414 x10⁻⁴ kgm²

Sigraph DESIGN	Maßstab / Maßblatt
f neues Org.gl.Nr. 20.05.92 / g Stand 26.06.92 / h Stand 20.11.92	Standardsteckerausführung
Datum 14.03.88, Name Herlung, Norm 18.03.88	Drehstrom-Servomotor selbstgekühlt mit/ohne Bremse, Schutzart IP64, Bauform IMB5
Siemens AG	Typ 1FT507.
Ersatz für 510 34549 e	510.34549 h

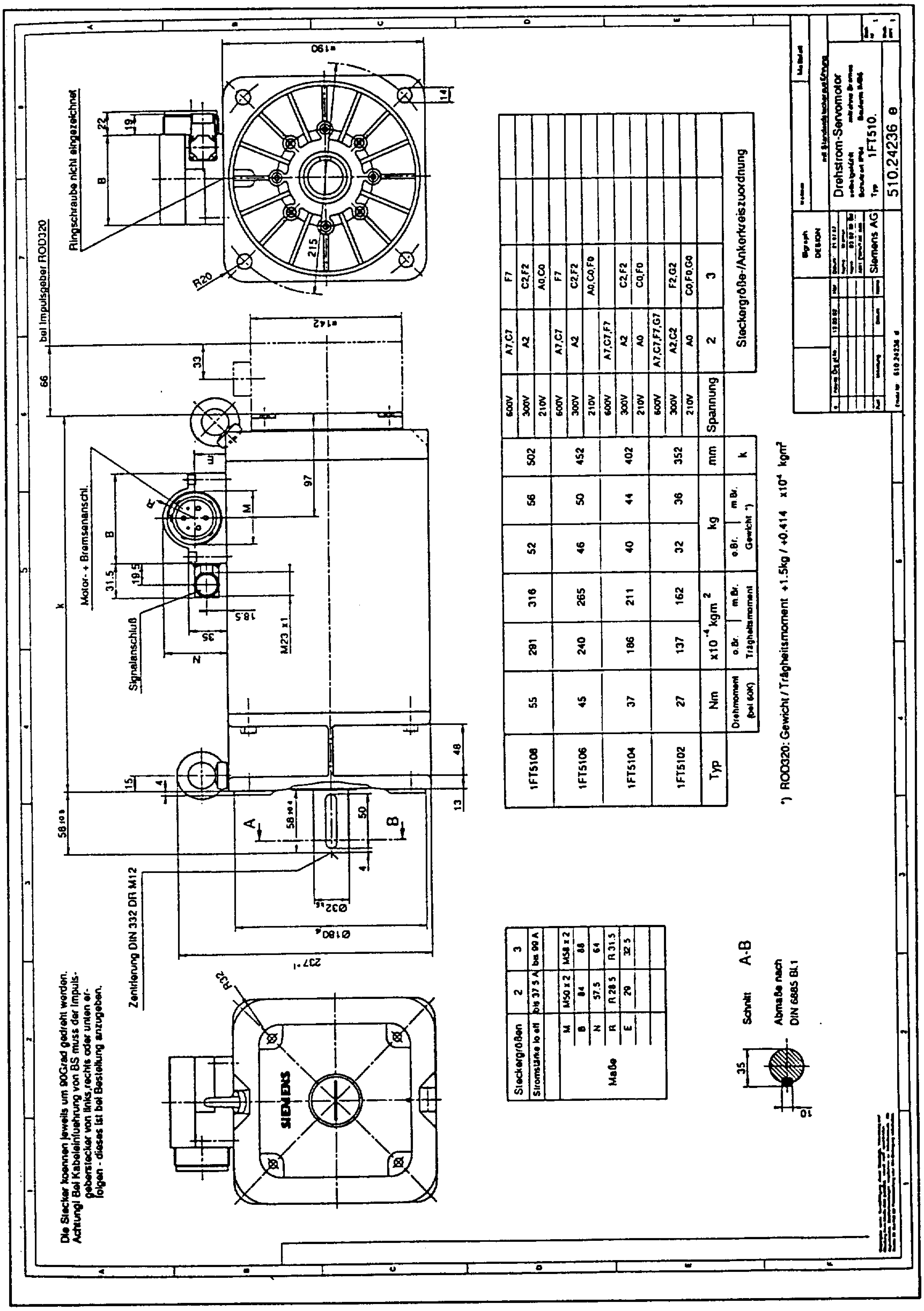
Dimension drawing of 1FT5072 to 1FT5076 AC servomotors with connectors (size 1) - type of construction IM B5



Steckergrößen		2	3
Stromstärke Io eff		bis 37.5A	bis 99 A
Maße	M	M50 x 2	M58 x 2
	B	84	88
	N	57.5	64
	R	R 28.5	R 31.5
	E	29	32.5

Typ	Nm	x10⁻⁴ kgm² o Br	x10⁻⁴ kgm² m Br.	kg o Br	kg m Br. *)	mm k	Spannung	1	2	3
1FT5076	18	52.1	59.6	21	22.5	373	600V	C7	F7,G7,K7	
							300V		C2,F2	G2,K2
							210V		C0	F0,G0,K0
1FT5074	14	37.9	45.4	17	18.5	323	600V	C7,F7	G7,K7	
							300V		C2,F2,G2	K2
							210V		C0,F0	G0,K0
1FT5072	10	24	31.5	13.5	15	273	600V	C7,F7,G7	K7	
							300V	C2,F2	G2,K2	
							210V		C0,F0,G0	K0
	Drehmoment (bei 60K)	Trägheitsmoment		Gewicht		k	Steckergröße-/Ankerkreiszuordnung			

Dimension drawing of 1FT5072 to 1FT5076 AC servomotors with connectors (size 2) type of construction IM B5

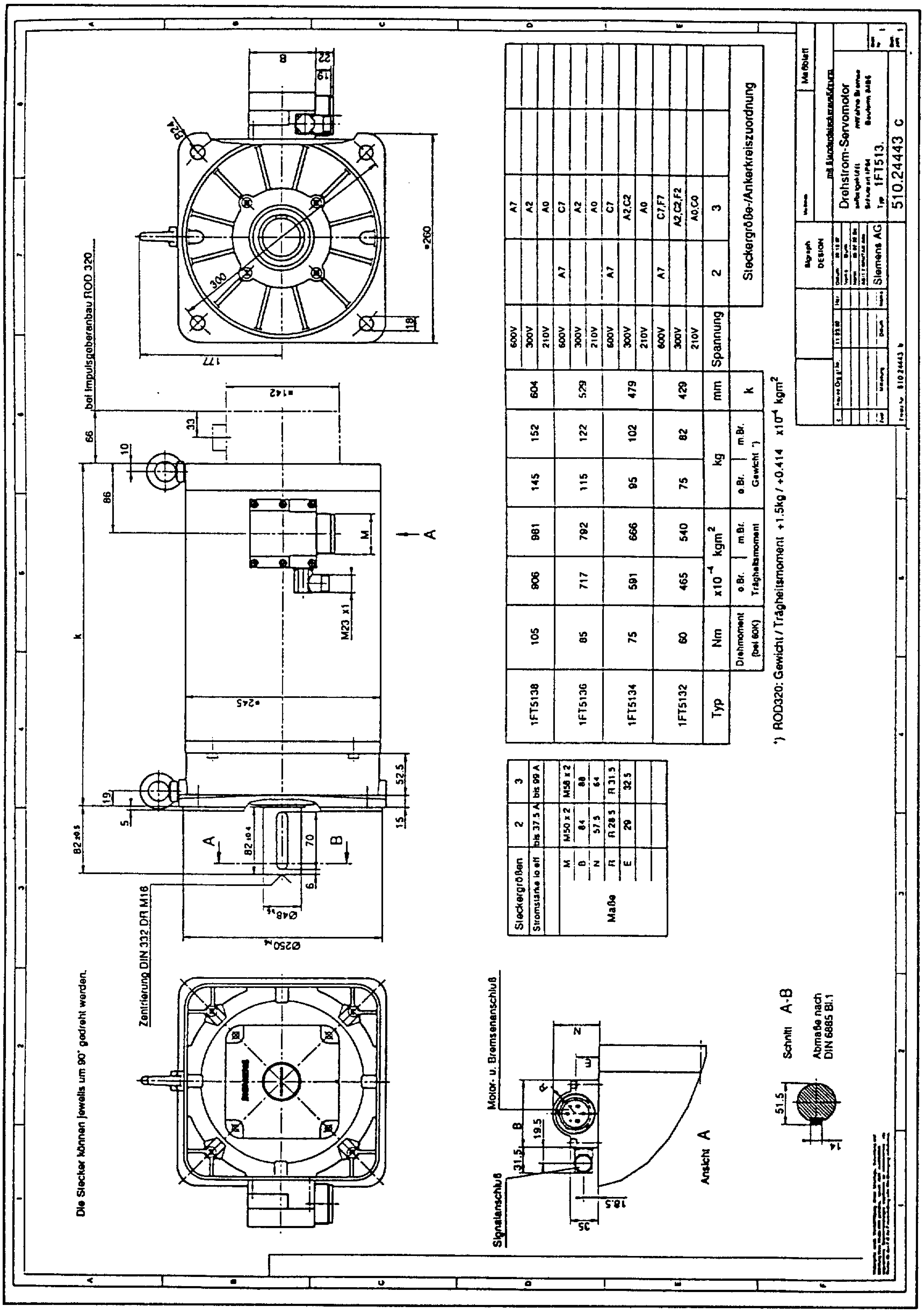


Steckergrößen		2	3
Stromstärke Io eff		bis 37.5 A	bis 99 A
Maße	M	M50 x 2	M58 x 2
	B	84	88
	N	57.5	64
	R	R 28.5	R 31.5
	E	29	32.5

Typ	Nm	$x10^{-4}$ kgm^2		kg		mm	Spannung	2	3
	Drehmoment (bei 60K)	o.Br. Trägheitsmoment	m.Br. Trägheitsmoment	o.Br. Gewicht *)	m.Br. Gewicht *)	k		Steckergröße-/Ankerkreiszuordnung	
1FT5108	55	291	316	52	56	502	600V	A7,C7	F7
							300V	A2	C2,F2
							210V		A0,C0
1FT5106	45	240	265	46	50	452	600V	A7,C7	F7
							300V	A2	C2,F2
							210V		A0,C0,F0
1FT5104	37	186	211	40	44	402	600V	A7,C7,F7	
							300V	A2	C2,F2
							210V	A0	C0,F0
1FT5102	27	137	162	32	36	352	600V	A7,C7,F7,G7	
							300V	A2,C2	F2,G2
							210V	A0	C0,F0,G0

*) ROD320: Gewicht / Trägheitsmoment +1.5kg / +0.414 $x10^{4}$ kgm^2

Dimension drawing of 1FT5102 to 1FT5108 AC servomotors with connectors type of construction IM B5

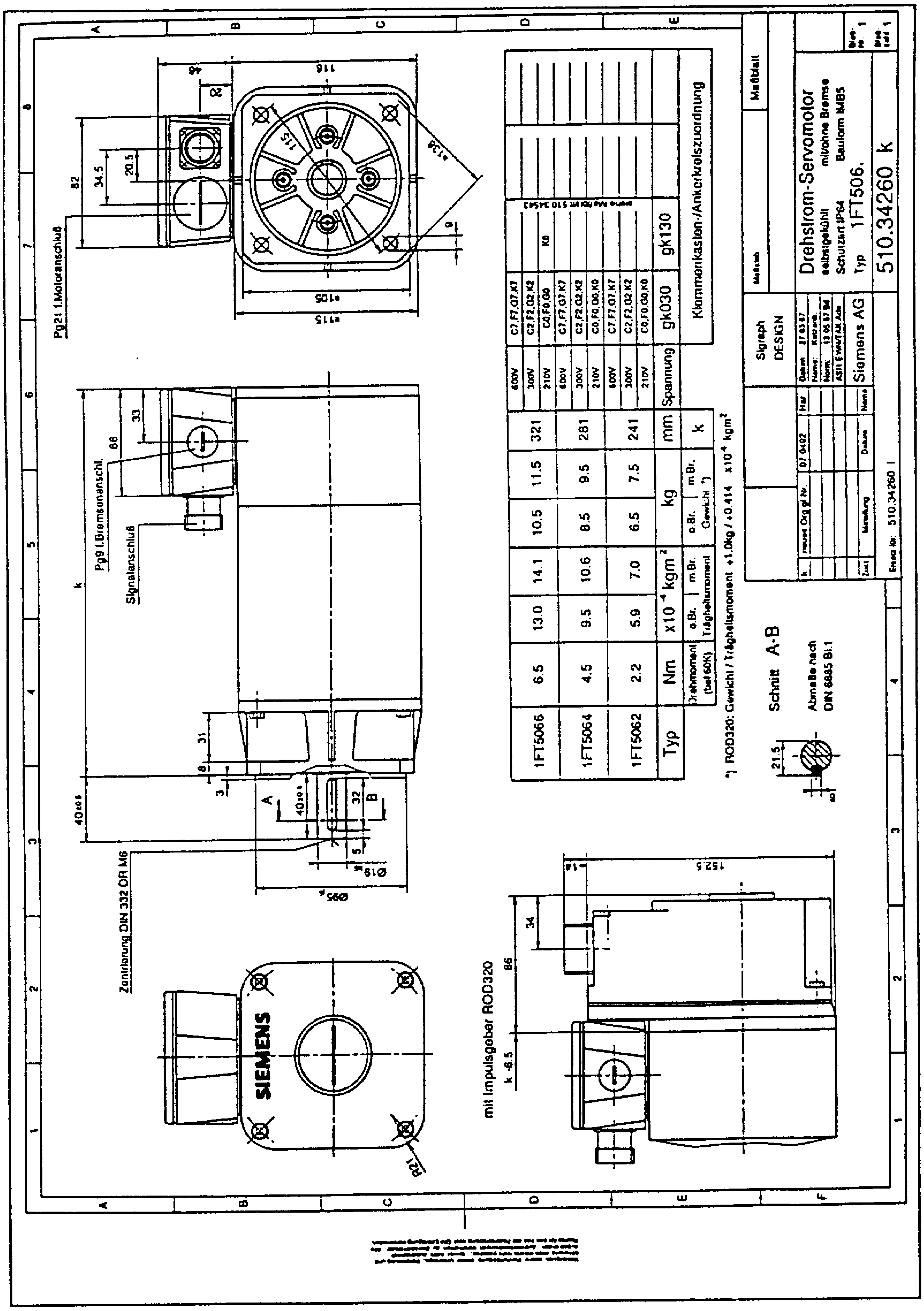


Steckergrößen		2	3
Stromstärke Io eff		bis 37.5 A	bis 99 A
Maße	M	M50 x 2	M58 x 2
	B	84	88
	N	57.5	64
	R	R 28.5	R 31.5
	E	29	32.5

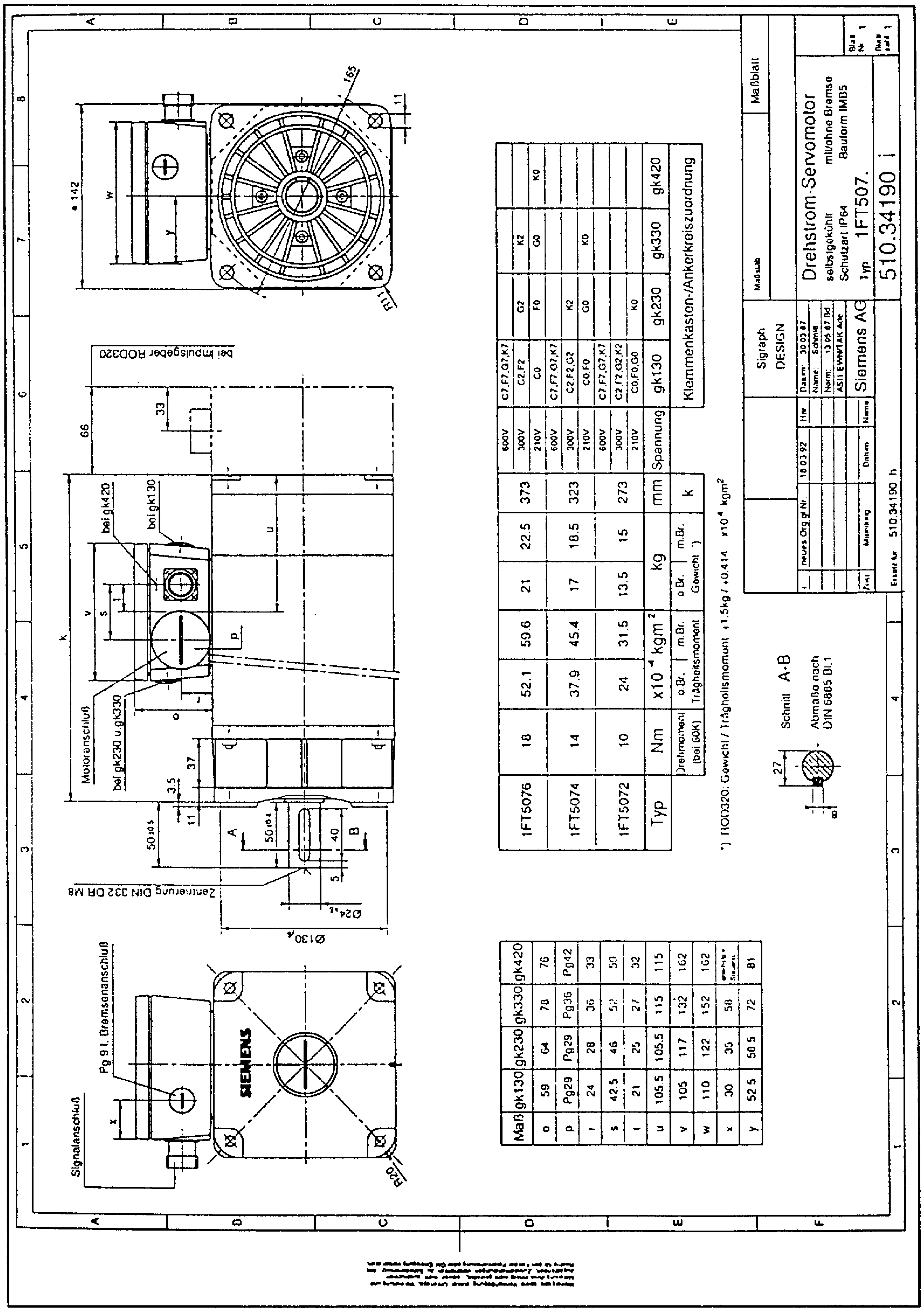
Typ	Nm	$x10^{-4}$ kgm^2		kg		mm	Spannung	2	3
	Drehmoment (bei 60K)	o.Br.	m.Br. Trägheitsmoment	o.Br.	m.Br. Gewicht *)	k		Steckergröße-/Ankerkreiszuordnung	
1FT5138	105	906	981	145	152	604	600V		A7
							300V		A2
							210V		A0
1FT5136	85	717	792	115	122	529	600V	A7	C7
							300V		A2
							210V		A0
1FT5134	75	591	666	95	102	479	600V	A7	C7
							300V		A2,C2
							210V		A0
1FT5132	60	465	540	75	82	429	600V	A7	C7,F7
							300V		A2,C2,F2
							210V		A0,C0

*) ROD320: Gewicht / Trägheitsmoment +1.5kg / +0.414 $x10^{-4}$ kgm^2

Dimension drawing of 1FT5132 to 1FT5138 AC servomotors with connectors type of construction IM B5



Dimension drawing of 1FT5062 to 1FT5066 AC servomotors - type of construction IM B5 - is only valid with the gk030 terminal box mounted



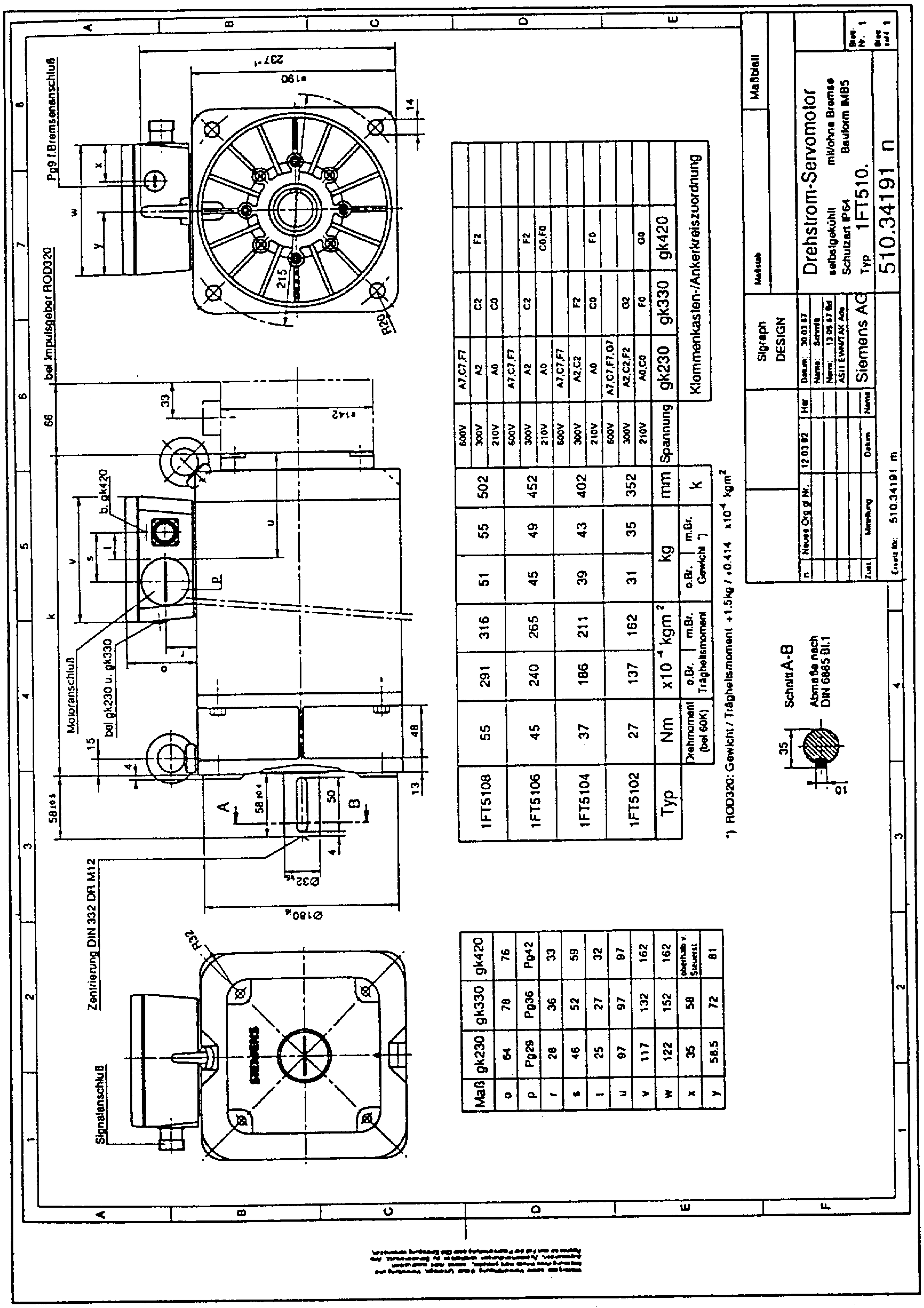
Maß	gk130	gk230	gk330	gk420
o	59	64	70	76
p	Pg29	Pg29	Pg36	Pg42
r	24	28	36	33
s	42.5	46	52	50
t	21	25	27	32
u	105.5	105.5	115	115
v	105	117	132	162
w	110	122	152	162
x	30	35	58	[illegible]
y	52.5	50.5	72	81

Typ	Nm Drehmoment (bei 60K)	x10^{-4} kgm^2 Trägheitsmoment o.Br.	x10^{-4} kgm^2 Trägheitsmoment m.Br.	kg Gewicht *) o.Br.	kg Gewicht *) m.Br.	mm k	Spannung	gk130	gk230	gk330	gk420
1FT5076	18	52.1	59.6	21	22.5	373	600V	C7,F7,G7,K7			
							300V	C2,F2	G2	K2	
							210V	C0	F0	G0	K0
1FT5074	14	37.9	45.4	17	18.5	323	600V	C7,F7,G7,K7			
							300V	C2,F2,G2	K2		
							210V	C0,F0	G0	K0	
1FT5072	10	24	31.5	13.5	15	273	600V	C7,F7,G7,K7			
							300V	C2,F2,G2,K2			
							210V	C0,F0,G0	K0		

Klemmenkasten-/Ankerkreiszuordnung

*) ROD320: Gewicht / Trägheitsmoment +1.5kg / +0.414 x10^4 kgm^2

Dimension drawing of 1FT5072 to 1FT5076 AC servomotors - type of construction IM B5



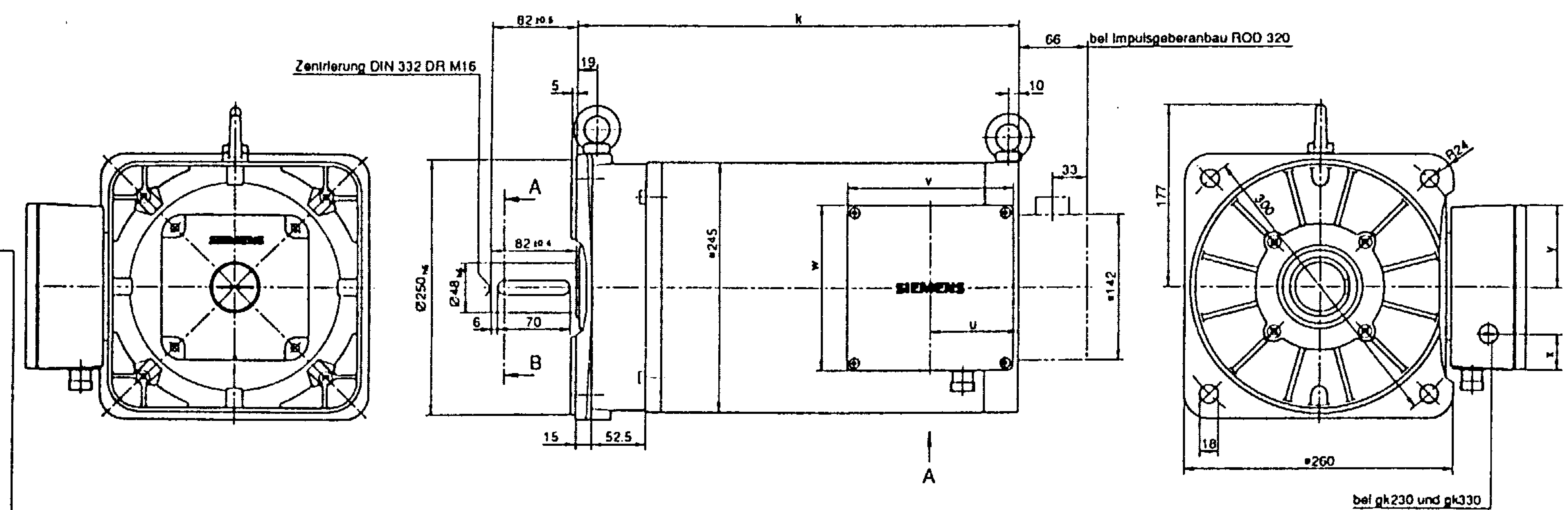
Maß	gk230	gk330	gk420
o	64	78	76
p	Pg29	Pg36	Pg42
r	28	36	33
s	46	52	59
t	25	27	32
u	97	97	97
v	117	132	162
w	122	152	162
x	35	58	oberhalb v. Steuerst.
y	58.5	72	81

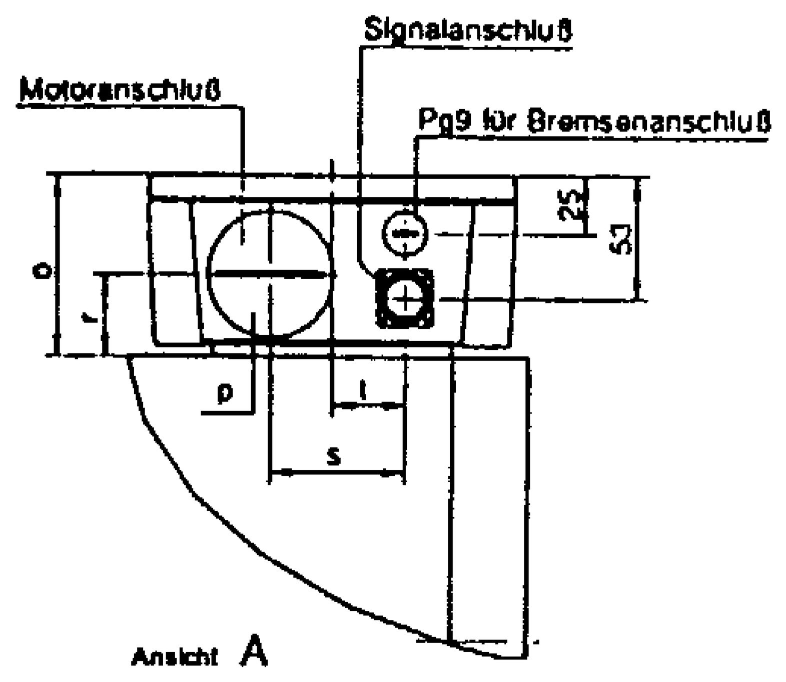
Typ	Nm Drehmoment (bei 60K)	$x10^{-4}$ kgm^2 Trägheitsmoment o.Br.	$x10^{-4}$ kgm^2 Trägheitsmoment m.Br.	kg Gewicht *) o.Br.	kg Gewicht *) m.Br.	mm k	Spannung	gk230	gk330	gk420
1FT5108	55	291	316	51	55	502	600V	A7,C7,F7		
							300V	A2	C2	F2
							210V	A0	C0	
1FT5106	45	240	265	45	49	452	600V	A7,C7,F7		
							300V	A2	C2	F2
							210V	A0		C0,F0
1FT5104	37	186	211	39	43	402	600V	A7,C7,F7		
							300V	A2,C2	F2	
							210V	A0	C0	F0
1FT5102	27	137	162	31	35	352	600V	A7,C7,F7,G7		
							300V	A2,C2,F2	G2	
							210V	A0,C0	F0	G0

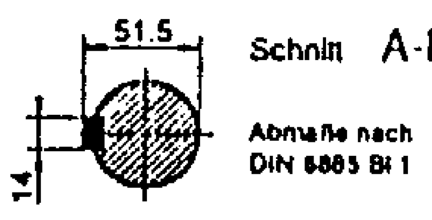
Klemmenkasten-/Ankerkreiszuordnung (gk230, gk330, gk420)

Dimension drawing of 1FT5102 to 1FT5108 AC servomotors - type of construction IM B5

Dimension drawing of 1FT5132 to 1FT5138 AC servomotors - type of construction IM B5





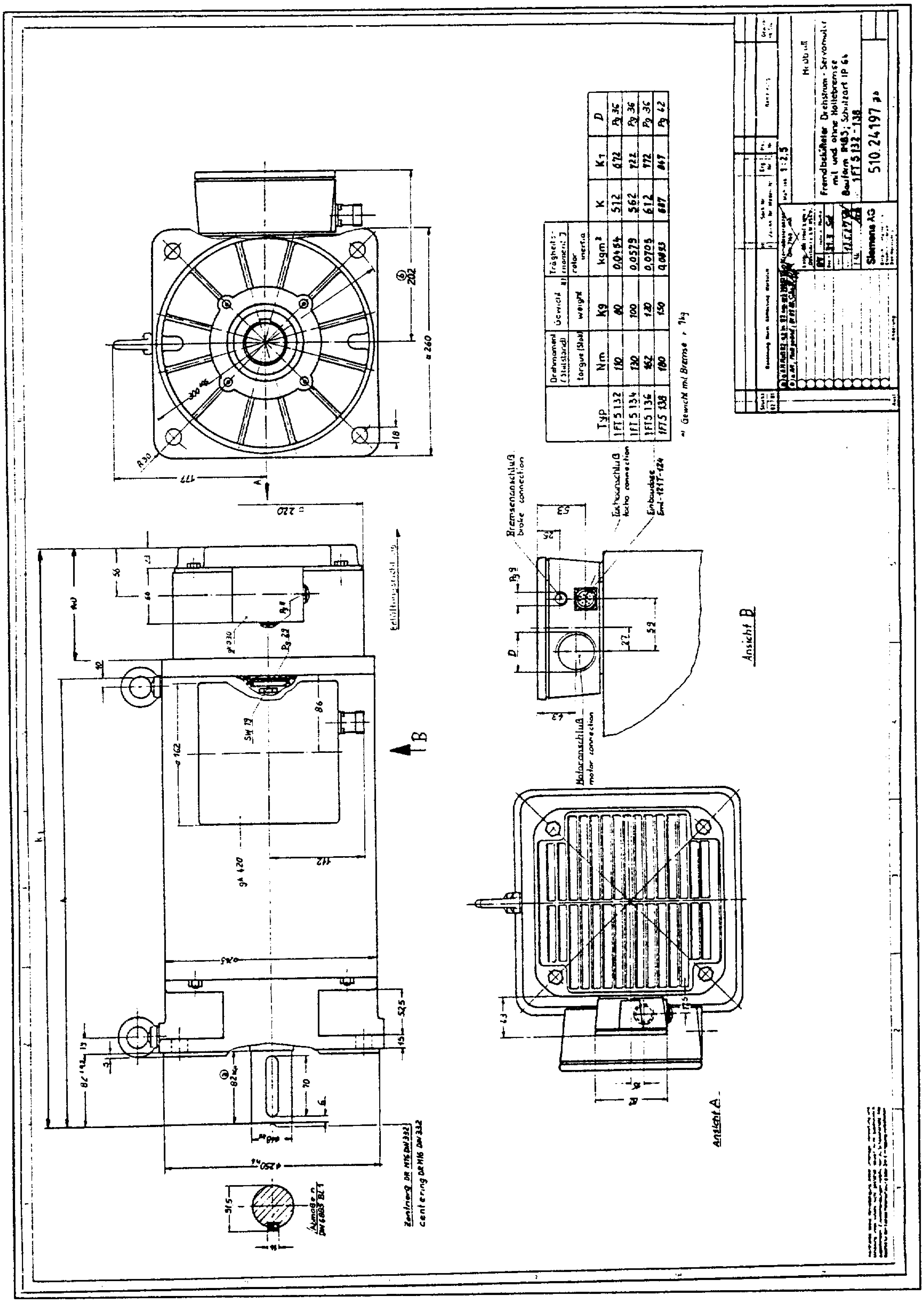


Maß	gk230	gk330	gk420
o	64	78	79.5
p	Pg29	Pg36	Pg36 o. Pg42
r	28	36	33
s	46	52	59
t	25	27	32
u	86	86	86
v	117	132	162
w	122	152	162
x	35	58	-
y	58.5	72	81

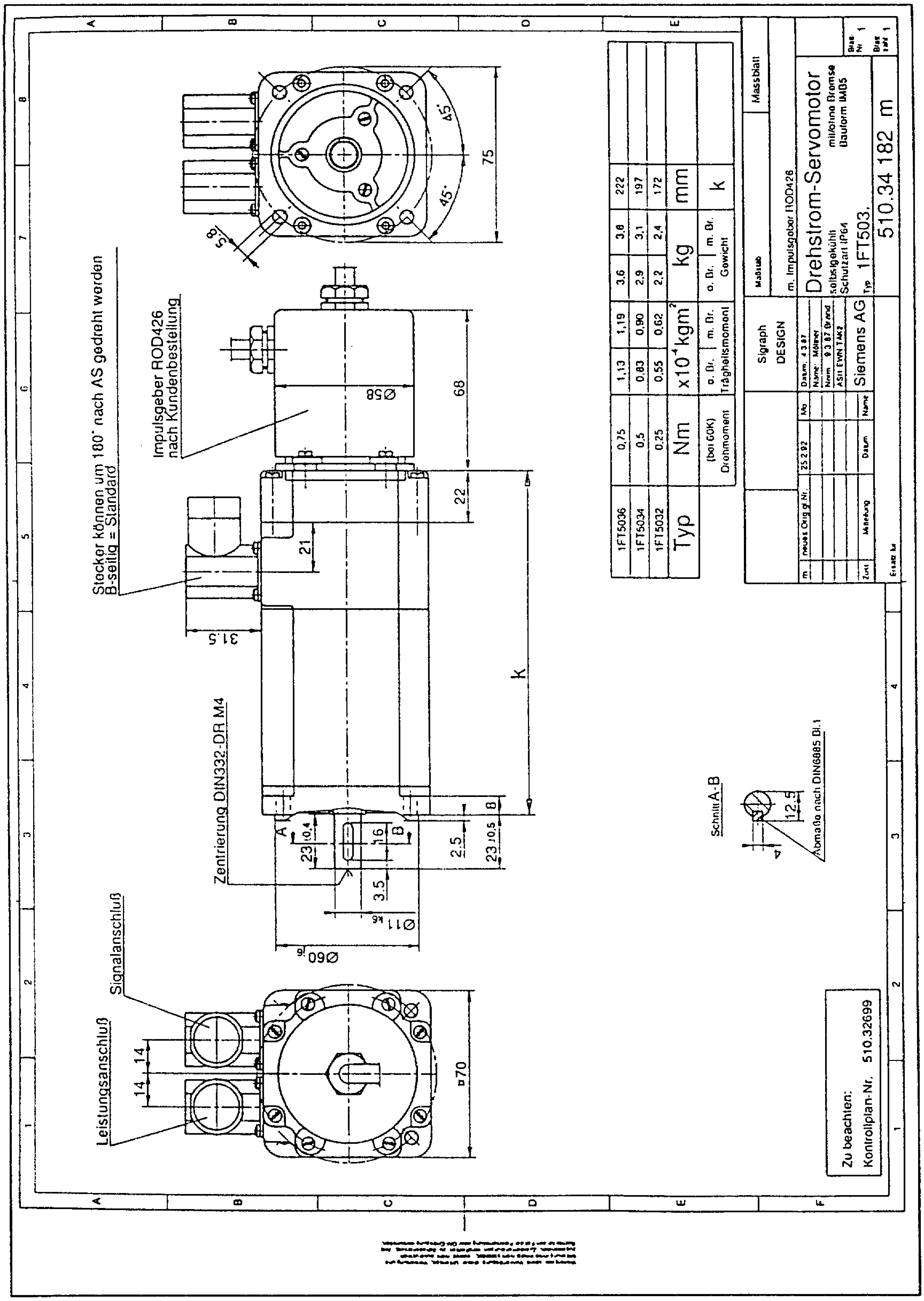
Typ	Drehmoment (bei 60K)	Trägheitsmoment o Br.	Trägheitsmoment m Br.	Gewicht *) o Br.	Gewicht *) m Br.	k	Spannung	Klemmenkasten-/Ankerkreiszuordnung gk230	gk330	gk420	
	Nm	$x10^{-4}$ kgm^2		kg		mm					
1FT5138	105	906	981	145	152	604	600V	A7			
							300V			A2	
							210V			A0	
1FT5136	85	717	792	115	122	529	600V	A7,C7			
							300V			A2	
							210V			A0	
1FT5134	75	591	666	95	102	479	600V	A7,C7			
							300V			A2,C2	
							210V			A0,C0	
1FT5132	60	465	540	75	82	429	600V	A7,C7,F7			
							300V			A2,C2,F2	
							210V			A0,C0	

*) ROD320; Gewicht / Trägheitsmoment +1.5kg / +0.414 $x10^{-4}$ kgm^2

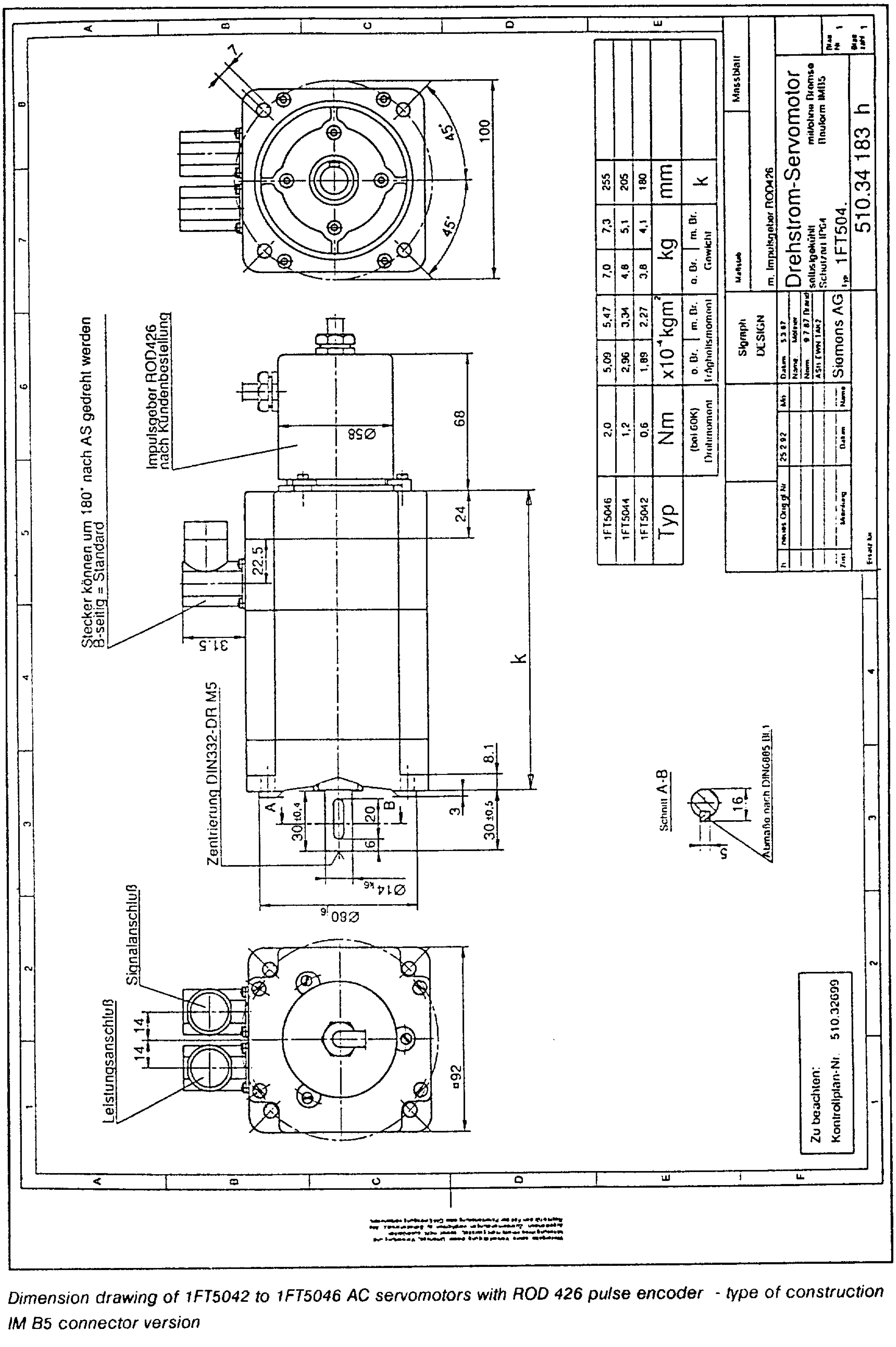
Maßblatt
Drehstrom-Servomotor
Typ 1FT513.
Siemens AG
510.24196 m



Dimension drawing of 1FT5132 to 1FT5138 AC servomotors - type of construction IM B5, force cooled

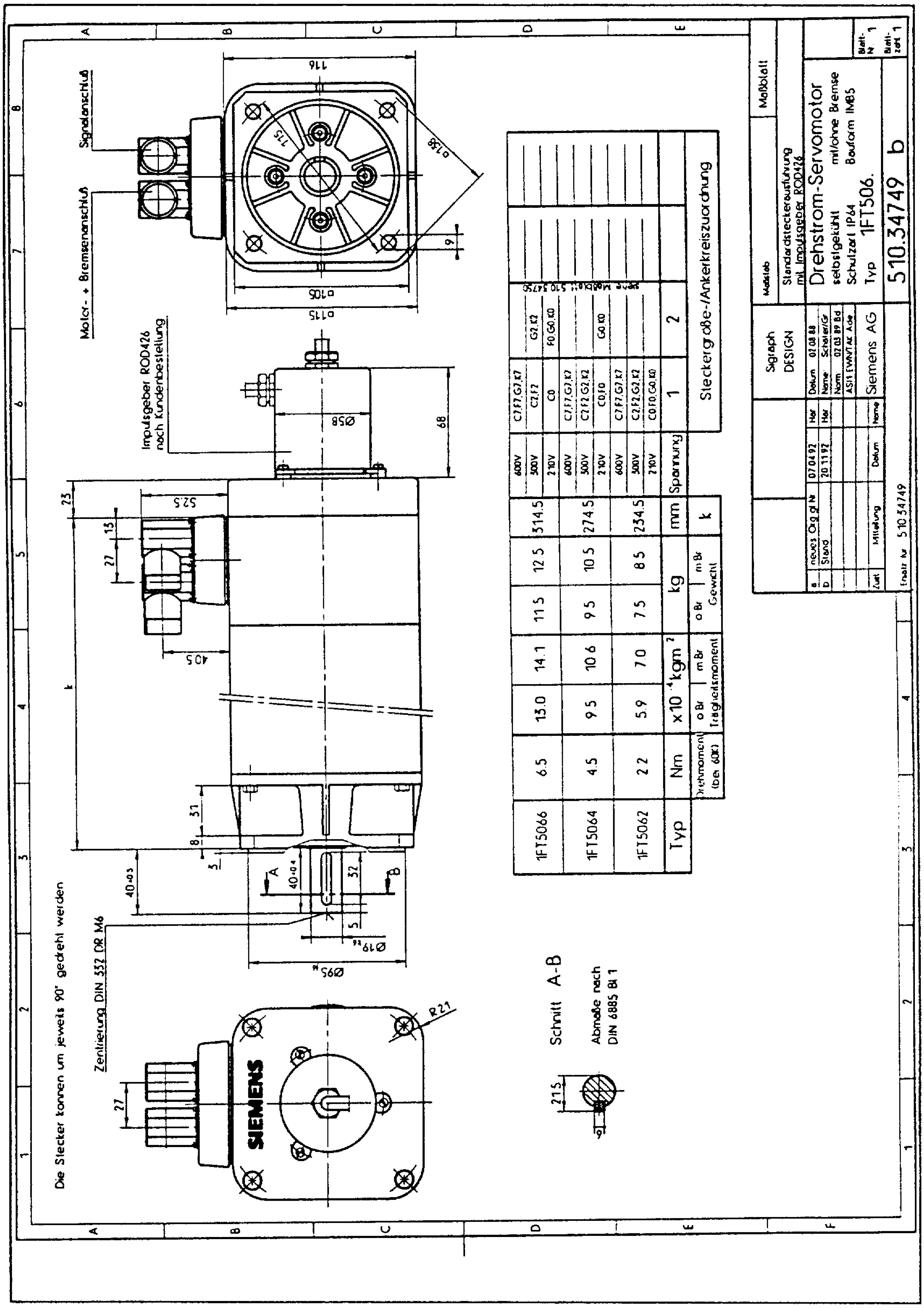


Dimension drawing of 1FT5032 to 1FT5036 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, connector version. (motor type 1FT5032-□□□7□-□ is not available)

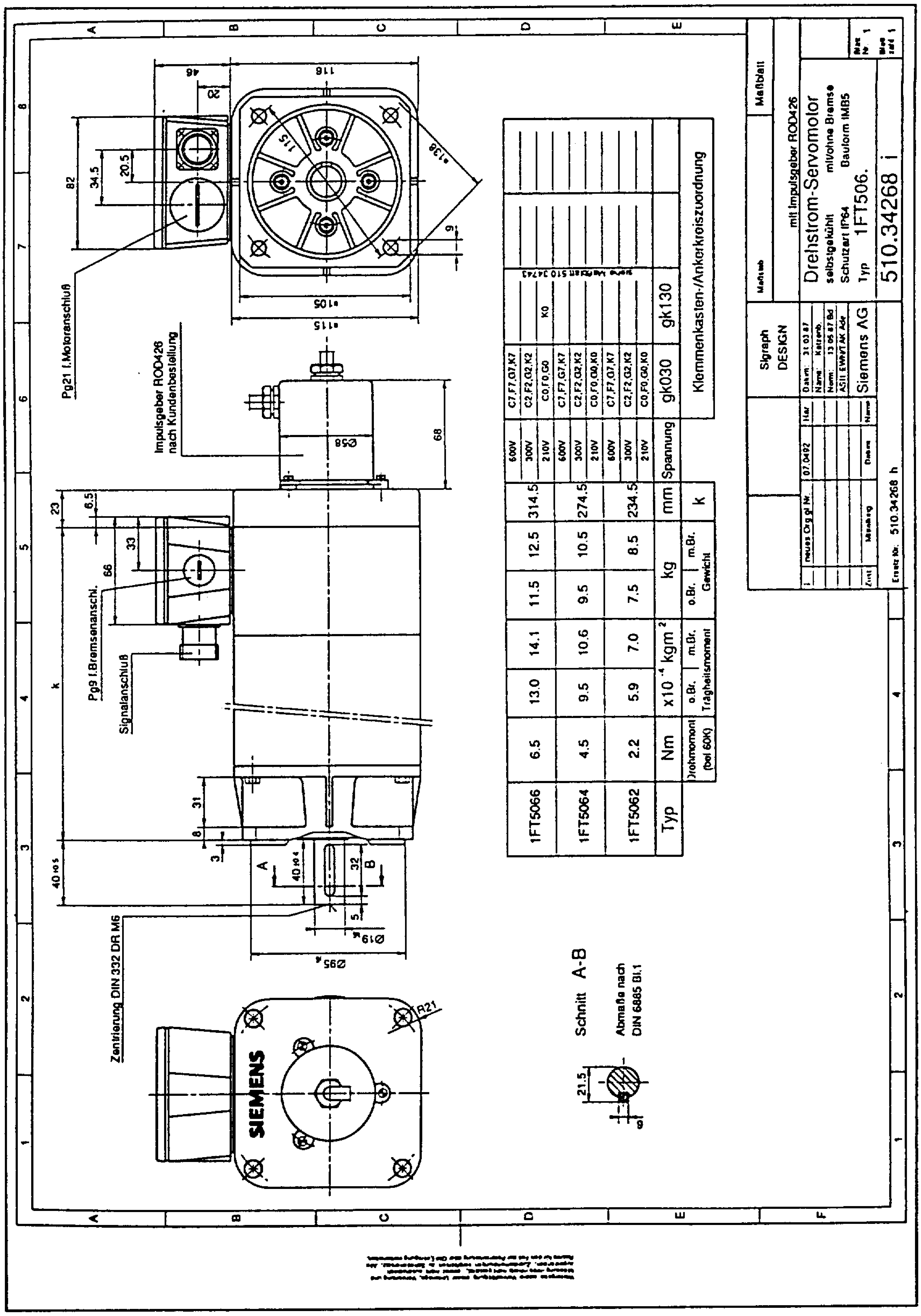


Typ	Nm (bei 60K) Drehmoment	$x10^{-4}$ kgm² Trägheitsmoment o. Br.	$x10^{-4}$ kgm² Trägheitsmoment m. Br.	kg Gewicht o. Br.	kg Gewicht m. Br.	mm k
1FT5046	2,0	5,09	5,47	7,0	7,3	255
1FT5044	1,2	2,96	3,34	4,8	5,1	205
1FT5042	0,6	1,89	2,27	3,8	4,1	180

Dimension drawing of 1FT5042 to 1FT5046 AC servomotors with ROD 426 pulse encoder - type of construction IM B5 connector version

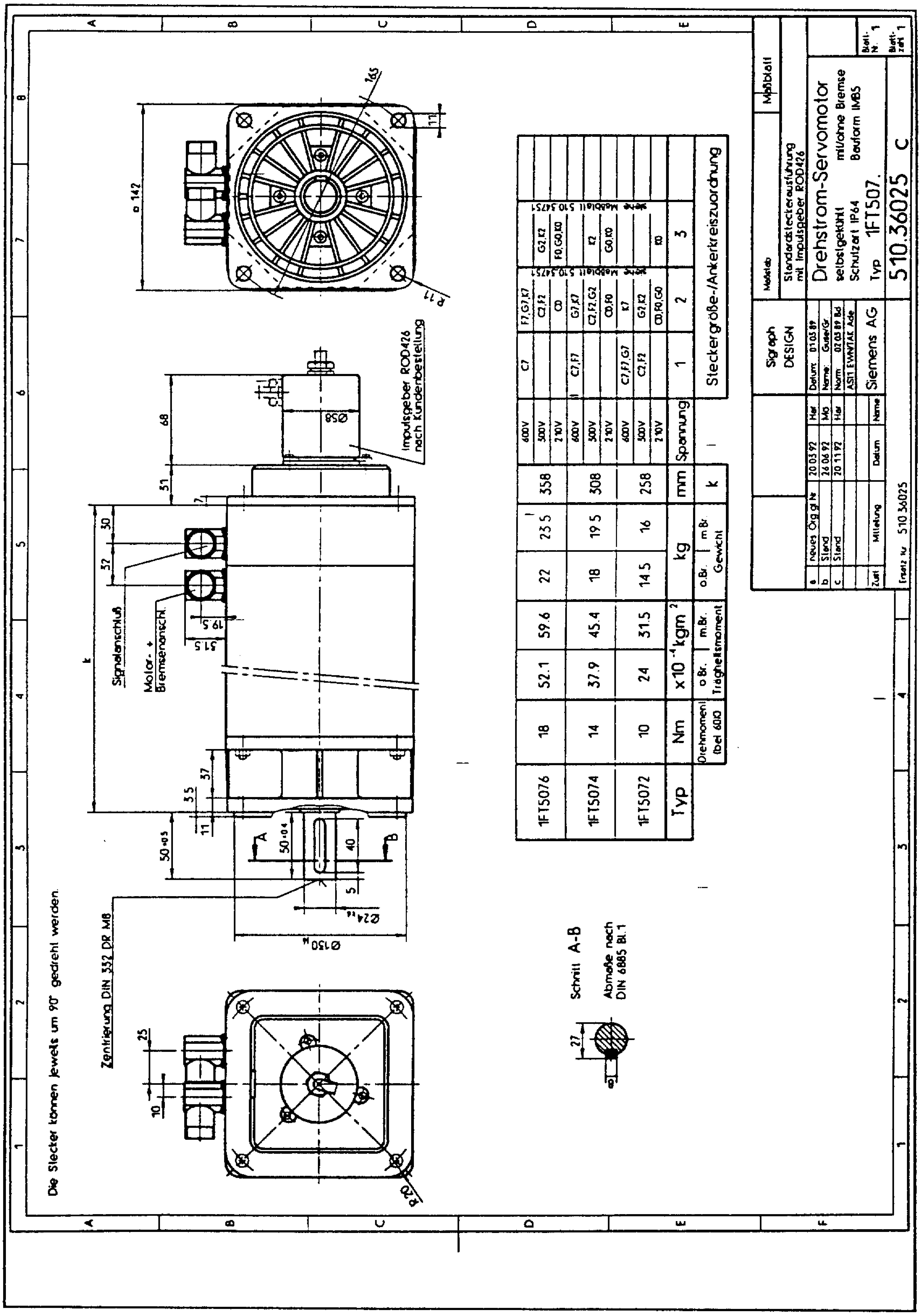


Dimension drawing of 1FT5062 to 1FT5066 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, connector version



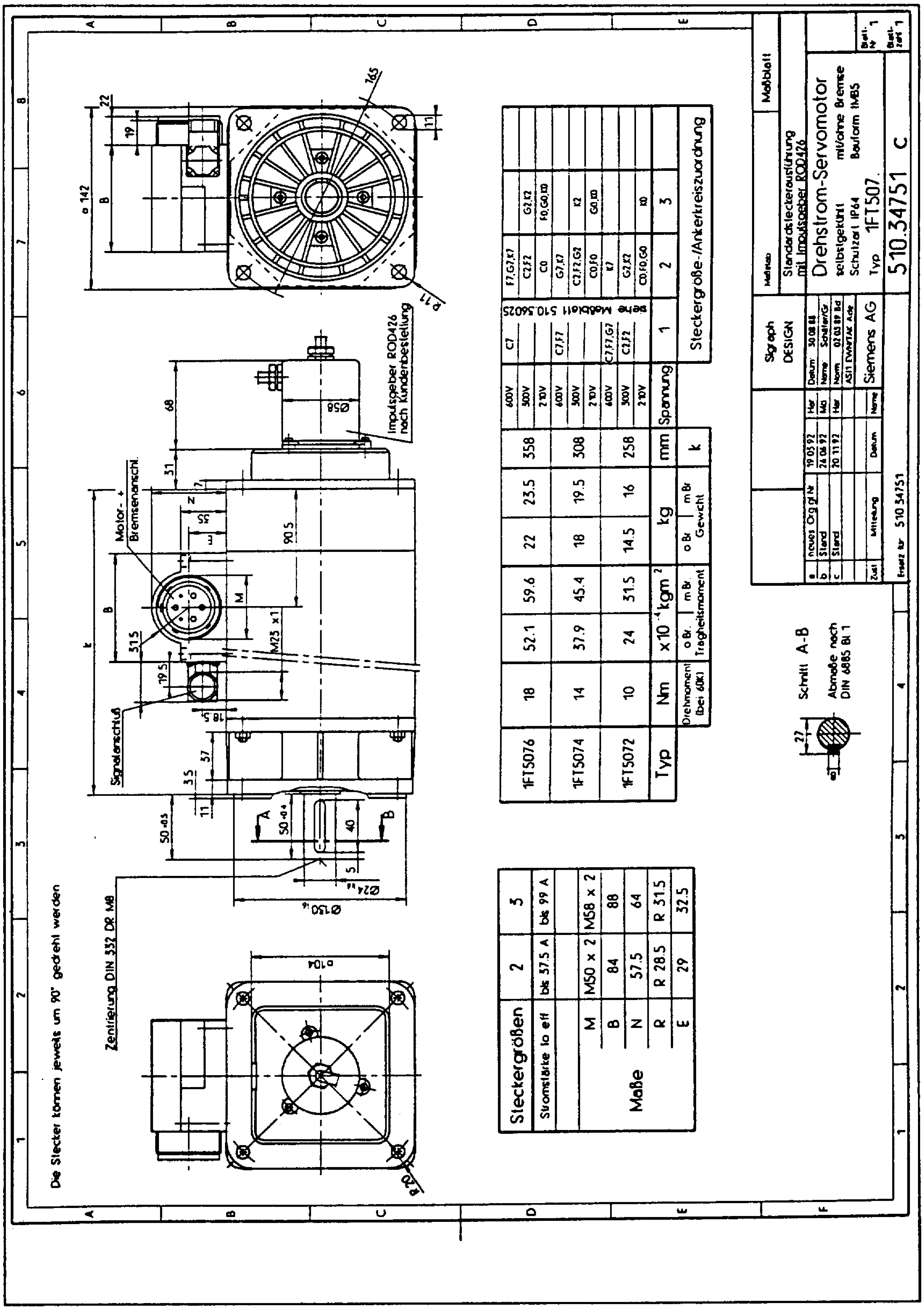
Typ	Nm	x10^{-4} kgm^2		kg		mm	Spannung	gk030	gk130
	Drehmoment (bei 60K)	o.Br. (Trägheitsmoment)	m.Br. (Trägheitsmoment)	o.Br. (Gewicht)	m.Br. (Gewicht)	k		Klemmenkasten-/Ankerkreiszuordnung	
1FT5066	6.5	13.0	14.1	11.5	12.5	314.5	600V	C7,F7,G7,K7	siehe Maßblatt 510.34743
							300V	C2,F2,G2,K2	
							210V	C0,F0,G0	K0
1FT5064	4.5	9.5	10.6	9.5	10.5	274.5	600V	C7,F7,G7,K7	
							300V	C2,F2,G2,K2	
							210V	C0,F0,G0,K0	
1FT5062	2.2	5.9	7.0	7.5	8.5	234.5	600V	C7,F7,G7,K7	
							300V	C2,F2,G2,K2	
							210V	C0,F0,G0,K0	

Dimension drawing of 1FT5062 to 1FT5066 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, only valid with gk030 terminal box mounted



Typ	Drehmoment (bei 60K) Nm	Trägheitsmoment o.Br. x10⁻⁴kgm²	Trägheitsmoment m.Br. x10⁻⁴kgm²	Gewicht o.Br. kg	Gewicht m.Br. kg	k mm	Spannung	Steckergröße-/Ankerkreiszuordnung 1	2	3
1FT5076	18	52.1	59.6	22	23.5	358	600V	C7	F7,G7,K7	
							500V		C2,F2	G2,K2
							210V		C0	F0,G0,K0
1FT5074	14	37.9	45.4	18	19.5	308	600V	C7,F7	G7,K7	
							500V		C2,F2,G2	K2
							210V		C0,F0	G0,K0
1FT5072	10	24	31.5	14.5	16	258	600V	C7,F7,G7	K7	
							500V	C2,F2	G2,K2	
							210V		C0,F0,G0	K0

Dimension drawing of 1FT5072 to 1FT5076 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, connector version - size 1

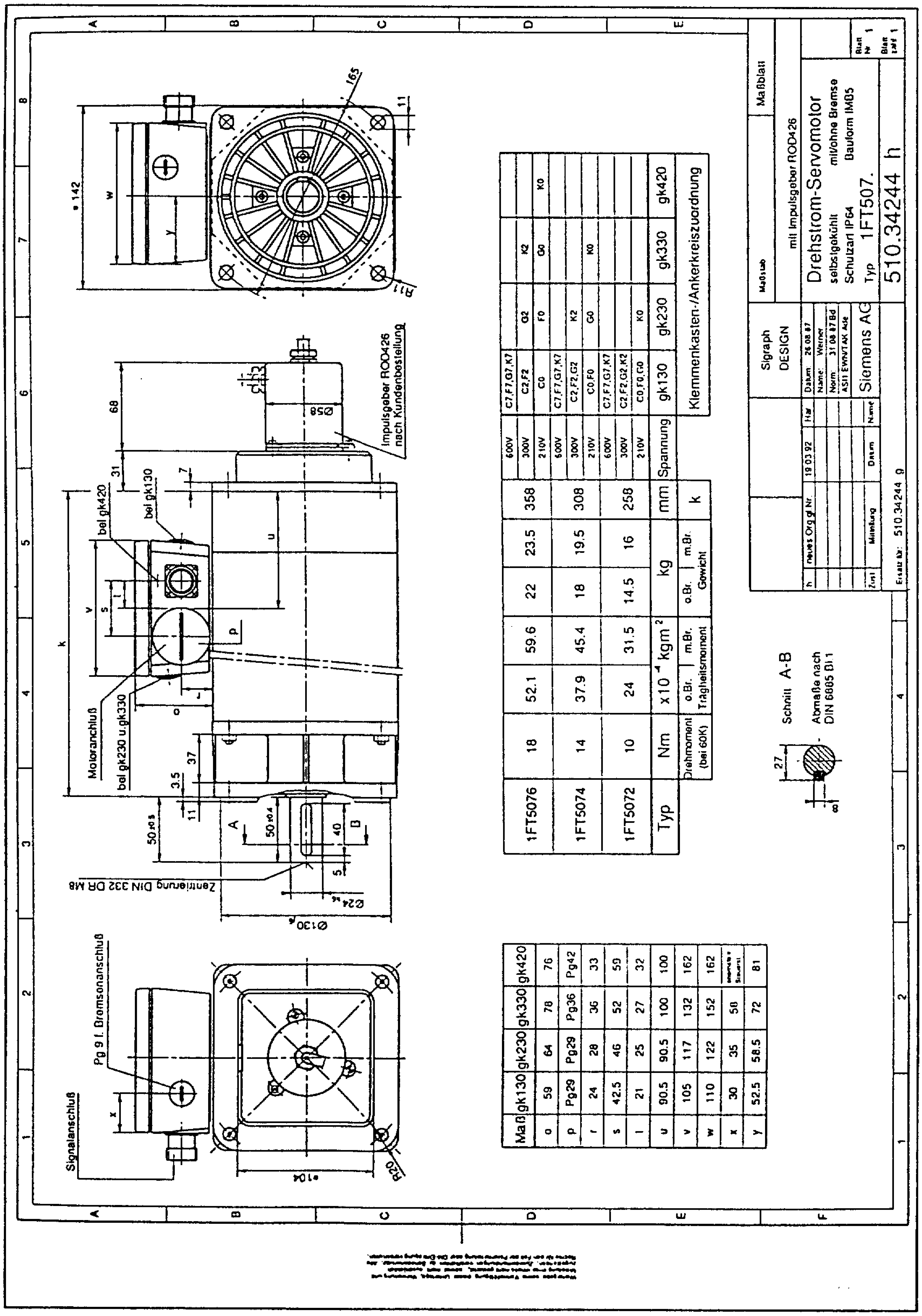


Steckergrößen		2	3
Stromstärke Io eff		bis 37.5 A	bis 99 A
Maße	M	M50 x 2	M58 x 2
	B	84	88
	N	57.5	64
	R	R 28.5	R 31.5
	E	29	32.5

Typ	Nm (Drehmoment bei 60K)	$x10^{-4}$ kgm² o Br. (Trägheitsmoment)	$x10^{-4}$ kgm² m Br. (Trägheitsmoment)	kg o Br (Gewicht)	kg m Br (Gewicht)	mm (k)	Spannung	1	2	3
1FT5076	18	52.1	59.6	22	23.5	358	600V	C7	F7,G7,K7	
							300V		C2,F2	G2,K2
							210V		C0	F0,G0,K0
1FT5074	14	37.9	45.4	18	19.5	308	600V	C7,F7	G7,K7	
							300V		C2,F2,G2	K2
							210V		C0,F0	G0,K0
1FT5072	10	24	31.5	14.5	16	258	600V	C7,F7,G7	K7	
							300V	C2,F2	G2,K2	
							210V		C0,F0,G0	K0

siehe Maßblatt 510.56025 — Steckergröße-/Ankerkreiszuordnung

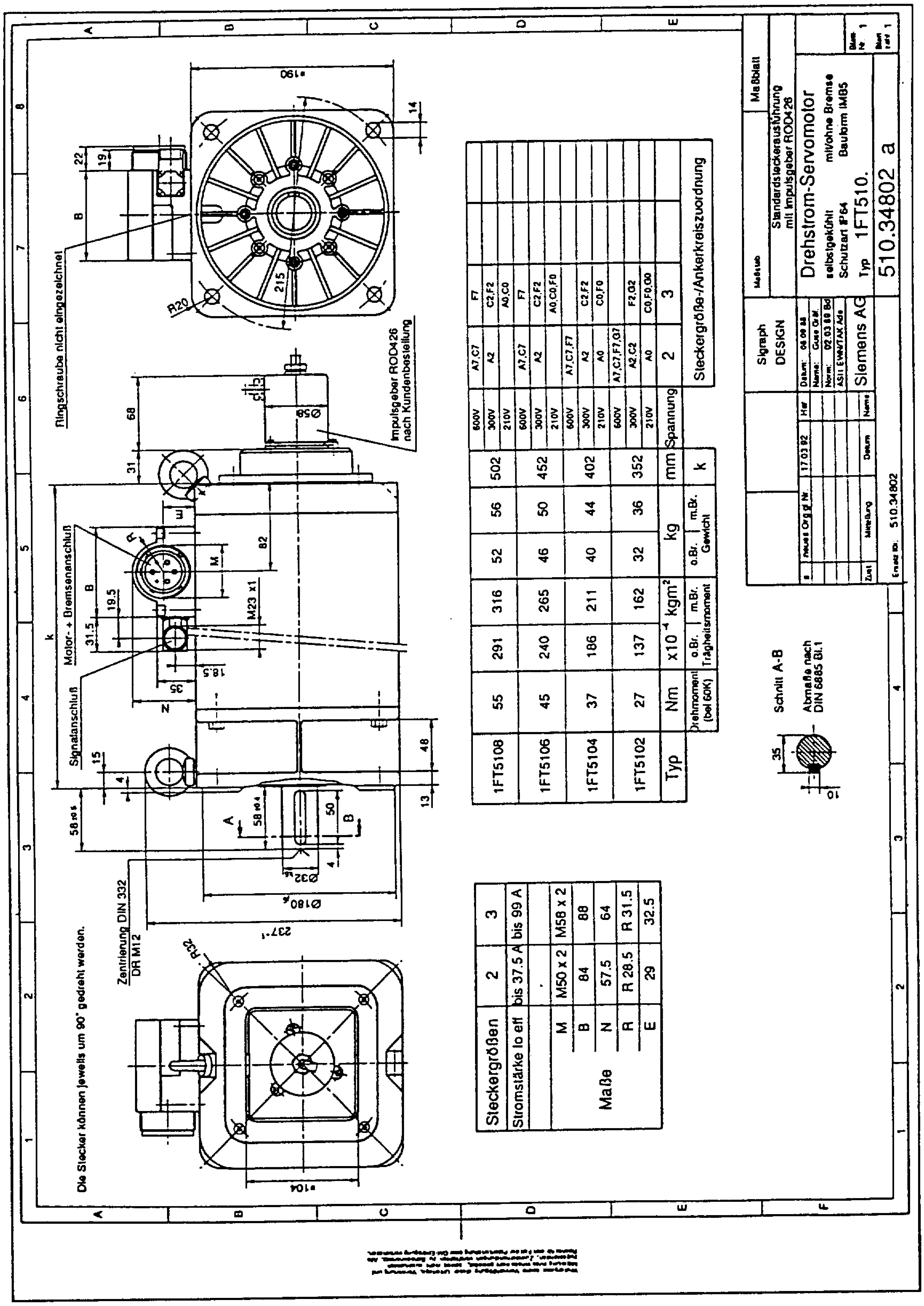
Dimension drawing of 1FT5072 to 1FT5076 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, connector version - size 2



Maß	gk130	gk230	gk330	gk420
o	59	64	78	76
p	Pg29	Pg29	Pg36	Pg42
r	24	28	36	33
s	42.5	46	52	59
l	21	25	27	32
u	90.5	90.5	100	100
v	105	117	132	162
w	110	122	152	162
x	30	35	58	[illegible]
y	52.5	58.5	72	81

Typ	Nm Drehmoment (bei 60K)	$x10^{-4}$ kgm^2 Trägheitsmoment o.Br.	$x10^{-4}$ kgm^2 Trägheitsmoment m.Br.	kg Gewicht o.Br.	kg Gewicht m.Br.	mm k	Spannung	gk130	gk230	gk330	gk420
1FT5076	18	52.1	59.6	22	23.5	358	600V	C7,F7,G7,K7			
							300V	C2,F2	G2	K2	
							210V	C0	F0	G0	K0
1FT5074	14	37.9	45.4	18	19.5	308	600V	C7,F7,G7,K7			
							300V	C2,F2,G2	K2		
							210V	C0,F0	G0	K0	
1FT5072	10	24	31.5	14.5	16	258	600V	C7,F7,G7,K7			
							300V	C2,F2,G2,K2			
							210V	C0,F0,G0	K0		

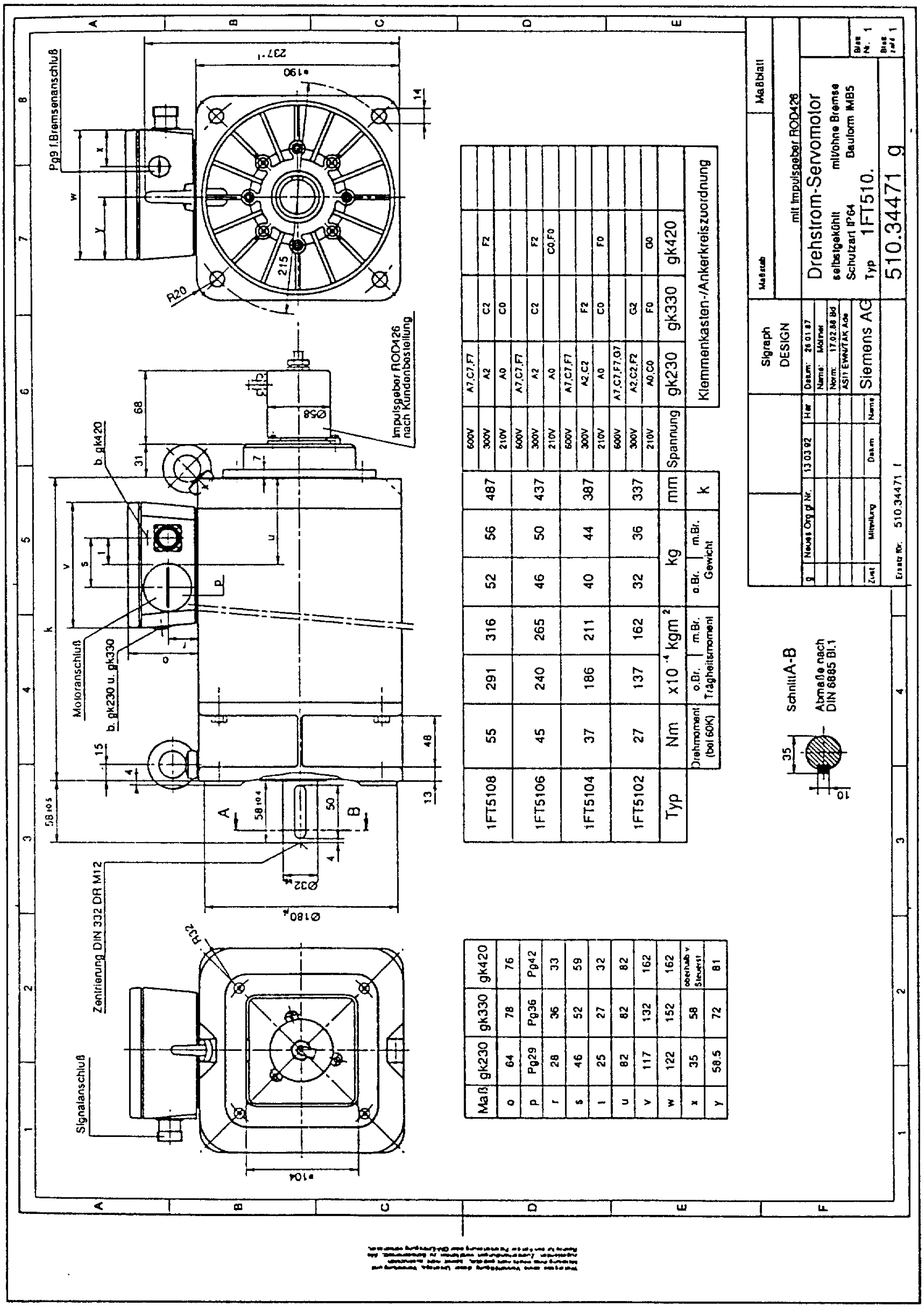
Dimension drawing of 1FT5072, 1FT5074 and 1FT5076 AC servomotors with ROD 426 pulse encoder, type of construction IM B5 - terminal box version



Steckergrößen		2	3
Stromstärke Io eff		bis 37.5 A	bis 99 A
		.	
Maße	M	M50 x 2	M58 x 2
	B	84	88
	N	57.5	64
	R	R 28.5	R 31.5
	E	29	32.5

Typ	Drehmoment (bei 60K) Nm	Trägheitsmoment o.Br. x10⁻⁴ kgm²	Trägheitsmoment m.Br. x10⁻⁴ kgm²	Gewicht o.Br. kg	Gewicht m.Br. kg	k mm	Spannung	Steckergröße-/Ankerkreiszuordnung 2	Steckergröße-/Ankerkreiszuordnung 3
1FT5108	55	291	316	52	56	502	600V	A7,C7	F7
							300V	A2	C2,F2
							210V		A0,C0
1FT5106	45	240	265	46	50	452	600V	A7,C7	F7
							300V	A2	C2,F2
							210V		A0,C0,F0
1FT5104	37	186	211	40	44	402	600V	A7,C7,F7	
							300V	A2	C2,F2
							210V	A0	C0,F0
1FT5102	27	137	162	32	36	352	600V	A7,C7,F7,G7	
							300V	A2,C2	F2,G2
							210V	A0	C0,F0,G0

Dimension drawing of 1FT5102 to 1FT5108 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, connector version

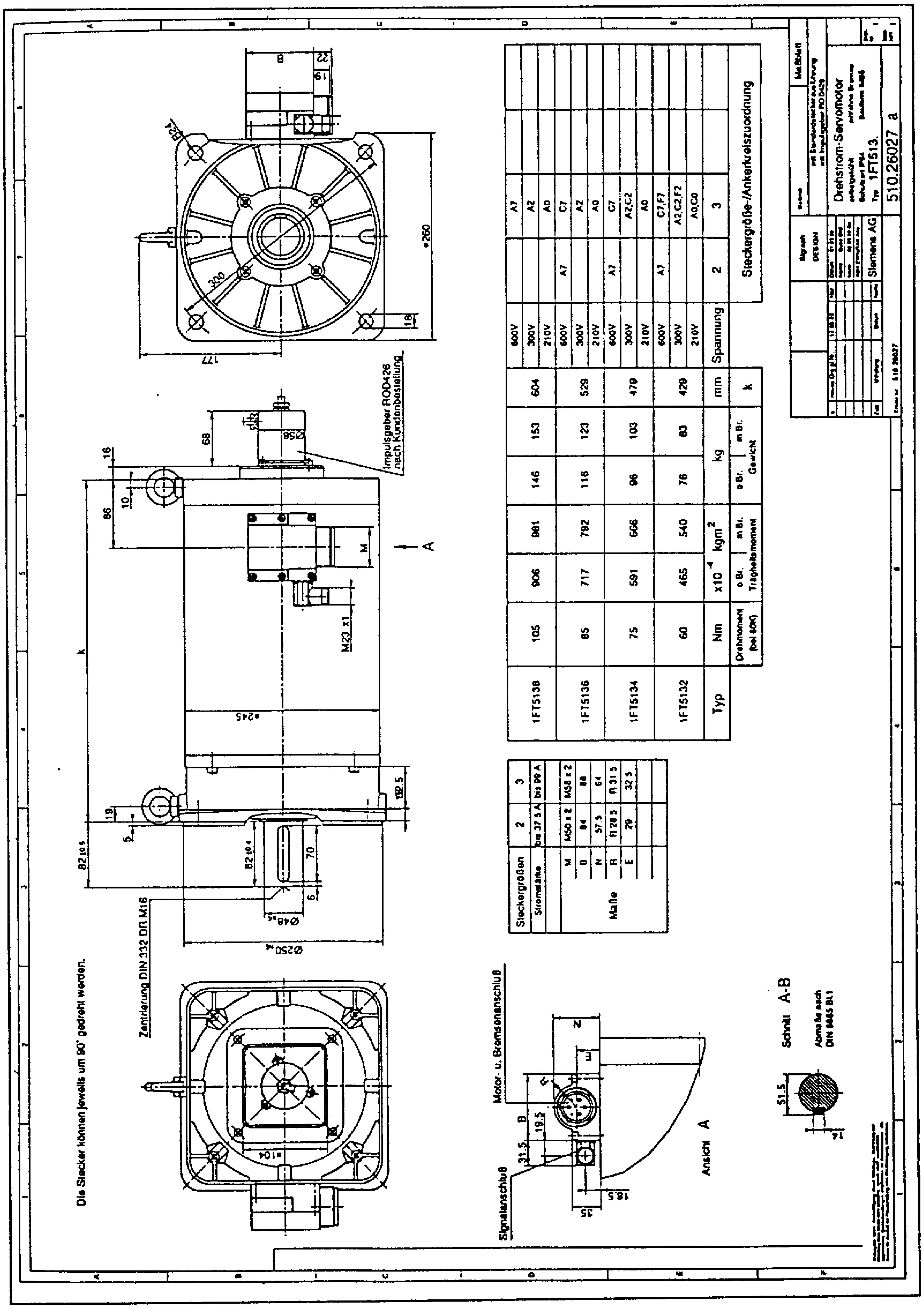


Maß	gk230	gk330	gk420
o	64	78	76
p	Pg29	Pg36	Pg42
r	28	36	33
s	46	52	59
t	25	27	32
u	82	82	82
v	117	132	162
w	122	152	162
x	35	58	oberhalb v Steuerst
y	58.5	72	81

Typ	Nm Drehmoment (bei 60K)	x10^{-4} kgm^2 Trägheitsmoment o.Br.	x10^{-4} kgm^2 Trägheitsmoment m.Br.	kg Gewicht o.Br.	kg Gewicht m.Br.	mm k	Spannung	gk230	gk330	gk420
1FT5108	55	291	316	52	56	487	600V	A7,C7,F7		
							300V	A2	C2	F2
							210V	A0	C0	
1FT5106	45	240	265	46	50	437	600V	A7,C7,F7		
							300V	A2	C2	F2
							210V	A0		C0,F0
1FT5104	37	186	211	40	44	387	600V	A7,C7,F7		
							300V	A2,C2	F2	
							210V	A0	C0	F0
1FT5102	27	137	162	32	36	337	600V	A7,C7,F7,G7		
							300V	A2,C2,F2	G2	
							210V	A0,C0	F0	G0

Klemmenkasten-/Ankerkreiszuordnung

Dimension drawing of 1FT5102, 1FT5104, 1FT5106 and 1FT5108 AC servomotors with ROD 426 pulse encoder - type of construction IM B5 - terminal box version

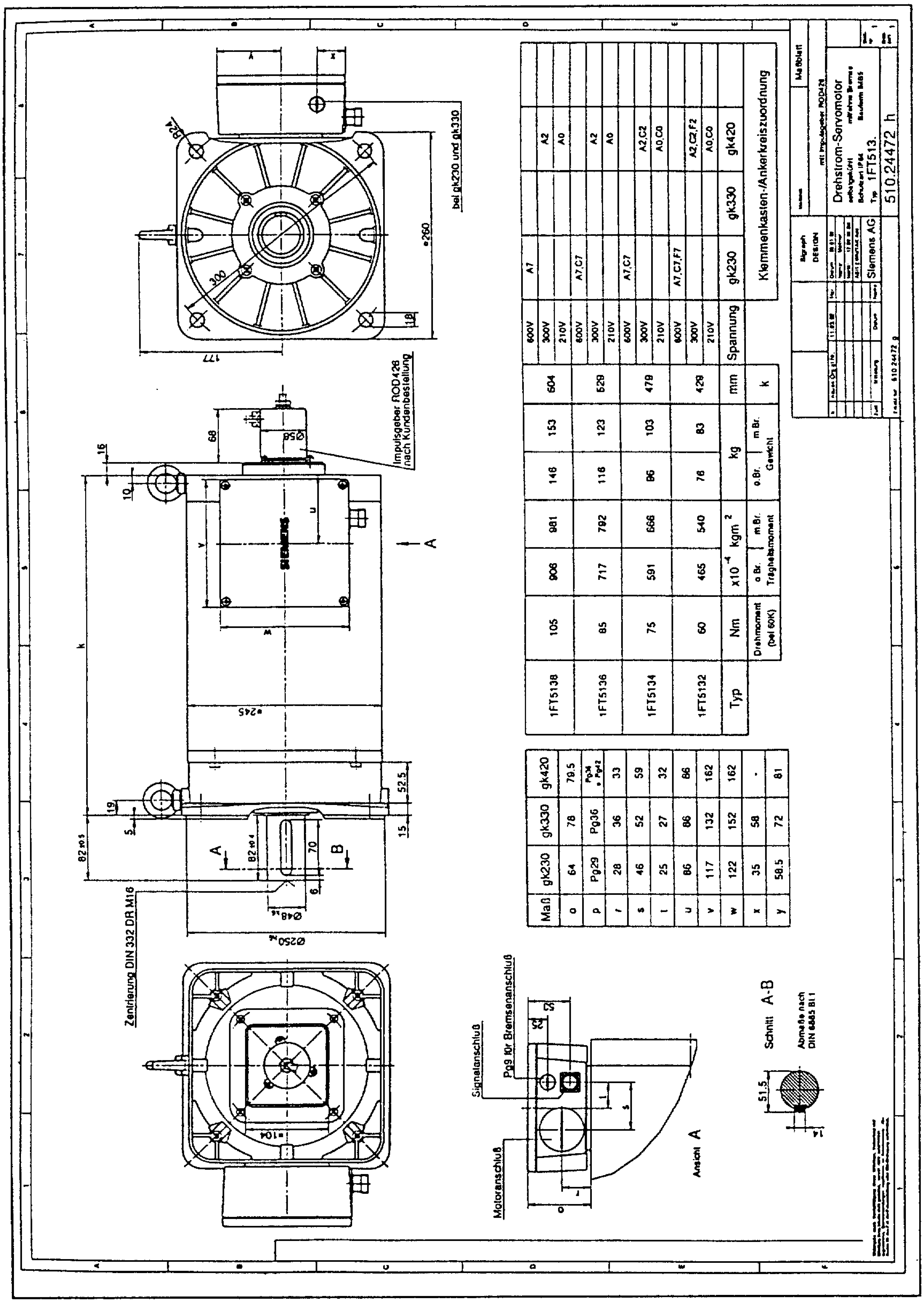


Steckergrößen		2	3
Stromstärke		bis 37.5 A	bis 99 A
Maße	M	M50 x 2	M58 x 2
	B	84	88
	N	57.5	64
	R	R 28.5	R 31.5
	E	29	32.5

Typ	Nm (Drehmoment, bei 60K)	x10⁻⁴ kgm² o Br. (Trägheitsmoment)	x10⁻⁴ kgm² m Br. (Trägheitsmoment)	kg o Br. (Gewicht)	kg m Br. (Gewicht)	mm (k)	Spannung	2	3
1FT5138	105	906	981	146	153	604	600V		A7
							300V		A2
							210V		A0
1FT5136	85	717	792	116	123	529	600V	A7	C7
							300V		A2
							210V		A0
1FT5134	75	591	666	96	103	479	600V	A7	C7
							300V		A2,C2
							210V		A0
1FT5132	60	465	540	76	83	429	600V	A7	C7,F7
							300V		A2,C2,F2
							210V		A0,C0

Steckergröße-/Ankerkreiszuordnung

Dimension drawing of 1FT5132 to 1FT5138 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, connector version

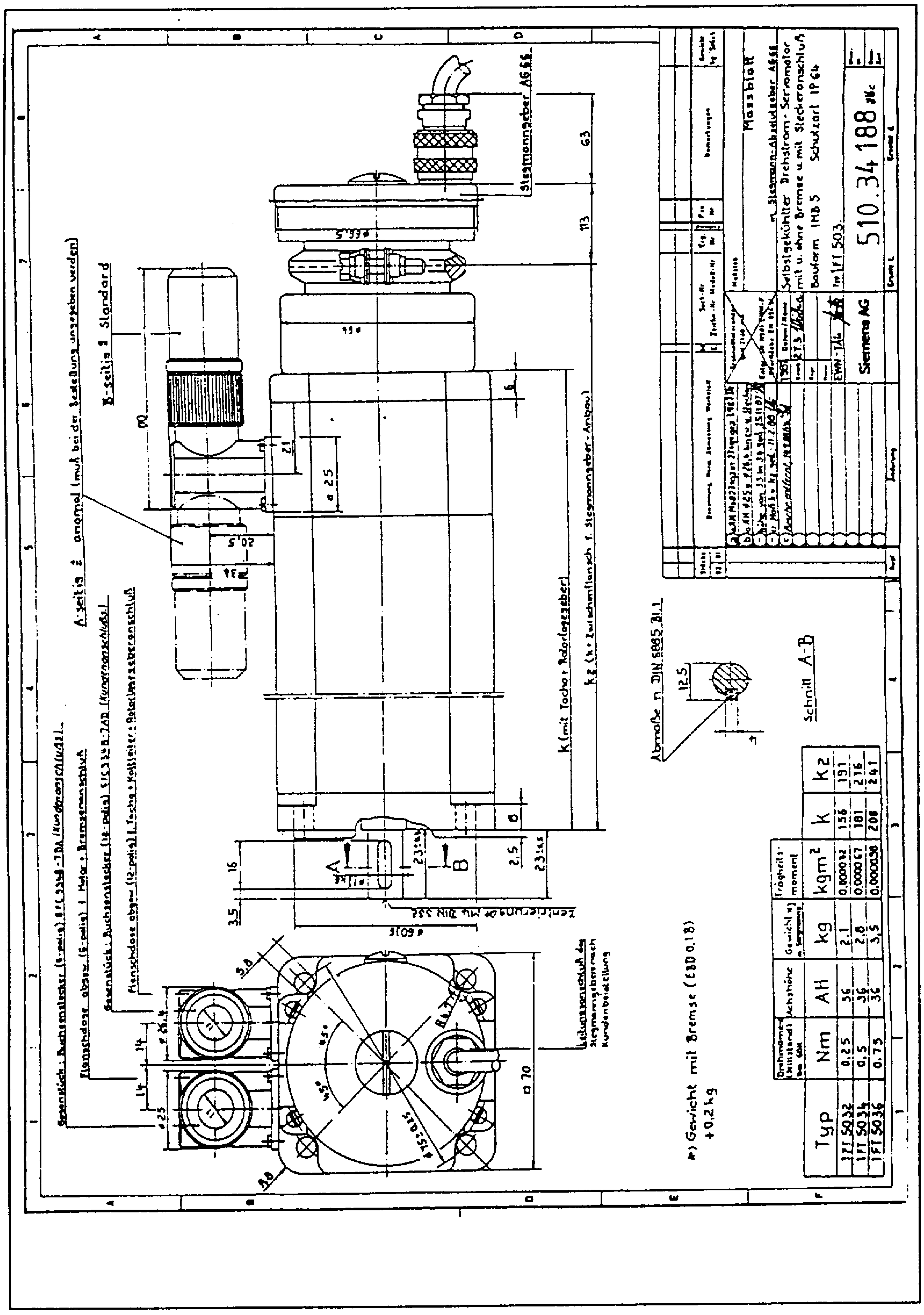


Maß	gk230	gk330	gk420
o	64	78	79.5
p	Pg29	Pg36	Pg36 • Pg42
r	28	36	33
s	46	52	59
t	25	27	32
u	86	86	86
v	117	132	162
w	122	152	162
x	35	58	-
y	58.5	72	81

Typ	Drehmoment (bei 60K) Nm	Trägheitsmoment o.Br. $x10^{-4}$ kgm²	Trägheitsmoment m.Br. $x10^{-4}$ kgm²	Gewicht o.Br. kg	Gewicht m.Br. kg	k mm	Spannung	gk230	gk330	gk420
1FT5138	105	906	981	146	153	604	600V	A7		
							300V			A2
							210V			A0
1FT5136	85	717	792	116	123	529	600V	A7,C7		
							300V			A2
							210V			A0
1FT5134	75	591	666	96	103	479	600V	A7,C7		
							300V			A2,C2
							210V			A0,C0
1FT5132	60	465	540	76	83	429	600V	A7,C7,F7		
							300V			A2,C2,F2
							210V			A0,C0

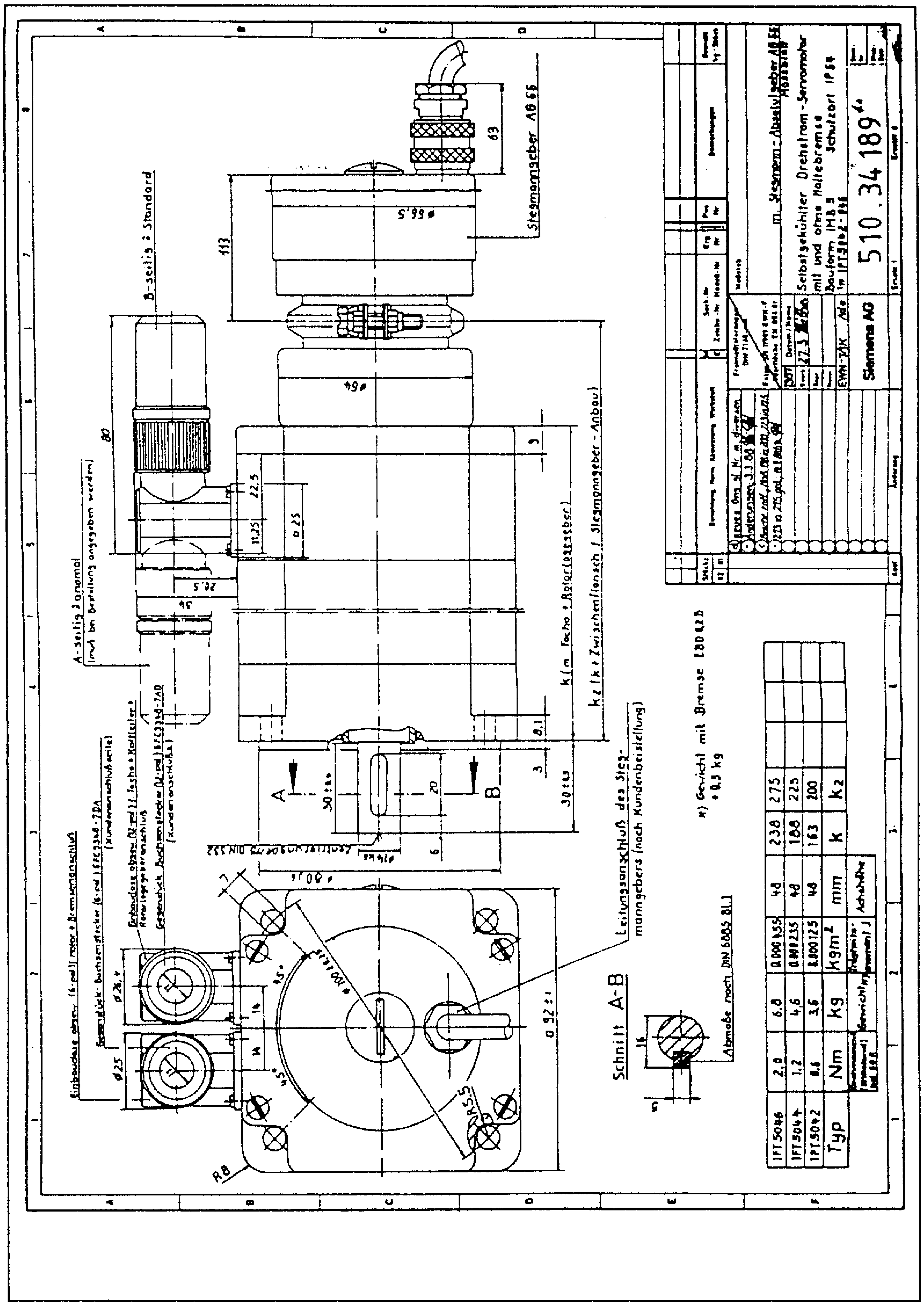
Klemmenkasten-/Ankerkreiszuordnung

Dimension drawing of 1FT5132 to 1FT5138 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, terminal box version

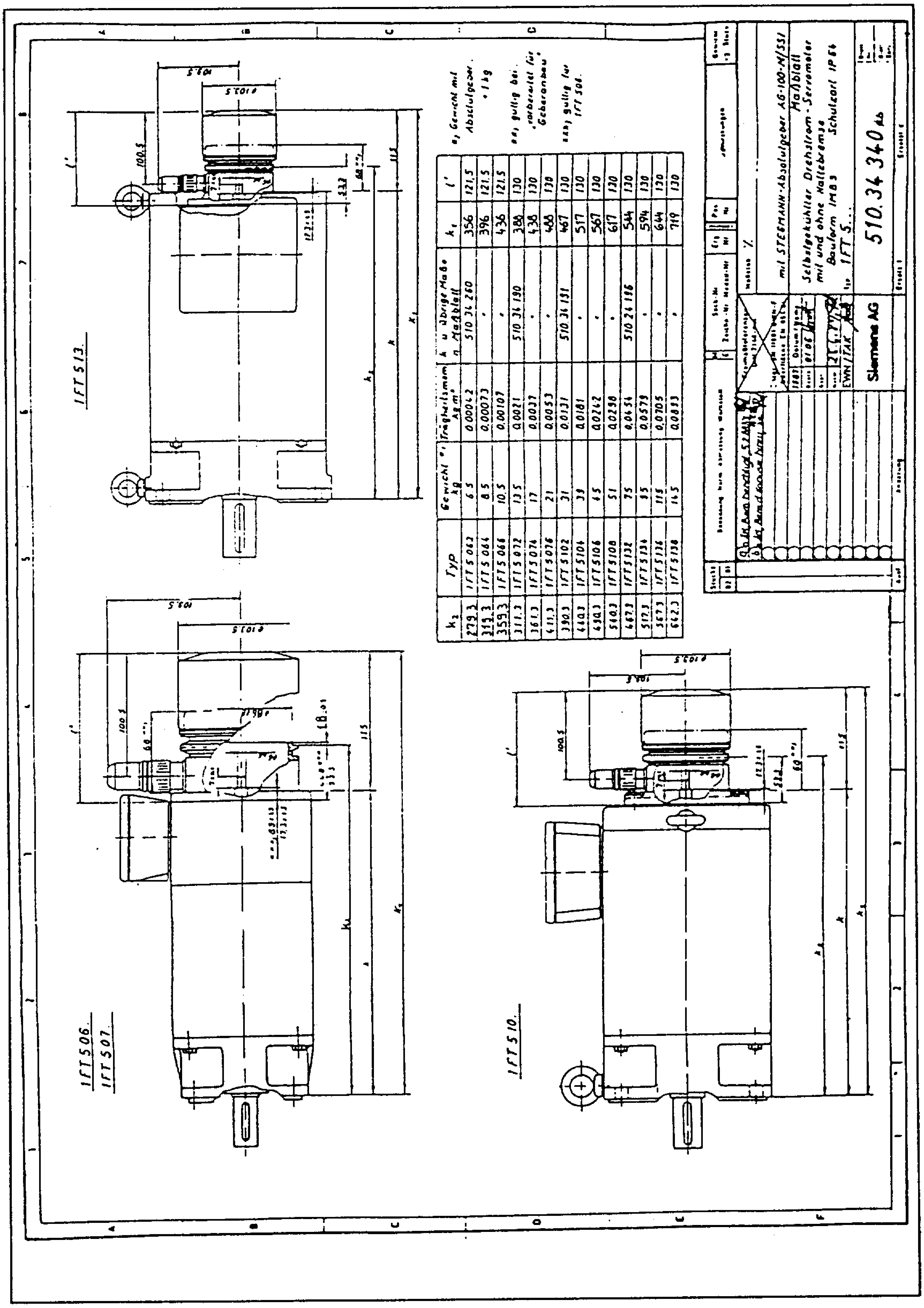


Typ	Drehmoment (Stillstand) bei 60K Nm	Achshöhe AH	Gewicht *) kg	Trägheitsmoment kgm^2	k	k2
1FT5032	0.25	36	2.1	0.000042	156	191
1FT5034	0.5	36	2.8	0.000067	181	216
1FT5036	0.75	36	3.5	0.000038	208	241

Dimension drawing of 1FT5032 to 1FT5036 AC servomotors with AG-66 absolute shaft angle encoder - type of construction IM B5

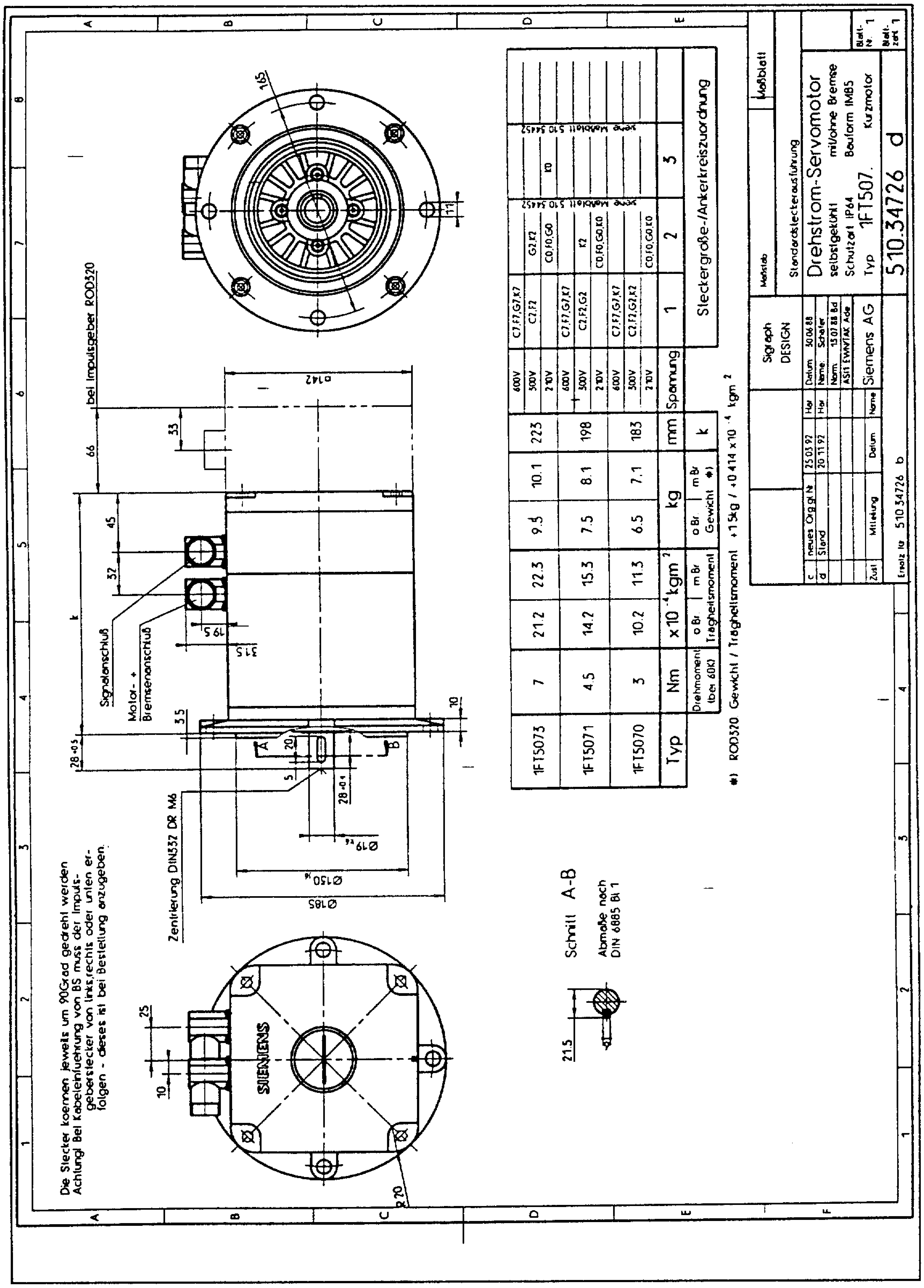


Dimension drawing of 1FT5042 to 1FT5046 AC servomotors with AG-66 absolute shaft angle encoder - type of construction IM B5

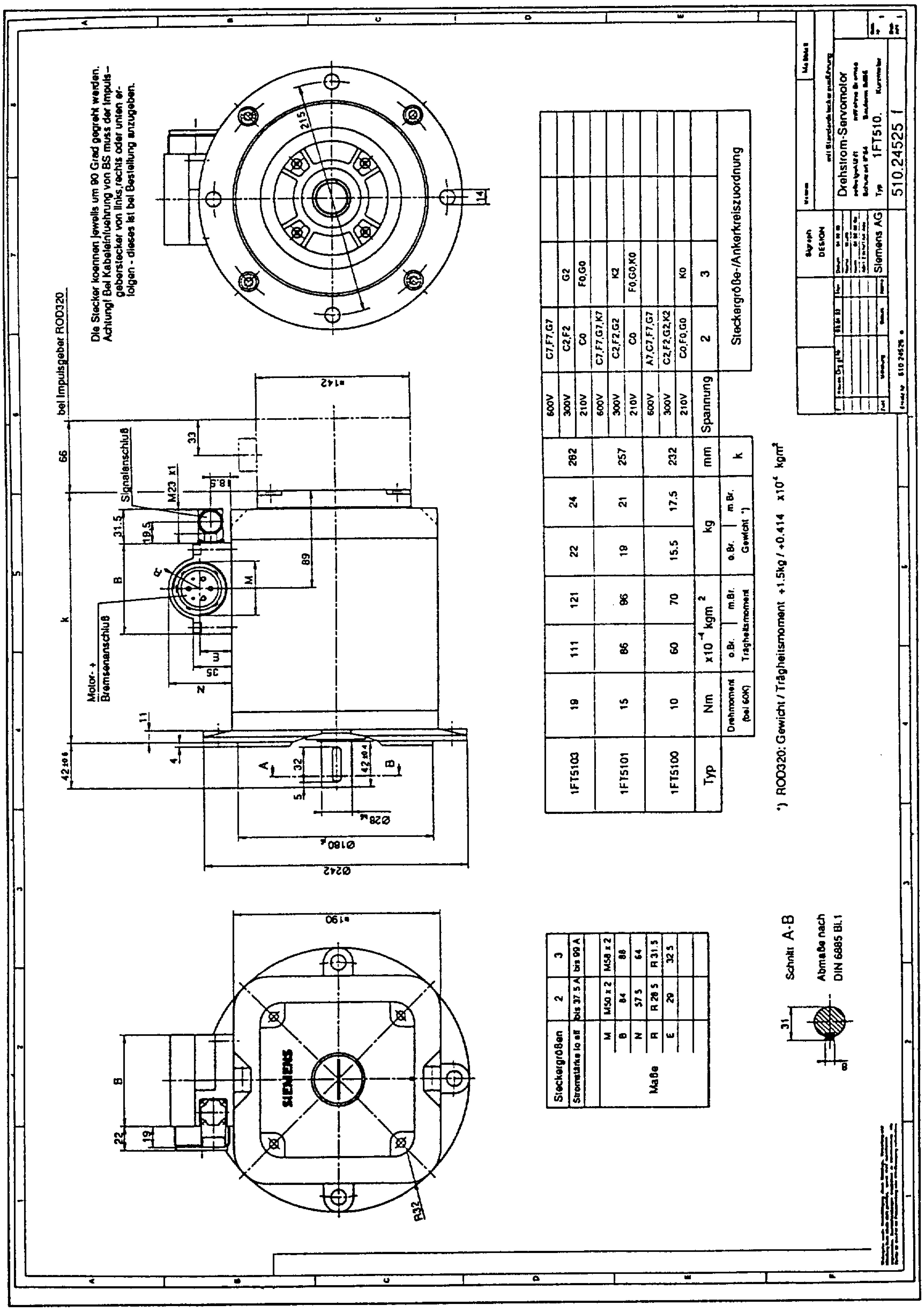


k_2	Typ	Gewicht *) kg	Trägheitsmom. kgm²	k u. übrige Maße n. Maßblatt	k_1	l'
279.3	1FT5062	6.5	0.00042	510 34 260	356	121.5
319.3	1FT5064	8.5	0.00073	"	396	121.5
359.3	1FT5066	10.5	0.00107	"	436	121.5
311.3	1FT5072	13.5	0.0021	510 34 190	388	130
361.3	1FT5074	17	0.0037	"	438	130
411.3	1FT5076	21	0.0053	"	488	130
390.3	1FT5102	31	0.0131	510 34 191	467	130
440.3	1FT5104	38	0.0181	"	517	130
490.3	1FT5106	45	0.0242	"	567	130
540.3	1FT5108	51	0.0298	"	617	130
467.3	1FT5132	75	0.0454	510 24 116	544	130
517.3	1FT5134	95	0.0579	"	594	130
567.3	1FT5136	115	0.0705	"	644	130
642.3	1FT5138	145	0.0833	"	719	130

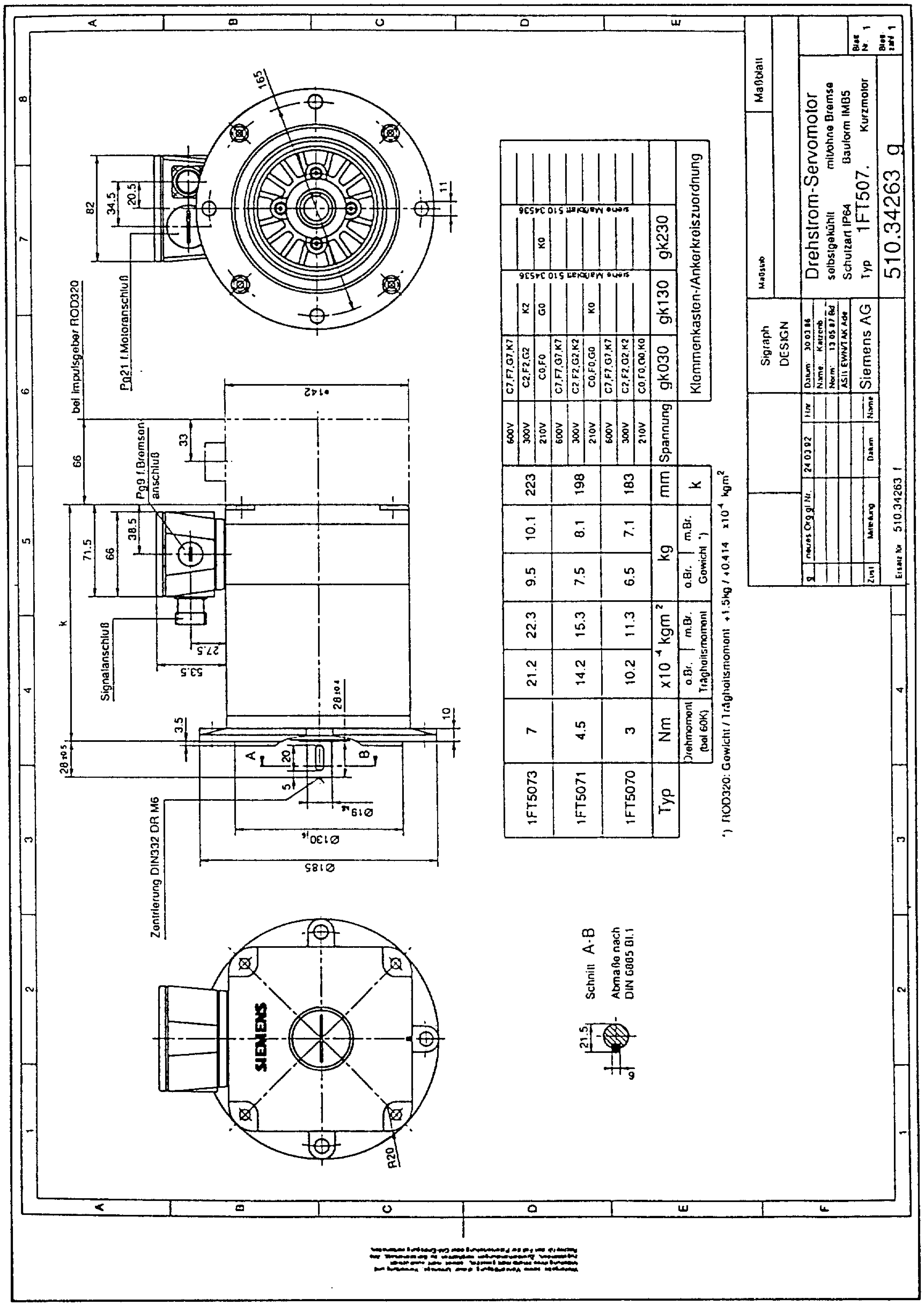
Dimension drawing of 1FT5062 to 1FT5138 AC servomotors AG-100-M/SSI absolute shaft angle encoder - type of construction IM B5



Dimension drawing of 1FT5070 to 1FT5073 AC servomotors - type of construction IM B5, connector version size 1 (including option with ROD 320 pulse encoder)



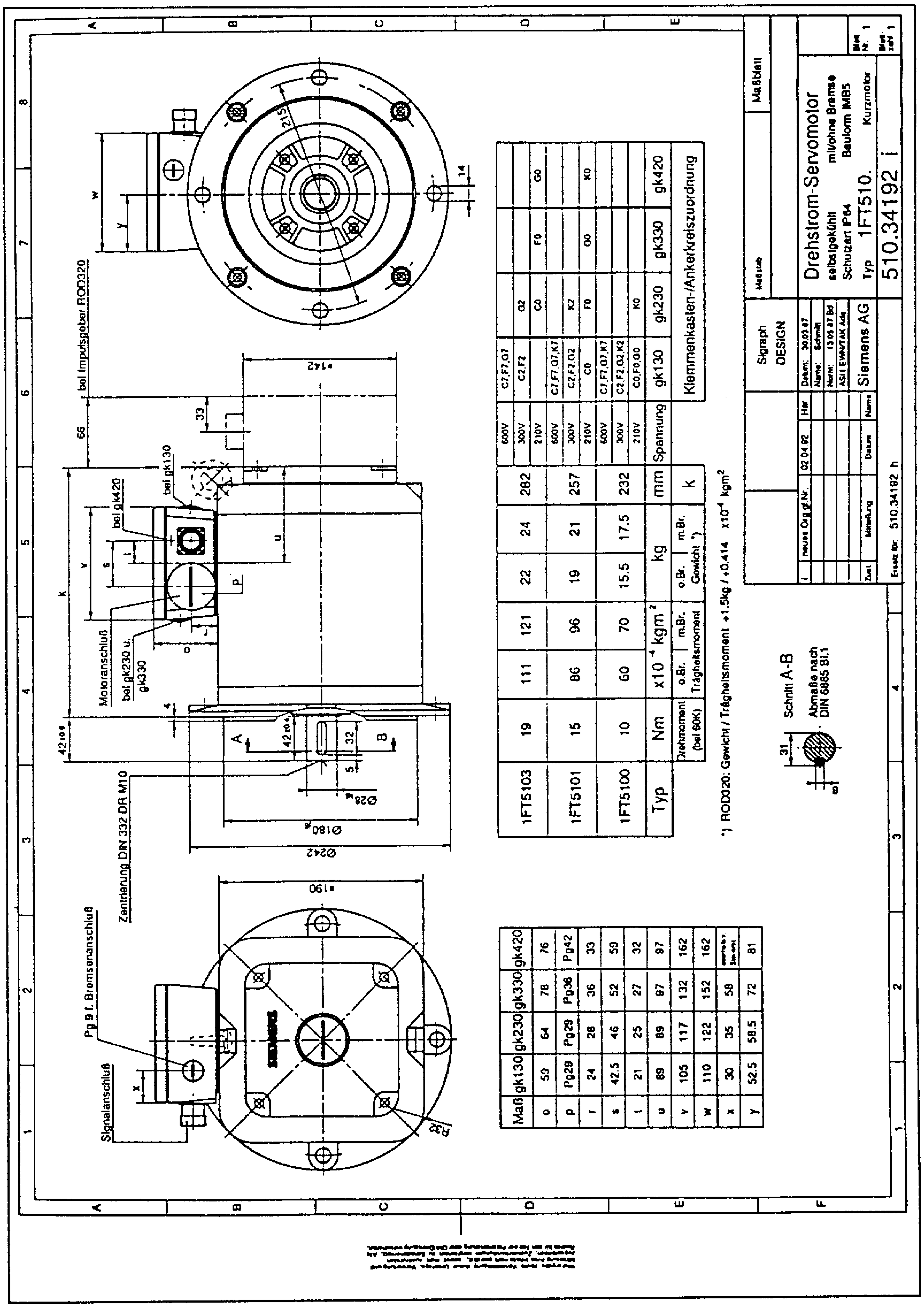
Dimension drawing of 1FT5100, 1FT5101 and 1FT5073 AC servomotors with connectors type of construction IM B5 (including option with ROD 320 pulse encoder)



Typ	Nm	x10^{-4} kgm^2		kg		mm	Spannung	gk030	gk130	gk230
	Drehmoment (bei 60K)	o.Br. Trägheitsmoment	m.Br.	o.Br. Gewicht *)	m.Br.	k		Klemmenkasten-/Ankerkreiszuordnung		
1FT5073	7	21.2	22.3	9.5	10.1	223	600V	C7,F7,G7,K7	siehe Maßblatt 510 34536	siehe Maßblatt 510 34536
							300V	C2,F2,G2	K2	
							210V	C0,F0	G0	K0
1FT5071	4.5	14.2	15.3	7.5	8.1	198	600V	C7,F7,G7,K7		
							300V	C2,F2,G2,K2		
							210V	C0,F0,G0	K0	
1FT5070	3	10.2	11.3	6.5	7.1	183	600V	C7,F7,G7,K7		
							300V	C2,F2,G2,K2		
							210V	C0,F0,G0,K0		

*) ROD320: Gewicht / Trägheitsmoment +1.5kg / +0.414 x10^{-4} kgm^2

Dimension drawing of 1FT5070, 1FT5071 and 1FT5073 AC servomotors - type of construction IM B5 - only valid with the gk030 terminal box mounted

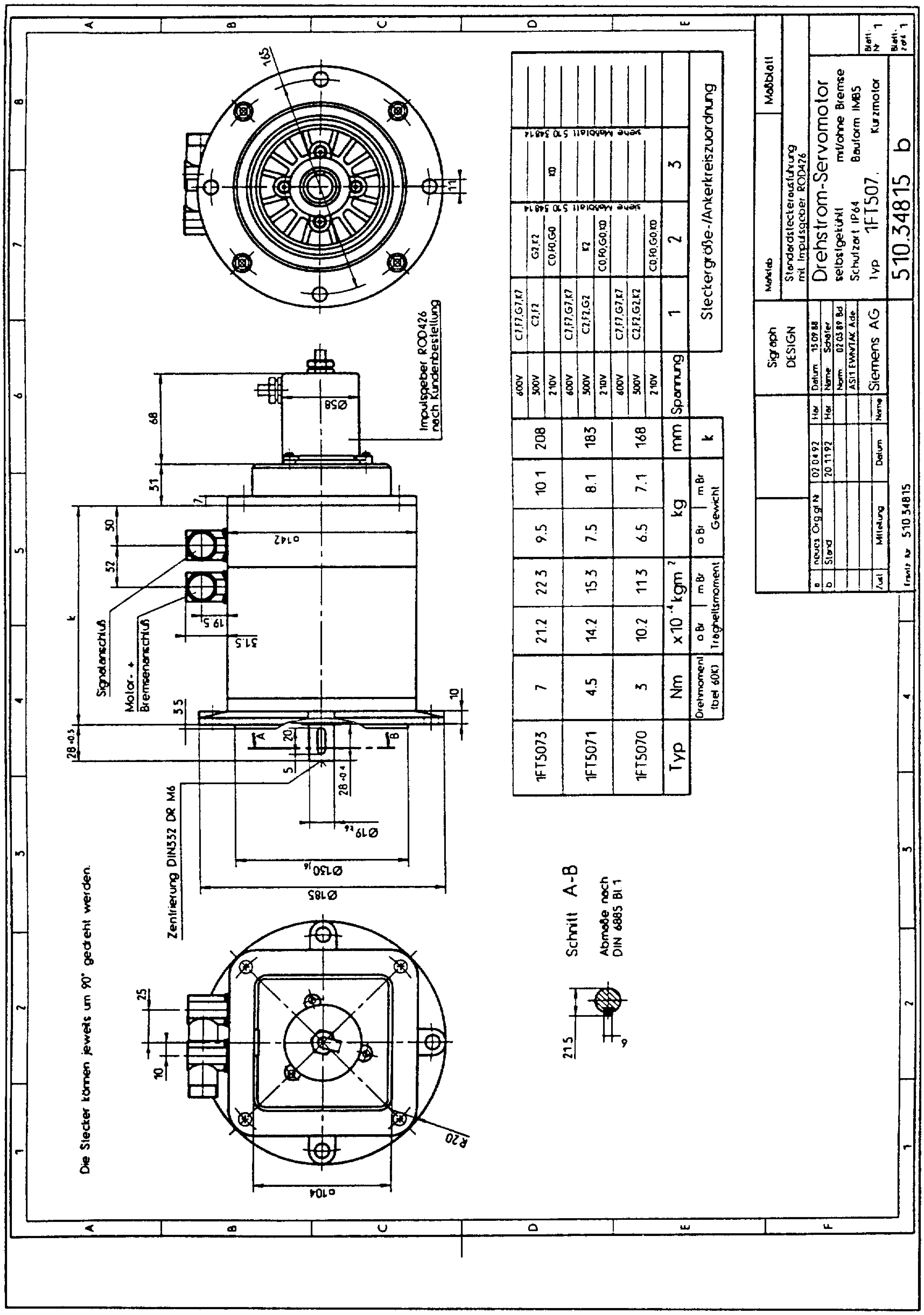


Maß	gk130	gk230	gk330	gk420
o	59	64	78	76
p	Pg29	Pg29	Pg36	Pg42
r	24	28	36	33
s	42.5	46	52	59
t	21	25	27	32
u	89	89	97	97
v	105	117	132	162
w	110	122	152	162
x	30	35	58	[illegible]
y	52.5	58.5	72	81

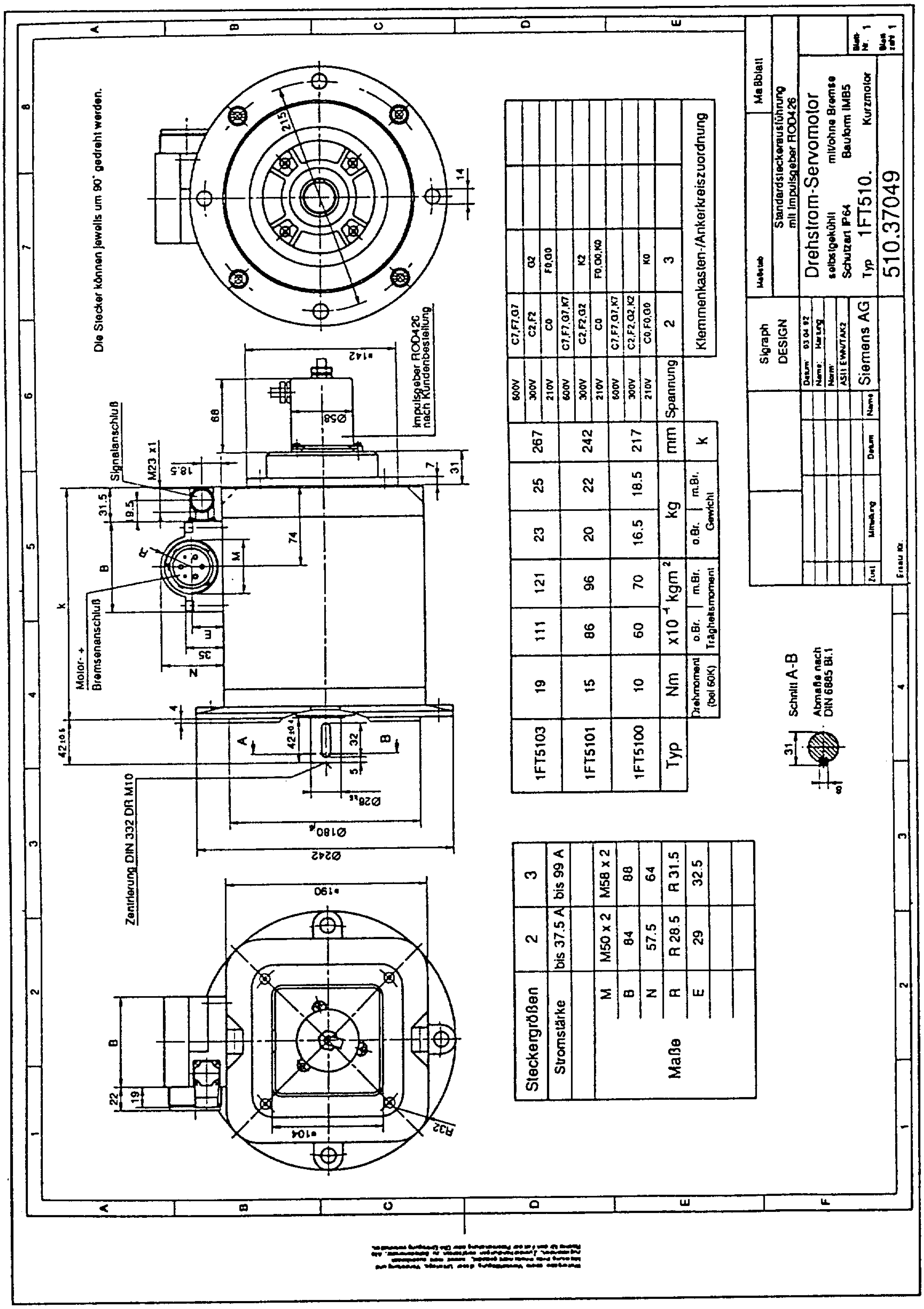
Typ	Nm	$x10^{-4}$ kgm²		kg		mm	Spannung	gk130	gk230	gk330	gk420
	Drehmoment (bei 60K)	o.Br.	m.Br.	o.Br.	m.Br.	k		Klemmenkasten-/Ankerkreiszuordnung			
		Trägheitsmoment		Gewicht *)							
1FT5103	19	111	121	22	24	282	600V	C7,F7,G7			
							300V	C2,F2	G2		
							210V		C0	F0	G0
1FT5101	15	86	96	19	21	257	600V	C7,F7,G7,K7			
							300V	C2,F2,G2	K2		
							210V	C0	F0	G0	K0
1FT5100	10	60	70	15.5	17.5	232	600V	C7,F7,G7,K7			
							300V	C2,F2,G2,K2			
							210V	C0,F0,G0	K0		

*) ROD320: Gewicht / Trägheitsmoment +1.5kg / +0.414 $x10^{-4}$ kgm²

Dimension drawing of 1FT5100, 1FT5101 and 1FT5103 AC servomotors - type of construction IM B5



Dimension drawing of 1FT5070 to 1FT5073 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, connector version size 1



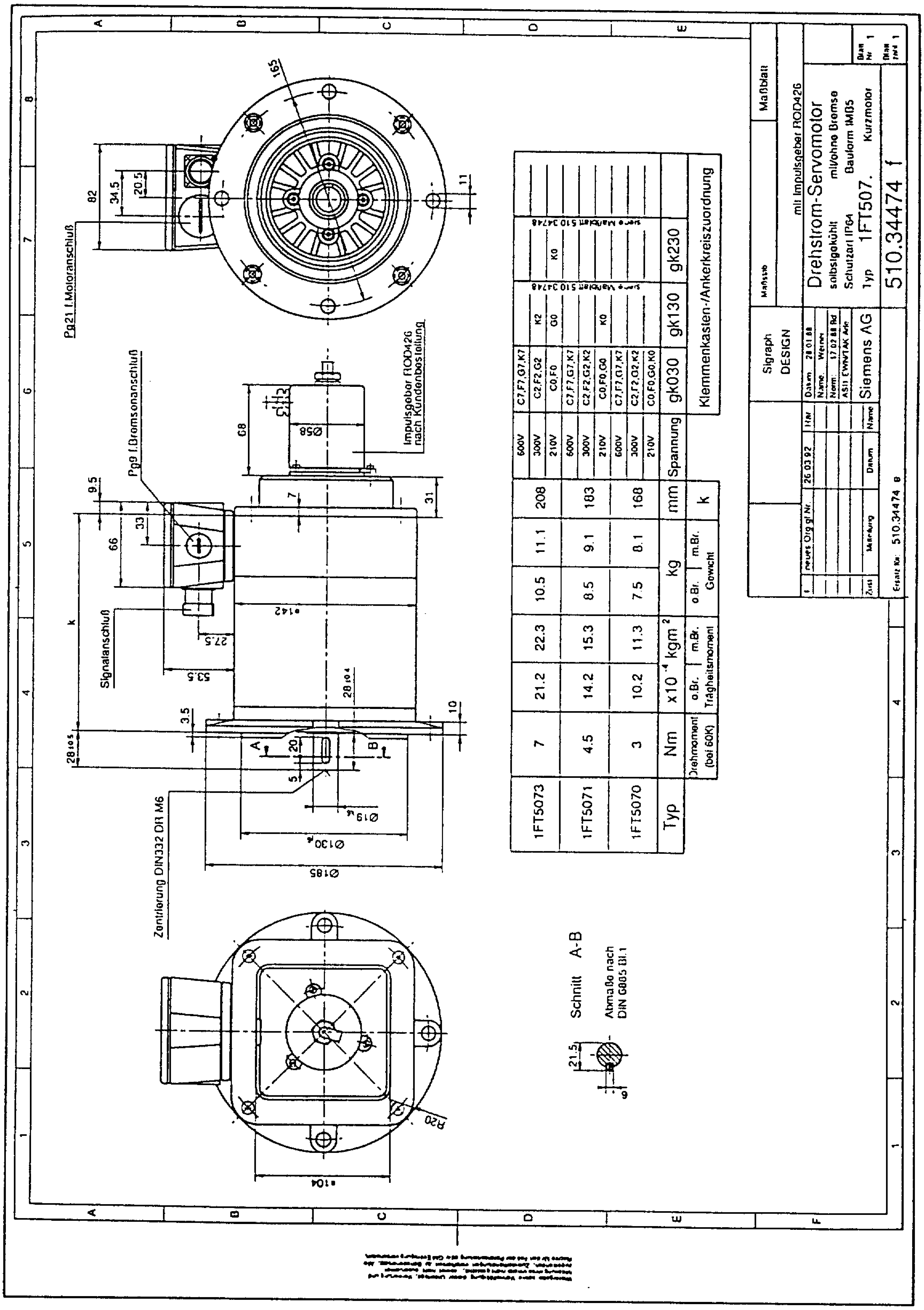
Steckergrößen		2	3
Stromstärke		bis 37.5 A	bis 99 A
Maße	M	M50 x 2	M58 x 2
	B	84	88
	N	57.5	64
	R	R 28.5	R 31.5
	E	29	32.5

Typ	Nm (Drehmoment (bei 60K))	$x10^{-4}$ kgm^2 o.Br. (Trägheitsmoment)	$x10^{-4}$ kgm^2 m.Br. (Trägheitsmoment)	kg o.Br. (Gewicht)	kg m.Br. (Gewicht)	mm (k)
1FT5103	19	111	121	23	25	267
1FT5101	15	86	96	20	22	242
1FT5100	10	60	70	16.5	18.5	217

Klemmenkasten-/Ankerkreiszuordnung

Typ	Spannung	2	3
1FT5103	600V	C7,F7,G7	
	300V	C2,F2	G2
	210V	C0	F0,G0
1FT5101	600V	C7,F7,G7,K7	
	300V	C2,F2,G2	K2
	210V	C0	F0,G0,K0
1FT5100	600V	C7,F7,G7,K7	
	300V	C2,F2,G2,K2	
	210V	C0,F0,G0	K0

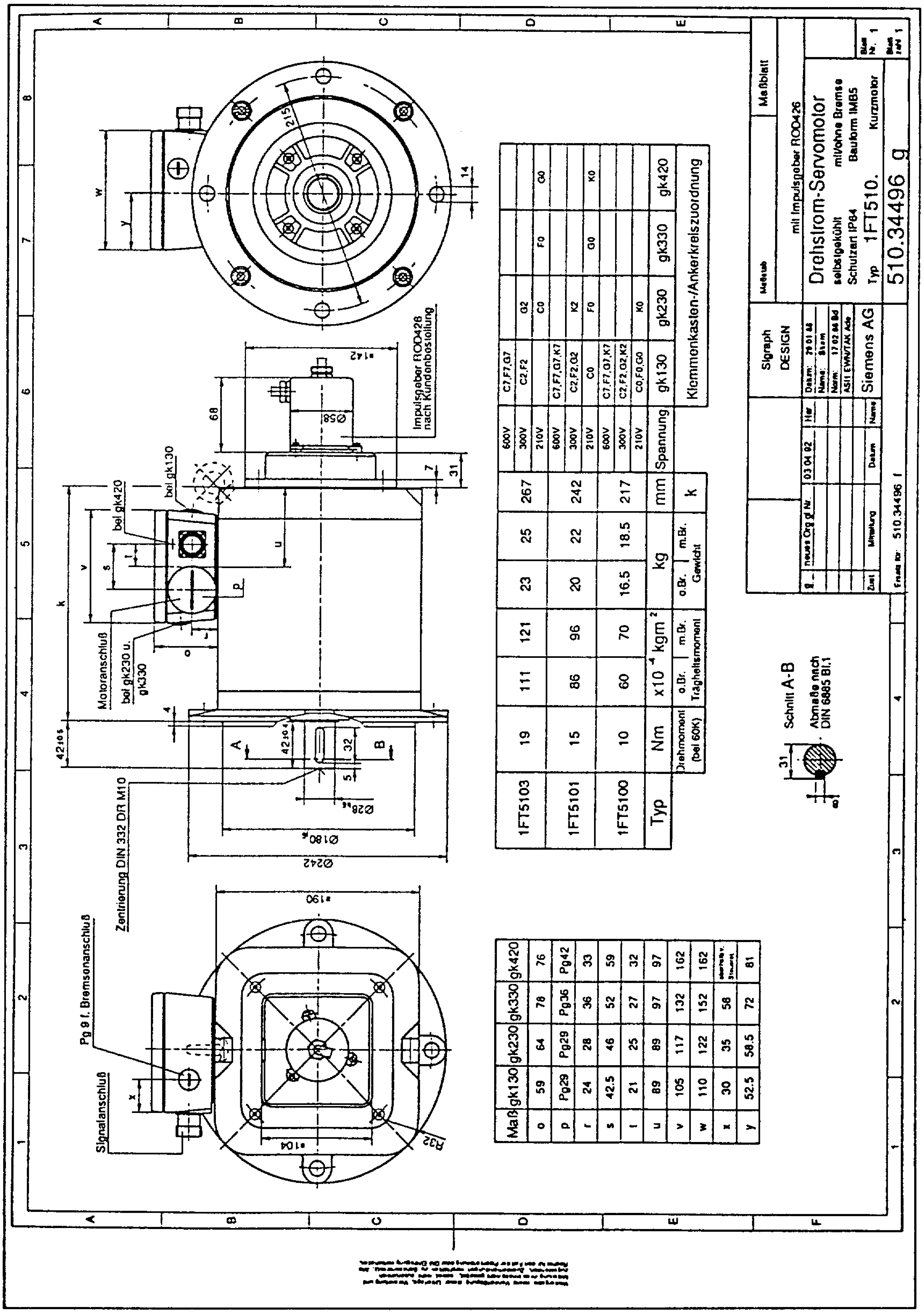
Dimension drawing of 1FT5100 to 1FT5103 AC servomotors with ROD 426 pulse encoder - type of construction IM B5, connector version



Typ	Nm Drehmoment (bei 60K)	x10^{-4} kgm^2 Trägheitsmoment o.Br.	m.Br.	kg Gewicht o.Br.	m.Br.	mm k	Spannung	gk030	gk130	gk230
1FT5073	7	21.2	22.3	10.5	11.1	208	600V	C7,F7,G7,K7		
							300V	C2,F2,G2	K2	
							210V	C0,F0	G0	K0
1FT5071	4.5	14.2	15.3	8.5	9.1	183	600V	C7,F7,G7,K7		
							300V	C2,F2,G2,K2		
							210V	C0,F0,G0	K0	
1FT5070	3	10.2	11.3	7.5	8.1	168	600V	C7,F7,G7,K7		
							300V	C2,F2,G2,K2		
							210V	C0,F0,G0,K0		

Klemmenkasten-/Ankerkreiszuordnung

Dimension drawing of 1FT5070, 1FT5071 and 1FT5073 AC servomotors with ROD 426 pulse encoder - type of construction IM B5 - only valid with gk030 terminal box mounted



Maß	gk130	gk230	gk330	gk420
o	59	64	78	76
p	Pg29	Pg29	Pg36	Pg42
r	24	28	36	33
s	42.5	46	52	59
t	21	25	27	32
u	89	89	97	97
v	105	117	132	162
w	110	122	152	162
x	30	35	58	[illegible]
y	52.5	58.5	72	81

Typ	Nm Drehmoment (bei 60K)	$x10^{-4}$ kgm² Trägheitsmoment o.Br.	$x10^{-4}$ kgm² Trägheitsmoment m.Br.	kg Gewicht o.Br.	kg Gewicht m.Br.	mm k	Spannung	gk130	gk230	gk330	gk420
1FT5103	19	111	121	23	25	267	600V	C7,F7,G7			
							300V	C2,F2	G2		
							210V		C0	F0	G0
1FT5101	15	86	96	20	22	242	600V	C7,F7,G7,K7			
							300V	C2,F2,G2	K2		
							210V	C0	F0	G0	K0
1FT5100	10	60	70	16.5	18.5	217	600V	C7,F7,G7,K7			
							300V	C2,F2,G2,K2			
							210V	C0,F0,G0	K0		

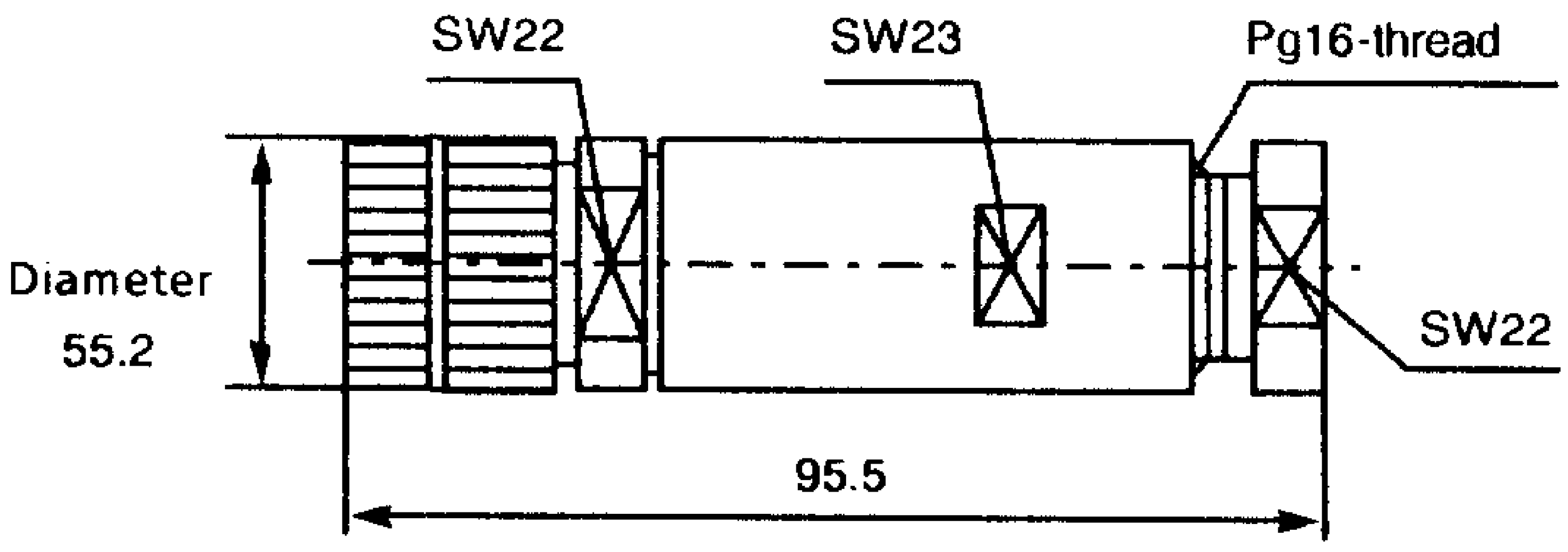
Klemmenkasten-/Ankerkreiszuordnung

Dimension drawing of 1FT5100, 1FT5101 and 1FT5103 AC servomotors with ROD 426 pulse encoder - type of construction IM B5

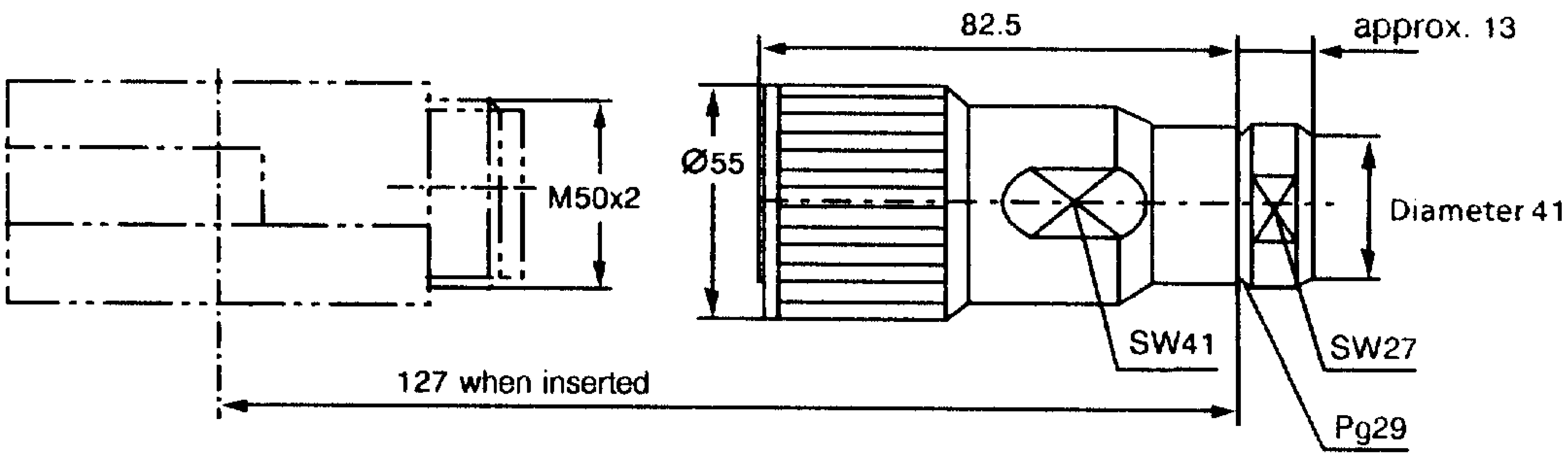
2.10.3 Round connectors

Round connectors for power connection

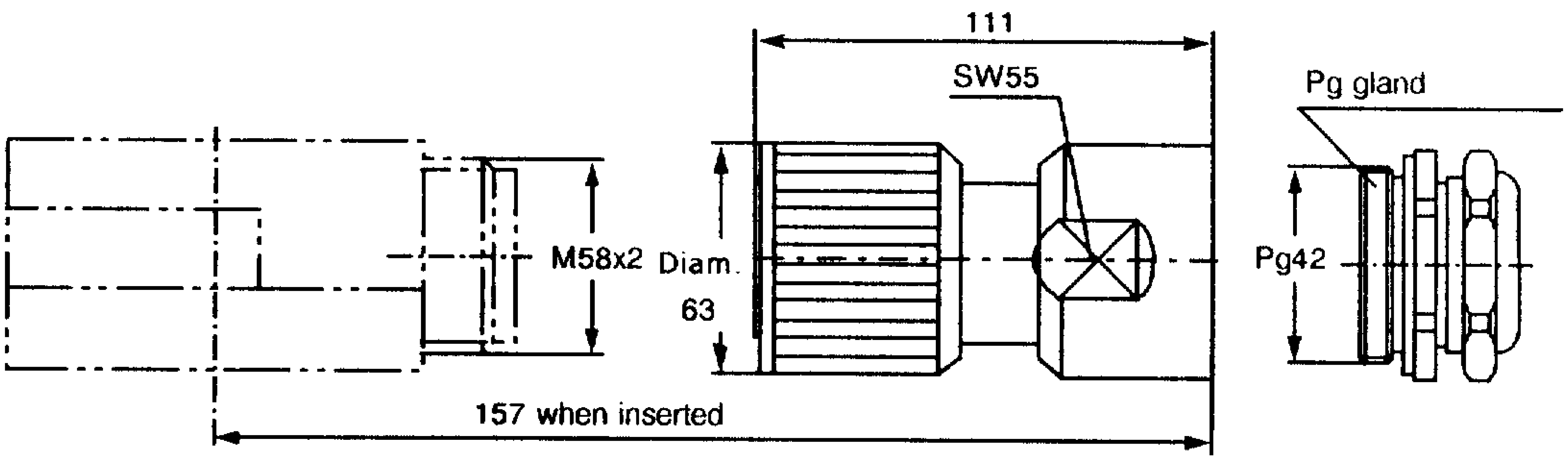
Connector size 1 (6FC9348-7DN01)



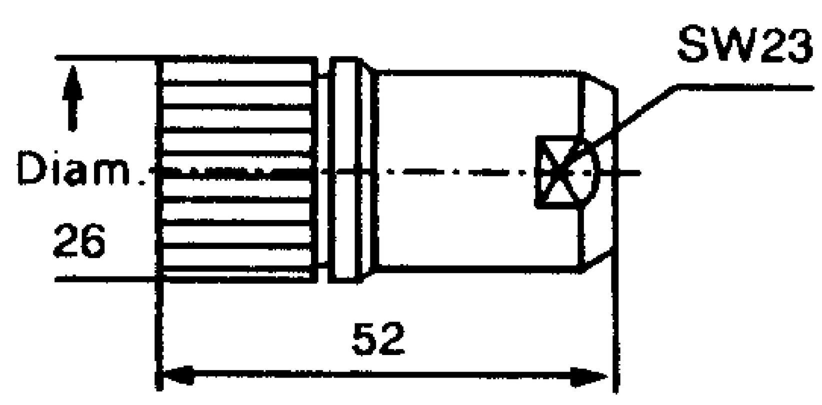
Connector size 2 (6FC9348-7DC01 and 6FC9348-7DG01)



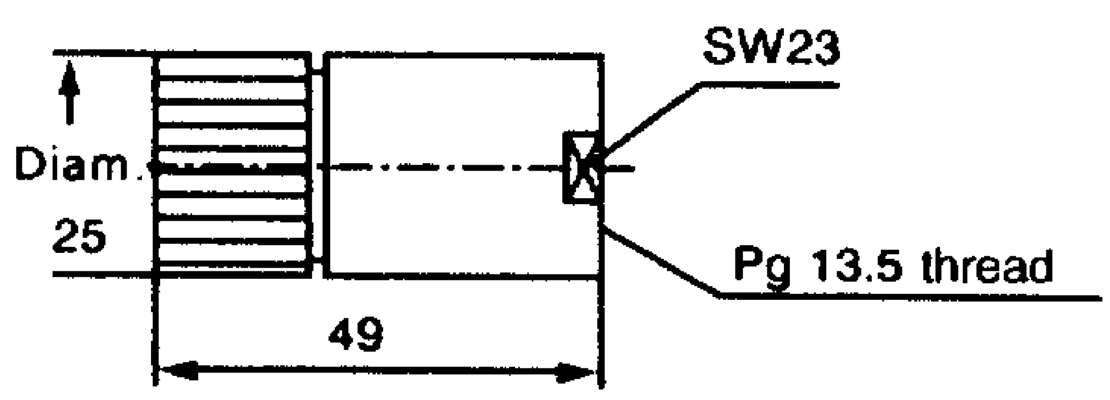
Connector size 3 (6FC9348-7DA and 6FC9348-7DK)



Round connector. 12-pin for signal connection

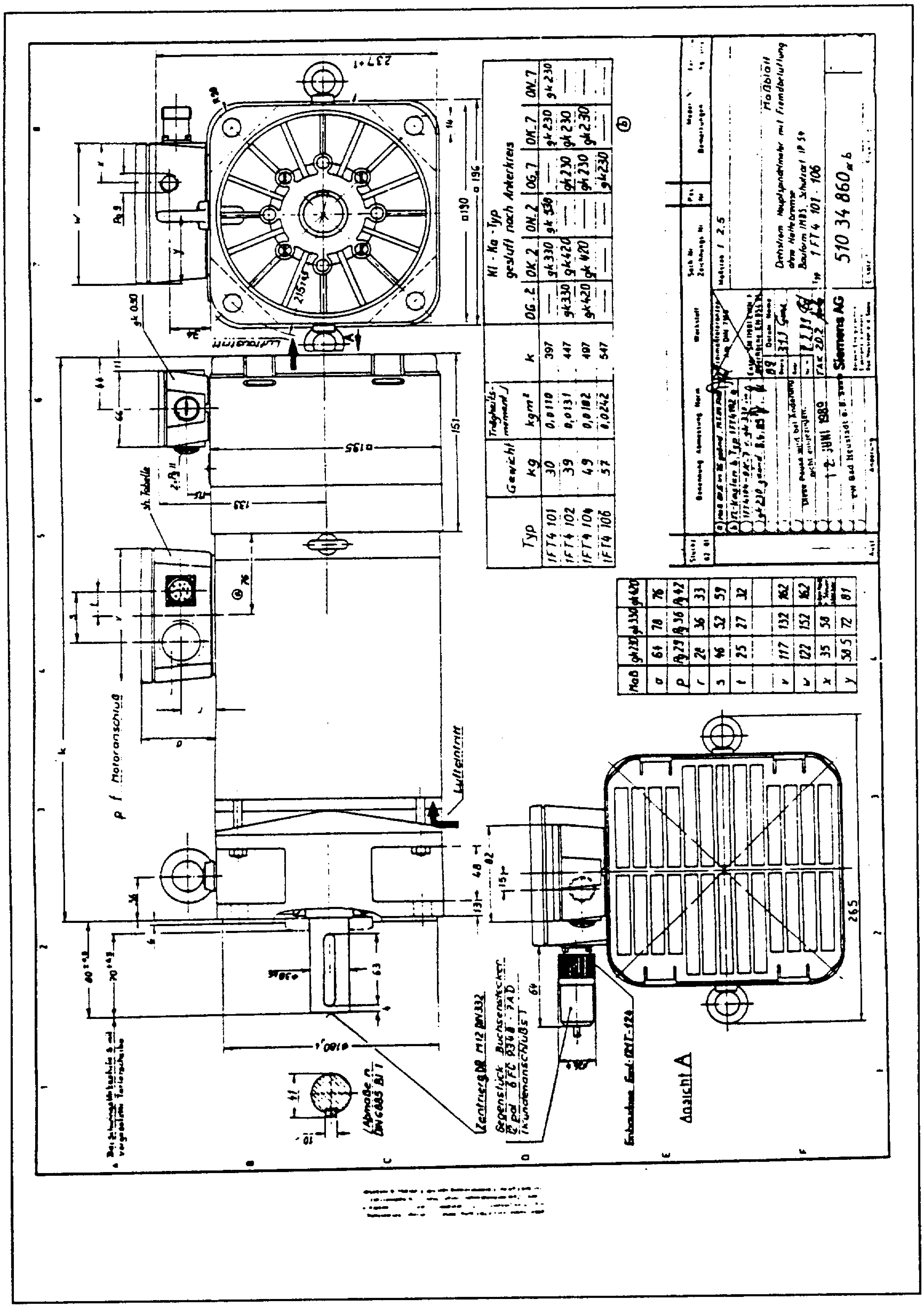


with integrated cable clamping



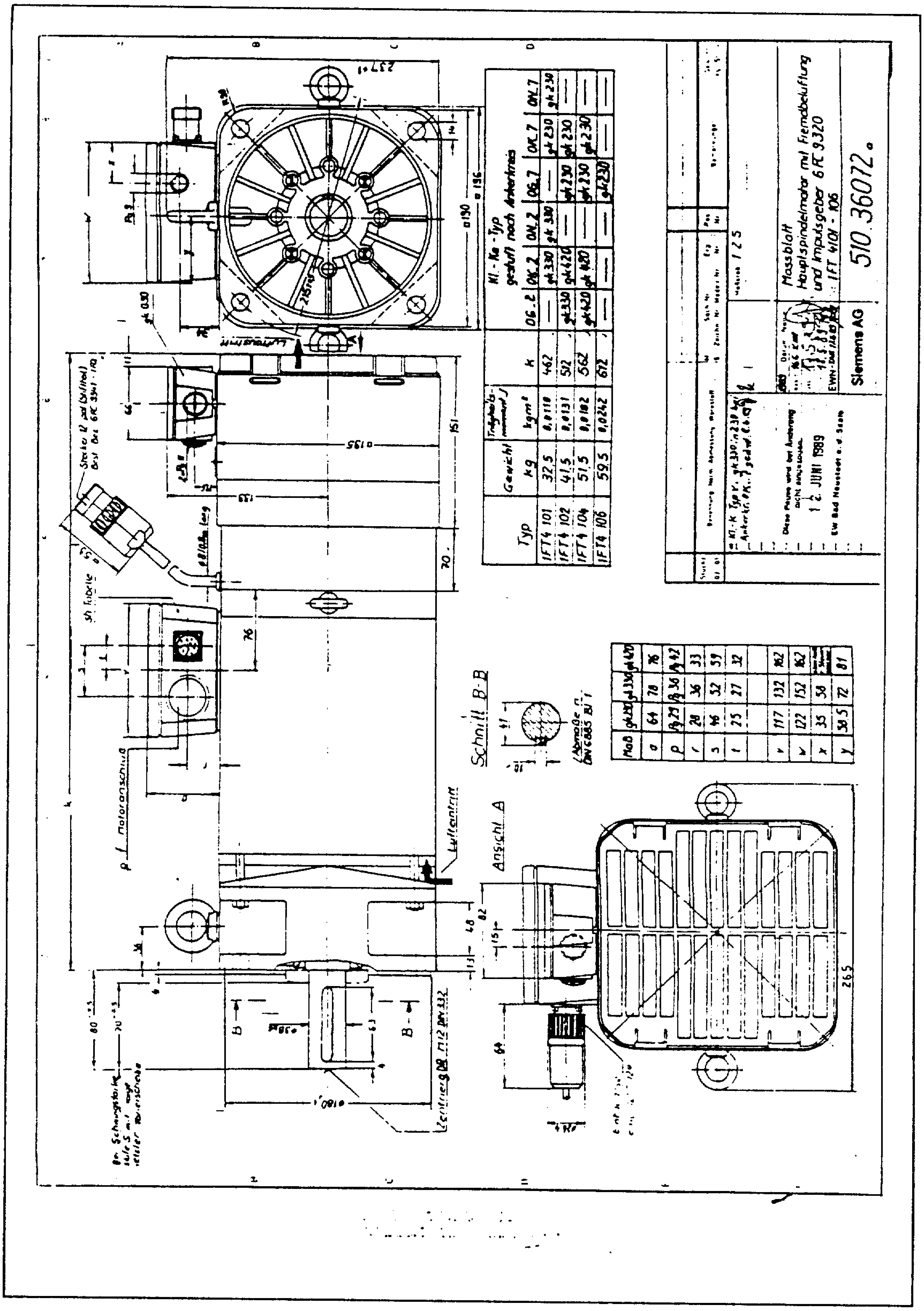
with Pg 13.5 thread for Pg gland

Caution: Connectors are not included in the EWN scope of supply!

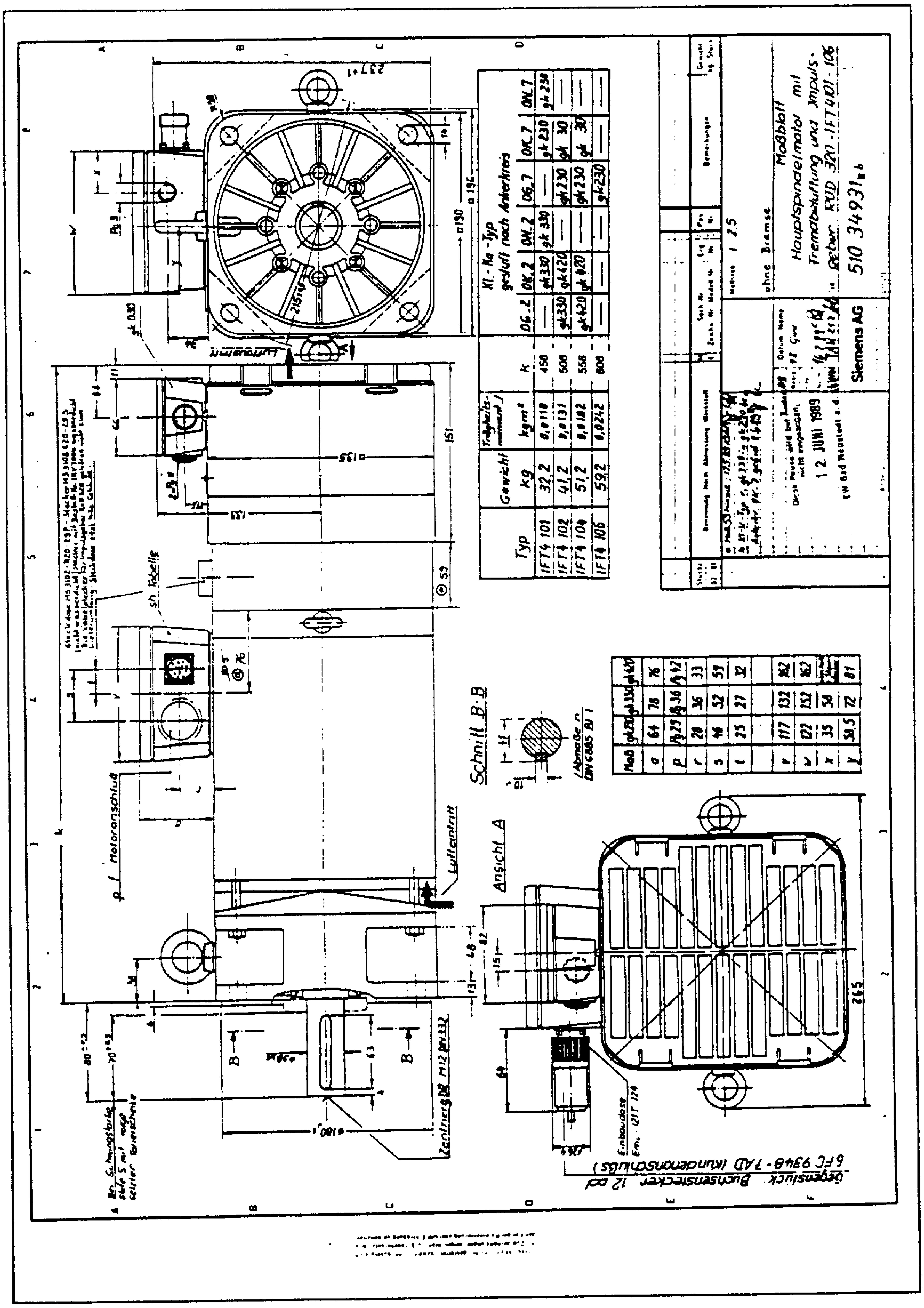


Dimension drawing of 1FT4101 to 1FT4106 AC servomotors, force-ventilated, degree of protection IP 54

 6ZB5 420-0AS02



Dimension drawing of 1FT4101 to 1FT4106 AC servomotors, force-ventilated with ROD 426 pulse encoder (6FC9320)



Dimension drawing of 1FT4101 to 1FT4106 AC servomotors, force-ventilated with ROD 320 pulse encoder

2.11 Mounting instructions

	WARNING
	The system should always be disconnected and be in a no-voltage condition when any work is carried out! Voltage is always present at the motor terminals when the rotor is turning as a result of the permanent magnets.

1FT5 servomotors and PWM converters can be connected up according to DIN VDE 0113 and VDA[1]. Cross-sections can be connected according to DIN VDE 0113 Part 1/02.86 Table BI and BII for series machines with cables routed in a cable duct (4) and at +40 °C ambient temperature.

2.11.1 1FT5 servomotors

2.11.1.1 Mounting the servomotors

When transporting the motors, it is recommended that all of the lifting lugs provided are used.

	CAUTION
	• It should be ensured that the motor is not subject to any shocks or the shaft end axially stressed during mounting and start-up. • When the tachogenerator rotor is used to lock or turn the motor shaft using the hexagonal tachogenerator shaft end (size 19) for 1FT506. to 1FT513.[2] motors, a maximum torque of 100 Nm cannot be exceeded, as otherwise the motor will be damaged.

The servomotors must be mounted so that sufficient heat dissipation through radiation and natural convection is guaranteed. For force-cooled motors, the heated, discharged air must not be drawn in again.

High surface temperatures can occur on the servomotors and if required protection should be provided.

Belt forces applied to the motor shaft must not exceed the limiting values, according to the cantilever force diagrams in Section 2.9.

For motor versions with key in the motor shaft, this is factory balanced as a complete unit.

1) VDA Verband (German automobile industy association).
2) The hexagonal tachogenerator shaft end is not available for 1FT503. to 1FT504 motors

2.11.1.2 Servomotor connection

CAUTION

- Servomotors cannot and must not be directly connected to the line supply, and must only be operated using the appropriate SIMODRIVE 611 transistor PWM converter.
- Note the rating plate data and dimension the connecting cables accordingly (the tables on the following pages) and provide the correct cable strain relief measures.
- For safety-related circuits, the internal control devices in the converter do not provide electrical isolation from the line supply.

Power connections

The motors have two types of power connection. The connector design as version 1 and the terminal box design as version 2. For the connector design, there is a common connector[1)] for connecting the inverter section and holding brake. Special pre-assembled cables (refer to the table on the following page) are also available. For the terminal box design, the inverter section and holding brake connection are fed to the terminal board. A connector[1)] is provided in the terminal box for connecting the tachogenerator and rotor position encoder. Pre-assembled cables are also available in the accessory program to connect up the rotor position encoder to the converter (refer to the table "Accessories, encoder cables" on the following pages.

The connections are dimensioned for cable-cross sections, which are calculated from the RMS currents $I_{0\ RMS}$ at standstill torque M_0 and for a winding temperature rise of 100 K. The cable cross-sections can be determined according to the diagram "motor feeder cross-sections" .

The power cables must be protected, which can also be simultaneously used as servomotor overload protection.

If the RMS value of the rated power section current $I_{rated\ RMS}$ is less than or equal to the permissible RMS current of the cable, cable protection can be provided by the converter current limiting and the I^2t monitoring of the power section.

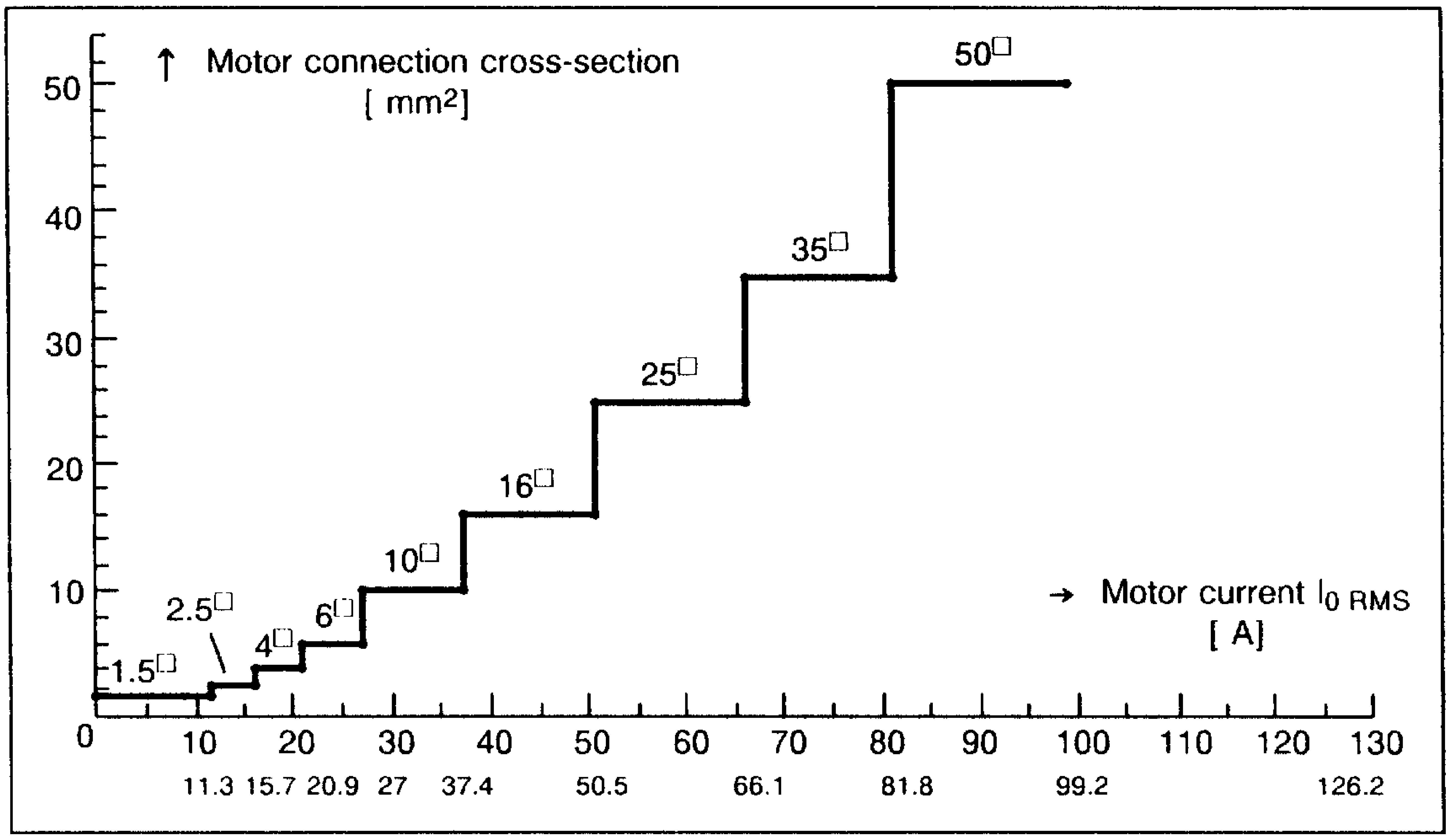
If this cannot be fulfilled, then, e.g. a thermal, delayed overload relay (without phase failure monitoring) can be used, which is set to the permissible current rating of the cable. Another possibility is to increase the cable cross-section to the RMS current I_{RMS} of the power section. In this case, it should be ensured that the cable cross-sections can be connected to the terminal box or the connectors depending on the connecting type selected.

The cable cross-sections for the motors and PWM converters are specified in the tables on the following pages. If other power sections and motor combinations are required than are listed in the tables, or if lower cable cross-sections are required, cable protection between the converter and motor must be provided according to the relevant regulations.

The motors can be protected against short-time and steady-state overload conditions up to $2 \cdot I_0$ using the integrated PTC thermistors and by appropriately evaluating the signal via terminal 5 or an external evaluation unit. Further, the PWM converter is protected by the I^2t monitoring, if $I_{0\ motor} \geq I_{rated\ converter}$.

1) Mating connector is not part of the motor scope of supply.

Additional overlod protection can be realized using a thermal, delayed overload relay (without phase failure monitoring). The response threshold should be set to ≤ 1.1 · I_{RMS} of the motor. If the relay frequently responds at this setting, then if required, higher response thresholds can be set, as long as this is permitted by DIN VDE 0113. The thus necessary restrictions regarding cable temperature must be taken into account. If the overload relay is simultaneously used as cable protection, this must be taken into account when setting the response threshold.



Motor connection cross-sections in the cable duct according to DIN VDE 0113 and VDA for series machines (+40 °C ambient temperature)

The current loading capability, according to DIN VDE 0113, Part 1/02.86 "Electrical equipment for industrial machines" is specified in the following table, for PVC-insulated cables with copper conductors without cable sheath, for a permissible operating temperature of 70 °C, and for an ambient temperature of +30 °C and +40 °C; according to the conditions as described in the Attachment to DIN VDE 0113, Part 1 and Section B 1.2.3.

Required cross-section [mm²]	$I_{0\,RMS}$ at +30 °C [A]	$I_{0\,RMS}$ at +40 °C [A]
1	10	8.7
1.5	13	11.3
2.5	18	15.7
4	24	20.9
6	31	27
10	43	37.4
16	58	50.5
25	76	66.1
35	94	81.8
50	114	99.2
70	145	126.1
95	176	153.1
120	203	176.6

Current loading capability

The mating connectors permit cables to connected with cross-sections according to DIN VDE 0113 and VDA. The cables are crimped to the connector contacts, which provides the following advantages:

- Reproducible termination technology using the correct tool
- Cables are not thermally stressed
- No cold solder joints
- High reliability
- Insulation crimping

The power cables (including brake feeder cable) are available as accessories for connecting the motors, and are either sold by the meter or as pre-assembled cables with connectors on the motor side. The brake feeder cables are screened. The screen is connected to the protective ground. The user should ensure that the screen is connected with the greatest possible surface area.

CAUTION

Screening should be integrated into the protective grounding concept. Open-circuit and unused conductors/electrical cables which can be touched, should be connected to protective ground. If the brake feeder conductors, in the Siemens accessory cables, are not to be used, the brake conductors and screen of the brake conductors should be connected to protective ground (open-circuit cables result in capacitive charging!).

Accessories, power cables		**Order No.**			
Core No. x cross-section [mm2]	Cable diameter [mm]	Cables without connectors (sold by the meter)	Cables with connectors (pre-assembled)	Connector (motor side)	
4 x 1.5 + 2 x 1.5	16.5 + 1.5	6FC9348-6DA	6FC9348-4A□01	6FC9348-7NA	1
4 x 2.5 + 2 x 1.5	16.8 + 1.5	-6DB	-4N□01	-7DN01	1
4 x 2.5 + 2 x 1.5	16.5 + 1.5	-6DB	-4B□01	-7DC01	2
4 x 4 + 2 x 1.5	16.8 + 1.5	-6DC	-4C□01	-7DC01	2
4 x 6 + 2 x 1.5	20.0 + 1.5	-6DE	-4E□01	-7DE01	2
4 x 10 + 2 x 1.5	23.6 + 1.5	-6DG	-4G□01	-7DG01	2
4 x 10 + 2 x 1.5	23.6 + 1.5	-6DG	-4P□	-7DV	3
4 x 16 + 2 x 1.5	30.0 + 1.5	-6DH	-4H□	-7DH	3
4 x 25 + 2 x 1.5	36.0 + 1.5	-6DK	-4K□	-7DK	3
4 x 35 + 2 x 1.5	40 0 + 1.5	-6DL	-4L□	-7DL	3
4 x 50 + 2 x 1.5	40 0 + 1.5	-6DM	-4M□	-7DM	3

Accessories, power cables

□ = Cable length→ B = 5 m, C = 10 m, D = 15 m, E = 18 m, H = 20 m, F = 25 m, J = 30 m, G = 50 m
Z = any (please specify length)[1]

1) *Cable length is specified by quoting the quantity (e.g. 6FC9348-6DC with the 75 m length specified)*

Terminal box Type	Cable gland [1]	Max. cable cross-section [mm2]	Studs	Dimensions without Pg Length x width [mm]
gk030	PG 21	4 x 4	Connector	82 x 66
gk130	PG 29	4 x 10	M4	110 x 105
gk230	PG 29	4 x 16	M5	122 x 117
gk330	PG 36	4 x 25	M5	152 x 132
gk420	PG 36/42	4 x 50	M10	162 x 162
gk420	2 x PG 36[3]	2 x 4 x 50	M10	162 x 162[3]

Overview of the terminal boxes

Connector types		Dimensions Diam. x length without Pg	Max. cross-section at the power terminals	Electrical data	
Order No.	Connect. size	[mm]	[mm2]	Current [A]	Voltage [V]
6FC9348-7DN01	1	25 x 59	1.5 + 2.5	15.7	600
-7DC01	2	55 x 76	1.5 + 2.5 + 4	20.9	600
-7DE01	2	55 x 76	6	27	600
-7DG01	2	55 x 76	10	37.4	600
-7DV[2]	3	63 x 111	10	37.4	600
-7DH	3	63 x 111	16	50.5	600
-7DK	3	63 x 111	25	66.1	600
-7DL	3	63 x 111	35	81.8	600
-7DM	3	63 x 111	50	99.2	600

Overview of the connector types

1) *Pg gland designed for SIMODRIVE cable accessories*
2) *For applications with lower motor utilization*
3) *Rotor position encoder can be connected through angled socket*

Servo-motor 1FT5[8]	Design for ΔT = 100K			Power section		Feed. cross-section dim. for the power section $\hat{I}_{rated\ RMS}$ [2] [mm2]	Terminal box gk [7]	Connector type 6FC9 348- [7] [9]
	I_0 [A]	$I_{0\ RMS}$ [A]	Feed. cross-sect.[1] [2] [mm2]	$\hat{I}_{rated}$ [A]	[A]			
062-0AC71	1.6	1.3	1.5	3	2.46	1.5	030	7DN01
-0AF71	2.4	2.0	1.5	3	2.46	1.5	030	7DN01
-0AG71	3.2	2.6	1.5	6	4.92	1.5	030	7DN01
-0AK71	4.6	3.8	1.5	6	4.92	1.5	030	7DN01
064-0AC71	3.3	2.7	1.5	6	4.92	1.5	030	7DN01
-0AF71	5.0	4.1	1.5	6	4.92	1.5	030	7DN01
-0AG71	6.7	5.5	1.5	12	9.9	1.5	030	7DN01
-0AK71	9.8	8.0	1.5	12	9.9	1.5	030	7DN01
066-0AC71	4.9	4.0	1.5	6	4.92	1.5	030	7DN01
-0AF71	7.3	6.0	1.5	12	9.9	1.5	030	7DN01
-0AG71	9.6	7.9	1.5	12	9.9	1.5	030	7DN01
-0AK71	14.5	11.9	2.5	20	16.3	4[5]	030	7DN01
072-0AC71	7.3	6.0	1.5	12	9.9	1.5	130	7DN01
-0AF71	11.0	9.0	1.5	12	9.9	1.5	130	7DN01
-0AG71	14.5	11.9	2.5	20	16.3	4	130	7DN01
-0AK71	21.0	17.2	4	40	32.7	10	130	7DC01
074-0AC71	11.0	9.0	1.5	12	9.9	1.5	130	7DN01
-0AF71	17.0	13.9	2.5	20	16.3	4[5]	130	7DN01
-0AG71	21.5	17.6	4	40	32.7	10[4]	130	7DC01
-0AK71	32.0	26.2	6	40	32.7	10	130	7DG01
076-0AC71	13.5	11.1	1.5	20	16.3	4[4]	130	7DN01
-0AF71	20.0	16.4	4	20	16.3	4	130	7DC01
-0AG71	26.0	21.3	6	40	32.7	10[4]	130	7DC01
-0AK71	39.0	32.0	10	40	32.7	10	130	7DG01
102-0AA71	12.5	10.3	1.5	20	16.3	4[4]	230	7DC01
-0AC71	20.5	16.8	4	20[3]	16.3	4	230	7DC01
-0AF71	31.0	25.4	6	40	32.7	10[4]	230	7DC01
-0AG71	38.5	31.6	10	40	32.7	10	230	7DG01
104-0AA71	17.0	13.9	2.5	20	16.3	4[4]	230	7DC01
-0AC71	27.5	22.6	6	40	32.7	10[4]	230	7DC01
-0AF71	41.5	34.0	10	60	49.2	16	230	7DG01
106-0AA71	20.5	16.8	4	20[3]	16.3	4	230	7DC01
-0AC71	33.0	27.1	10	40	32.7	10	230	7DG01
-0AF71	52.0	42.6	16	60	49.2	16	230	7DA
108-0AA71	25.5	20.9	4	40	32.7	10[4]	230	7DC01
-0AC71	40.0	32.8	10	40[3]	32.7	10	230	7DG01
-0AF71	62.5	51.3	25	80	65.6	35[4]	230	7DK
132-0AA71	28.0	23.0	6	40	32.7	10[4]	230	7DC01
-0AC71	44.0	36.1	10	60	49.2	16[4]	230	7DH
-0AF71	59.0	48.4	16	60	49.2	16	230	7DH
134-0AA71	33.5	27.5	10	40	32.7	10	230	7DG01
-0AC71	56.0	45.9	16	60	49.2	16	230	7DH
136-0AA71	39.0	32.0	10	40	32.7	10	230	7DG01
-0AC71	59.0	48.4	16	60	49.2	16	230	7DH
138-0AA71	48.5	39.8	16	60	49.2	16	230	7DH

Assignment of terminal boxes and power connectors for standard 1FT5 motors

Servo-motor 1FT5	Design for ΔT = 100K			Power section		Feed. cross-section dim. for the power section $I_{rated\ RMS}$ 2)	Terminal box gk 7)	Conn. type 6FC9 348- 7) 9)
	I_0 [A]	$I_{0\ RMS}$ [A]	Feed. cross-section 1) 2) [mm²]	I_{rated} [A]	[A]	[mm²]		
070-0AC71	2.1	1.7	1.5	3	2.5	1.5	030	7DN01
-0AF71	3.1	2.6	1.5	6	5.0	1.5	030	7DN01
-0AG71	4.2	3.5	1.5	6	5.0	1.5	030	7DN01
0AK71	6.2	5.1	1.5	12	9.9	1.5	030	7DN01
071-0AC71	3.5	2.9	1.5	6	5.0	1.5	030	7DN01
-0AF71	5.2	4.3	1.5	6	5.0	1.5	030	7DN01
-0AG71	6.4	5.3	1.5	12	9.9	1.5	030	7DN01
-0AK71	9.7	8.0	1.5	12	9.9	1.5	030	7DN01
073-0AC71	5.5	4.5	1.5	6	5.0	1.5	030	7DN01
-0AF71	8.2	6.7	1.5	12	9.9	1.5	030	7DN01
-0AG71	10.5	8.6	1.5	12	9.9	1.5	030	7DN01
-0AK71	16.0	13.2	2.5	20	16.3	4[5)]	030	7DN01
100-0AC71	8.0	6.6	1.5	12	9.9	1.5[4)]	130	7DC01
-0AF71	12.0	9.9	1.5	12	9.9	1.5[4)]	130	7DC01
-0AG71	16.0	13.2	2.5	20	16.3	4	130	7DC01
-0AK71	23.0	18.9	4	40	32.7	10[4)]	130	7DC01
101-0AC71	12.0	9.9	1.5	12	9.9	1.5	130	7DC01
-0AF71	18.0	14.8	2.5	20	16.3	4	130	7DC01
-0AG71	22.8	18.5	4	40	32.7	10[4)]	130	7DC01
-0AK71	33.5	27.5	10	40	32.7	10	130	7DG01
103-0AC71	16.0	13.2	2.5	20	16.3	4	130	7DC01
-0AF71	23.0	18.9	4	40	32.7	10[4)]	130	7DC01
-0AG71	30.0	24.6	6	40	32.7	10[4)]	130	7DE01

Assignment of terminal boxes and power connectors for short 1FT5 motors

Servo-motor 1FT5	Design for ΔT = 100K			Power section		Feed. cross-section dim. for the power section $I_{rated\ RMS}$ 2)	Terminal box gk 7)
	I_0 [A]	$I_{0\ RMS}$ [A]	Feed. cross-section 1) 2) [mm²]	$\hat{I}_{rated}$ [A]	[A]	[mm²]	
132-0SA71	35	28.7	10	40	32.7	10	420
132-0SC71	56	45.9	16	60	49.2	16	420
132-0SF71	75	61.5	25	80	65.6	25	420
134-0SA71	45	36.9	10	60	49.2	16[4)]	420
134-0SC71	75	61.5	25	80	65.5	25	420
136-0SA71	54	44.3	16	60	49.2	16	420
136-0SC71	81	66.4	35	80[3)]	65.5	25	420
138-0SA71	69	56.6	25	80	65.5	25	420

Assignment of terminal boxes and power connectors for standard, force-ventilated 1FT5 motors

Servo-motor 1FT5	Design for ΔT = 100K			Power section		Feed. cross-section dim. for the power section I_{rated} RMS 2) [mm2]	Term-inal box gk 7)
	I_0 [A]	$I_{0\,RMS}$ [A]	Feed. cross-section 1) 2) [mm2]	$\hat{I}_{rated}$ [A]	[A]		
101-0SK71	40	32.7	10	40	32.7	10	230
-0SN71	48	39.4	16	60	49.2	16	230
102-0SG71	42	34.5	10	60	49.2	16	230
-0SK71	57	46.8	16	60	49.2	16	230
104-0SG71	56	45.9	16	60	49.2	16	230
-0SK71	60	49.2	16	60	49.2	16	230
106-0SG71	56	45.9	16	60	49.2	16	230

Assignment of the terminal boxes for standard 1FT4 motors

General information:

1) *The cross-sections specified in the tables refer to a motor utilization of ΔT = 100 K winding temperature rise. Lower feeder cross-sections might be obtained for a utilization with ΔT = 60 K winding temperature rise and lower rating power sections.*

2) *The feeder cross-sections are dimensioned as follows: DIN VDE 0113, Part 1 from 2/86; Table B II for series machines, routed in cable ducts (4); +40 °C ambient temperture (Table B I).*

3) *With the specified power section, the motor cannot be fully utilized with ΔT = 100 K winding temperature rise.*

Motors with connector:

4) *Within the same connector size, a larger connector type must be provided for the appropriate feeder cross-sections. This must be taken into account when ordering.*

5) *Cable cross-section cannot be connected in the same connector size. Protective devices, matched to the maximum connectable feeder cross-section, should be provided.*

6) *Connector size is dimensioned according to the connection cross-section of the power section. The connector version cannot be used when the motor is fully utilized; in this case, a terminal box must be used.*

7) *Standard equipping according to the Table "Overview of terminal boxes" for terminal boxes, or Table "Overview of connector types" for connectors, in Section 2.11.1.*

8) *For 1FT503☐ and 1FT504☐ motors, connector type 6FC9348-DN01 is always required. The cable cross-section for the motors is 1.5 mm².*

9) *Mating connector required for connecting-up; this connector is not included with the motor.*

Rotor position encoder and tachogenerator connection

There are two methods of connecting and evaluating PTC thermistors. The PTC thermistor connections are connected to terminals 9 and 10 on the motor terminal block.

- Terminals 9 and 10 on the motor terminal block are wired, as standard, to the rotor position encoder, and more specifically to connector pins 9 and 10. Thus, evaluation is possible in the PWM converter.
- The PTC thermistors can also be evaluated using an external 3UN6, 3UN7, 3UN8 or 3UN9 evaluation unit. In this case, connections 9 and 10, which are fed to the rotor position encoder, should be disconnected at the motor terminal block, and should be connected together under the adjacent terminal 3 which is not used[1]. Terminals 9 and 10 on the motor terminal block can then be used for external connections.

Encoder cables

A connecting cable (encoder cable) is required between the servomotor and PWM converter. The rotor position encoder and tachogenerator signals are fed through the encoder cable. The customer is responsible for this connection. The rotor position encoder cables must be routed separately from the power cables in order to prevent noise.

Accessories, encoder cable and connectors	Order No.
Screened encoder cable 12 x 0.23 mm^2, sold by the meter **without** connector[4]	6FC9348-6AA
Screened encoder cable 12 x 0.23 mm^2, sold by the meter **without** connector[4] PVC external sheath, draggable, 7.5 x D_{max} bending radius	6FC9348-6BA
Screened encoder cable 12 x 0.23 mm^2 **with** connectors (converter: 6FC9348-7AT; motor: 6FC9348-7AD)	6FC9348-5M□
Screened encoder cable 12 x 0.23 mm^2 **with** connectors PVC external sheath, draggable, 7.5 x D_{max} bending radius	6FC9348-2M□
Mating connector for 1FT5/1FT4 AC servomotors with integrated gland for 8 mm diameter cable[2]	6FC9348-7AD
Mating connector for 1FT5/1FT4 AC servomotors, only with Pg 13.5 thread in the cable entry	6FC9348-7AL
Connector for 6SC611[3] PWM converter	6FC9348-7AT

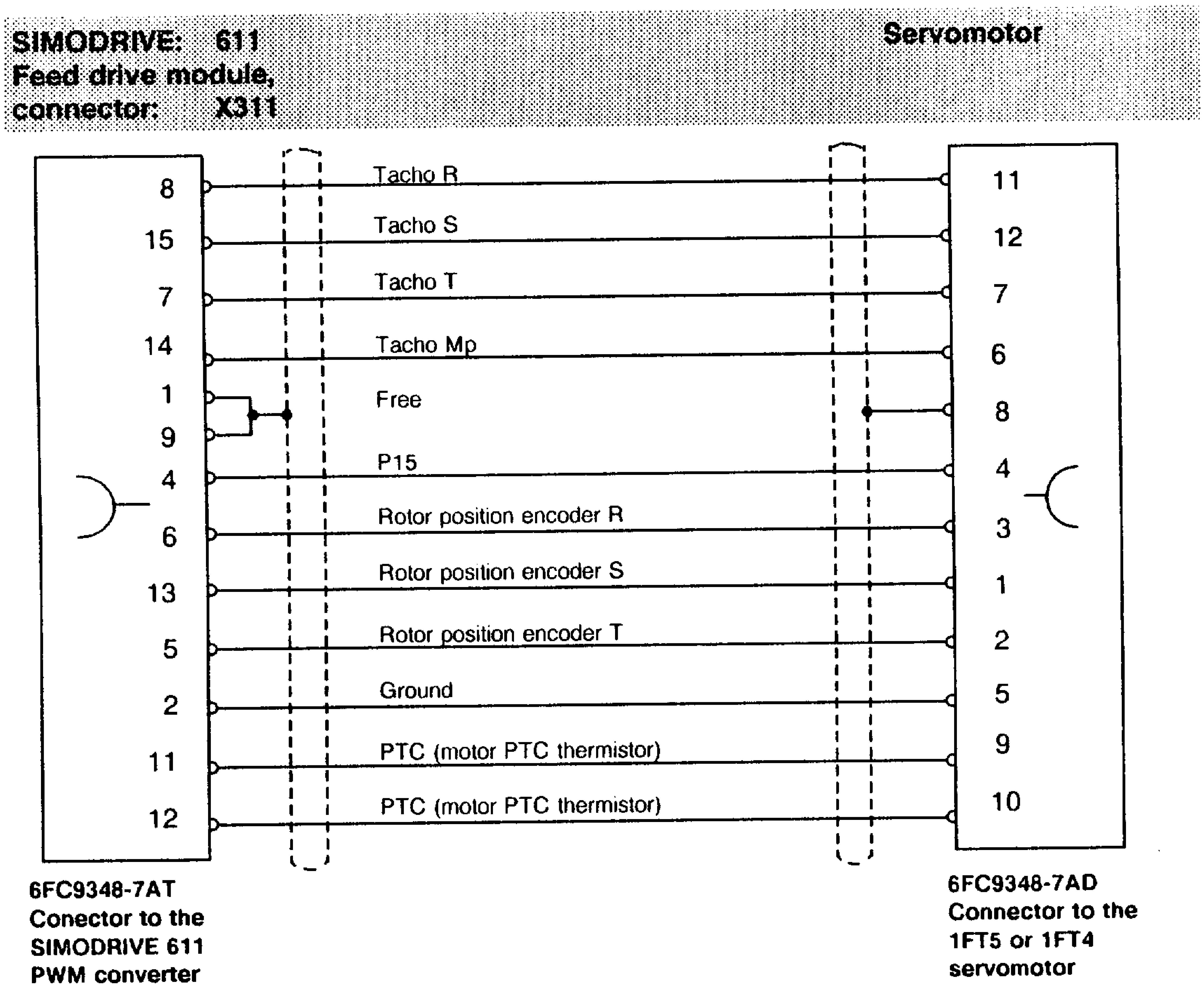
Encoder cable accessories

□ = Cable length→

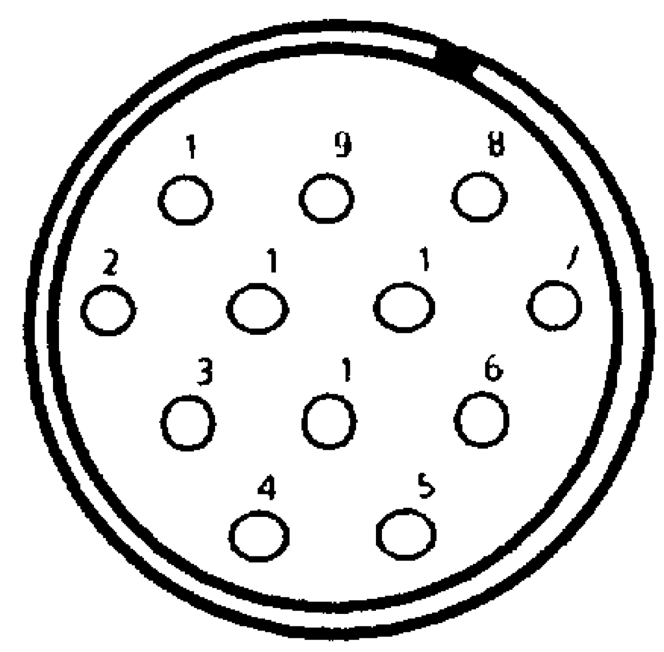
B = 5 m	F = 25 m
C = 10 m	J = 30 m
D = 15 m	G = 50 m
E = 18 m	Z = any (specify length)
H = 20 m	

1) *Only possible for motors with terminal boxes*
2) *Is **not** included with the 1FT5/1FT4 servomotors.*
3) *Is **not** included with the 6SC611 PWM converter.*
4) *Cable length is specified as quantity when ordering.*

Cable designation: Rotor position encoder cable
Order No.: Sold by the meter, draggable **6FC9 348-6BA□**
Sold by the meter, PVC standard version **6FC9 348-6AA□**



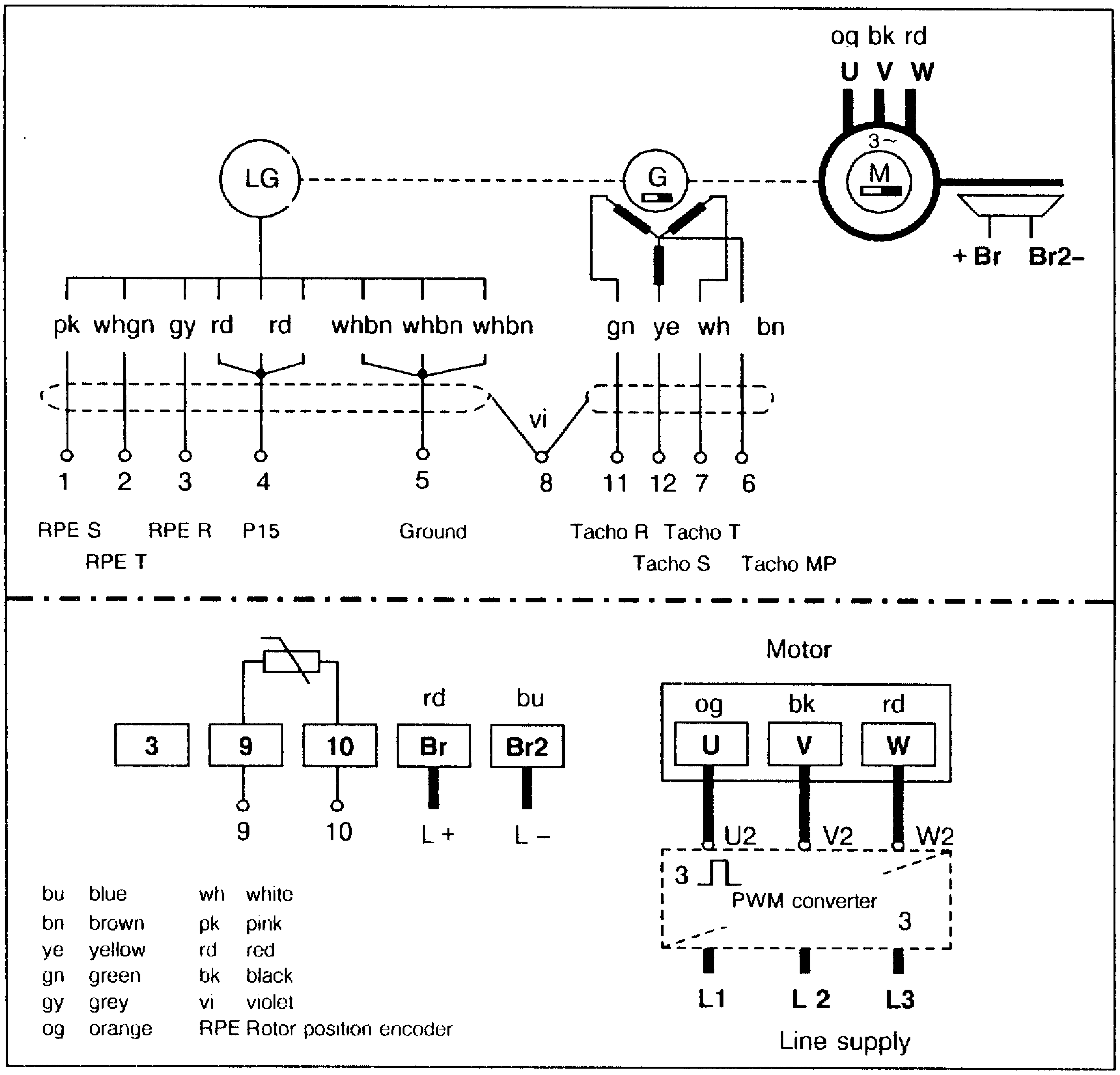
Connector
12-pin socket
connector
6FC9348-7AD



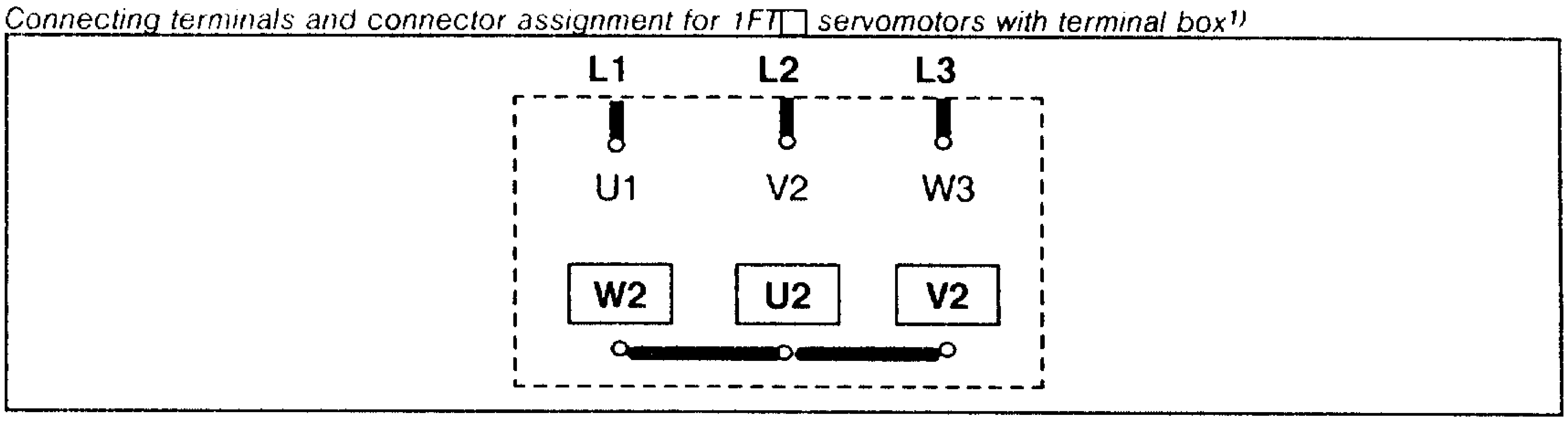
Crimp side

The encoder cable is available as pre-assembled cable under Order No. 6FC9348-5M □ or 6FC9348-2M□ (draggable) (refer to the table "Accessories, encoder cables").

 6ZB5 420-0AS02



Connecting terminals and connector assignment for 1FT□ servomotors with terminal box[1)]



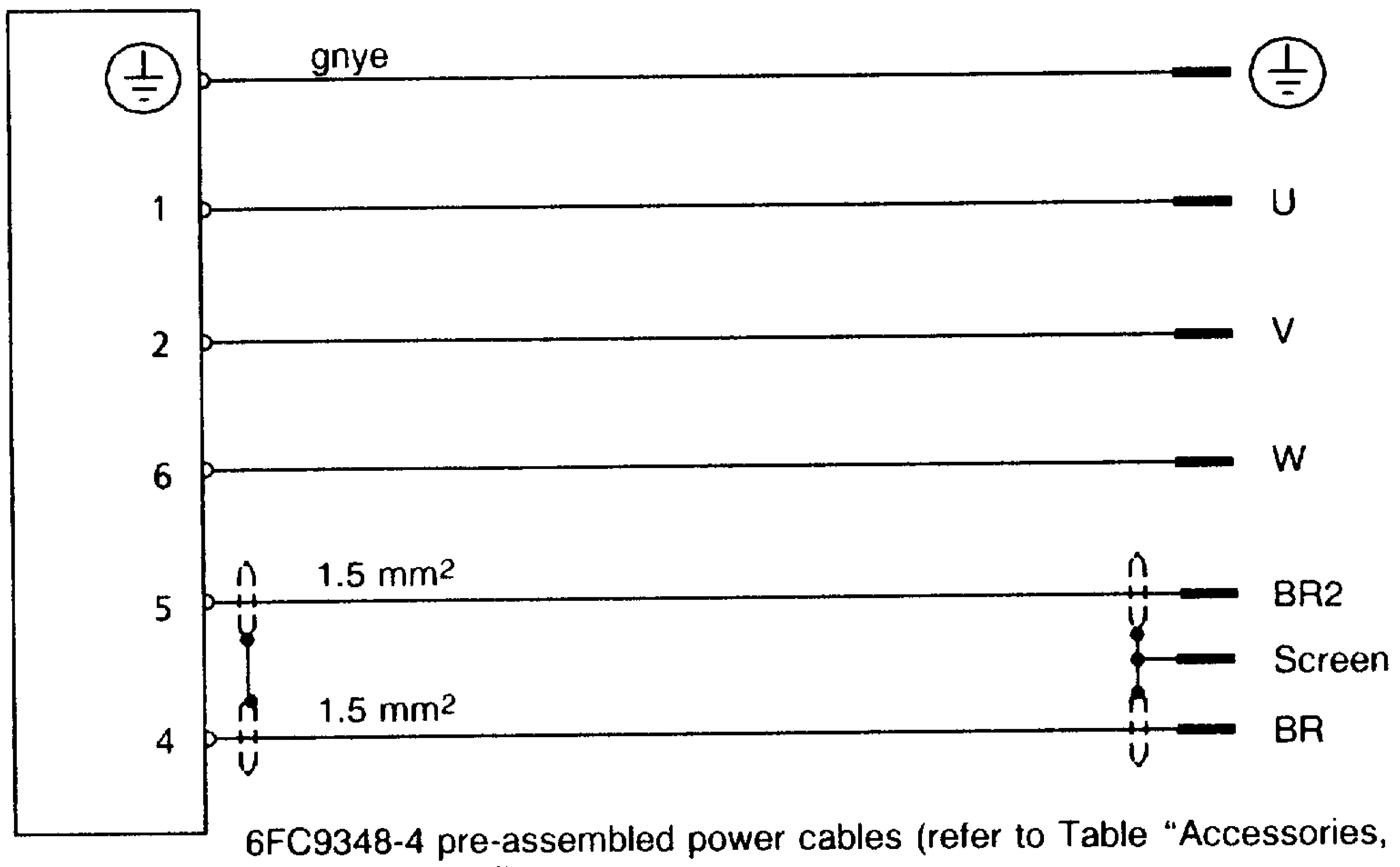
Connecting terminals in the fan terminal box for 1FT5 and 1FT4 servomotors

If 1FT5 motors with an armature circuit winding other than 600 V, is connected to a 600 V converter configuration, when a fault condition occurs, (tachogenerator cable interrupted), the specified maximum speed can be significantly exceeded.

1) *1FT503□ and 1FT504□ motors are not available with terminal boxes*

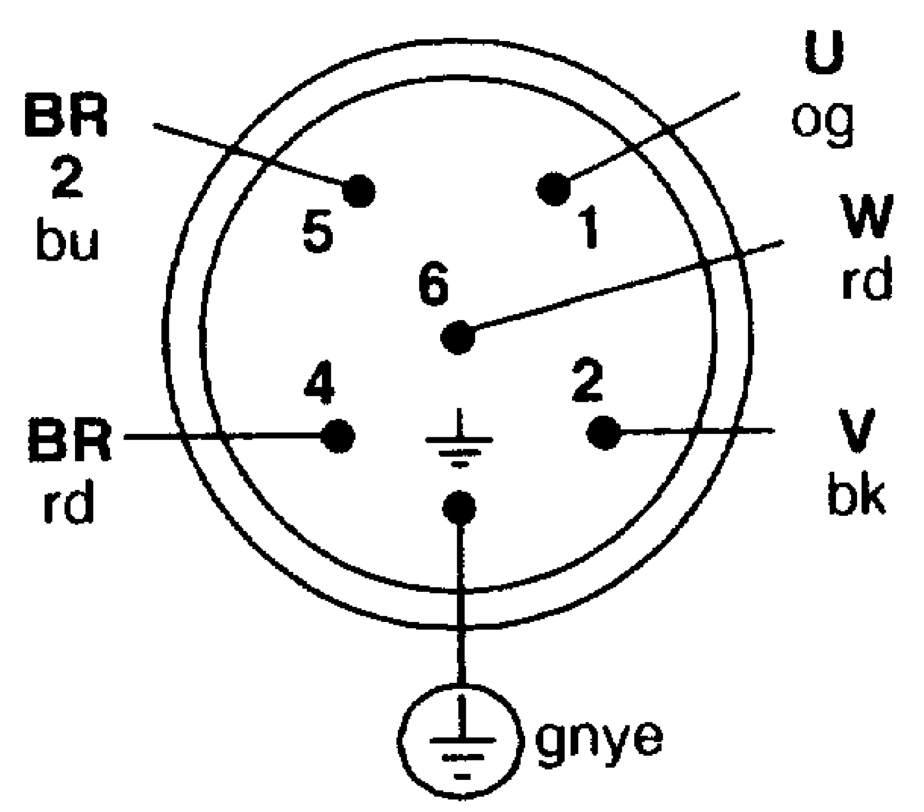
Cable designation: Power connector
Order No.: **6FC9348-4□□**

1FT503□ to 1FT504□ servomotors	**SIMODRIVE 611**
Board slot:	**Conductor sleeves acc. to**
Board connector: Size 1	**DIN 46228**



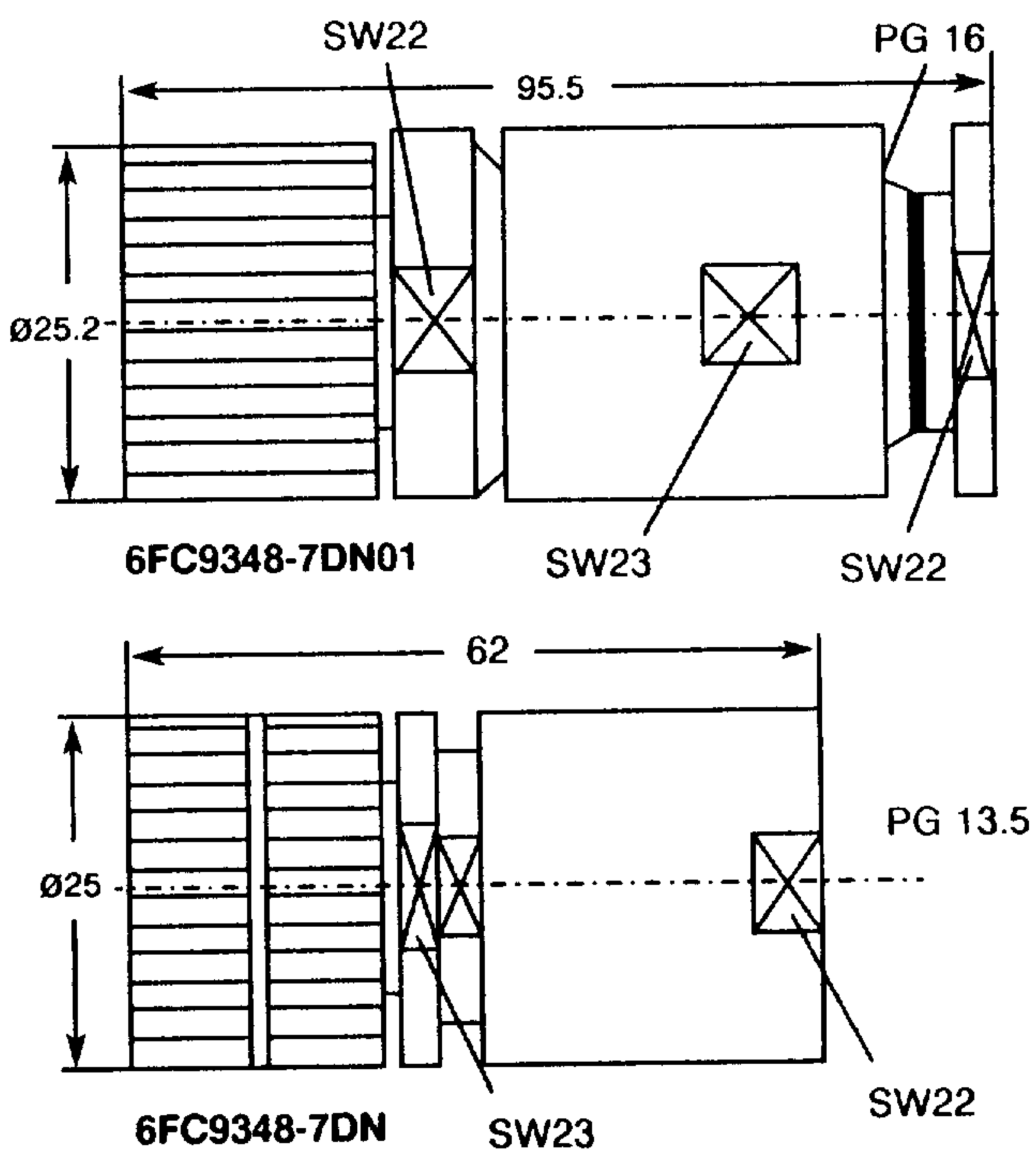
6FC9348-4 pre-assembled power cables (refer to Table "Accessories, power cables")[1)]

1FT502□ to 1FT504□ servomotors



6FC9348-7DA and 6FC9348-7DN mating connectors

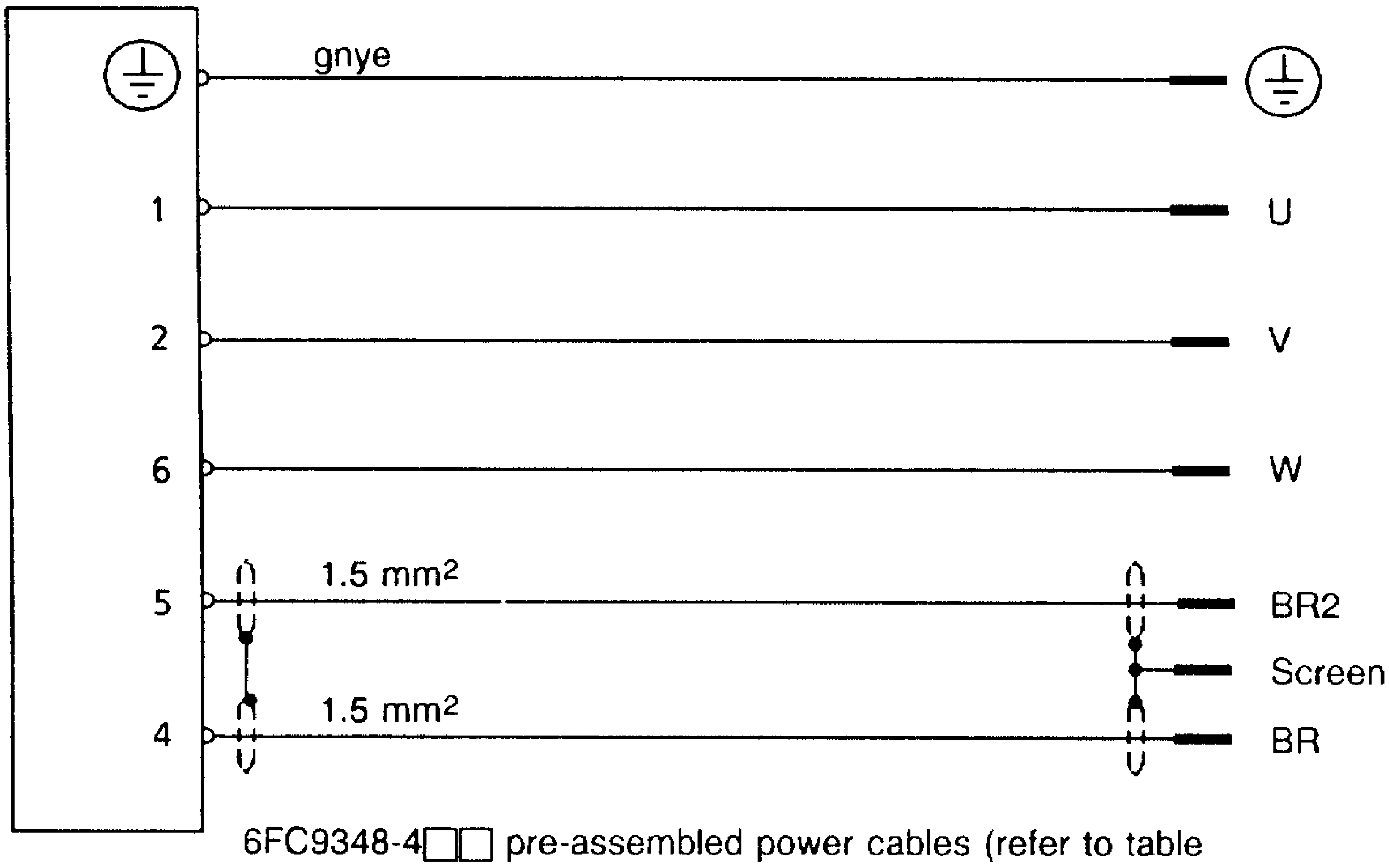
View of the connector pins of the motor flange socket.



1) *Conductors which are not used, e.g. brake conductors for motors without brakes, should be connected to protective ground PE; the screen should always be connected to PE.*

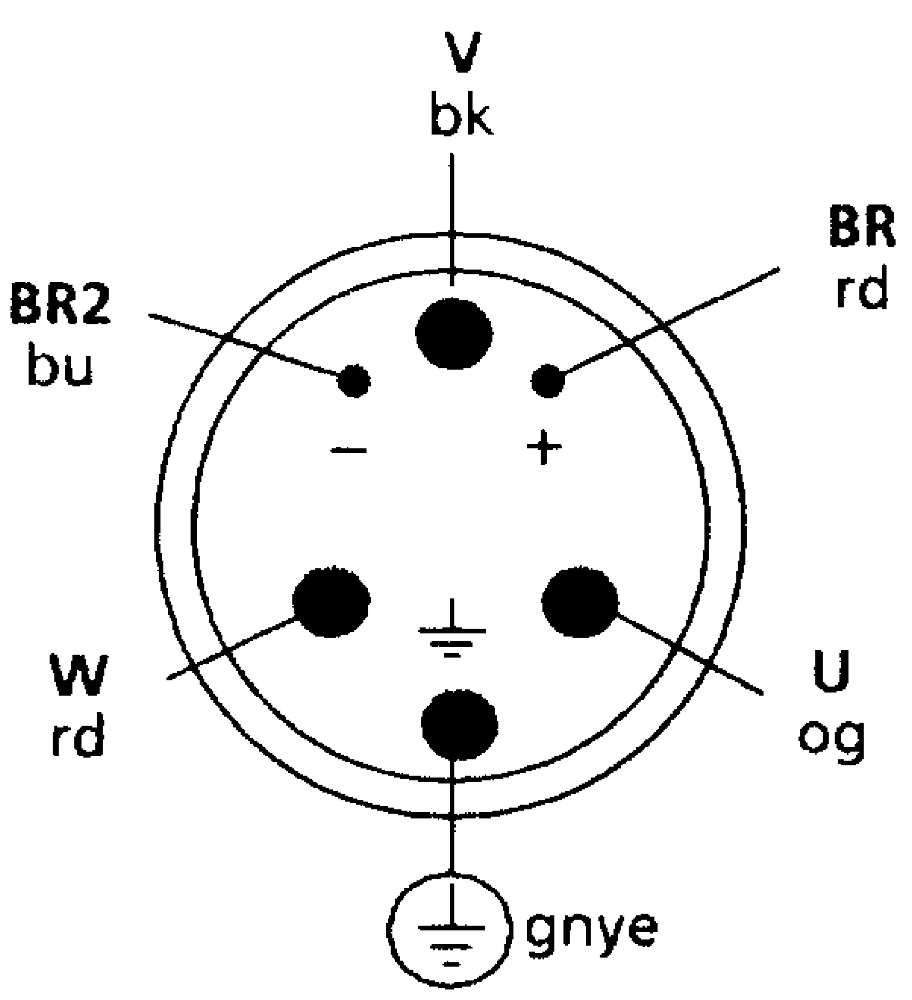
Cable designation: Power connector
Order No.: **6FC9348-4□□**

1FT06□ to 1FT513□ servomotors	**SIMODRIVE 611**
Board slot:	**connector sleeves acc. to**
Board connector: Connector sizes 2 and 3	**DIN 46228**



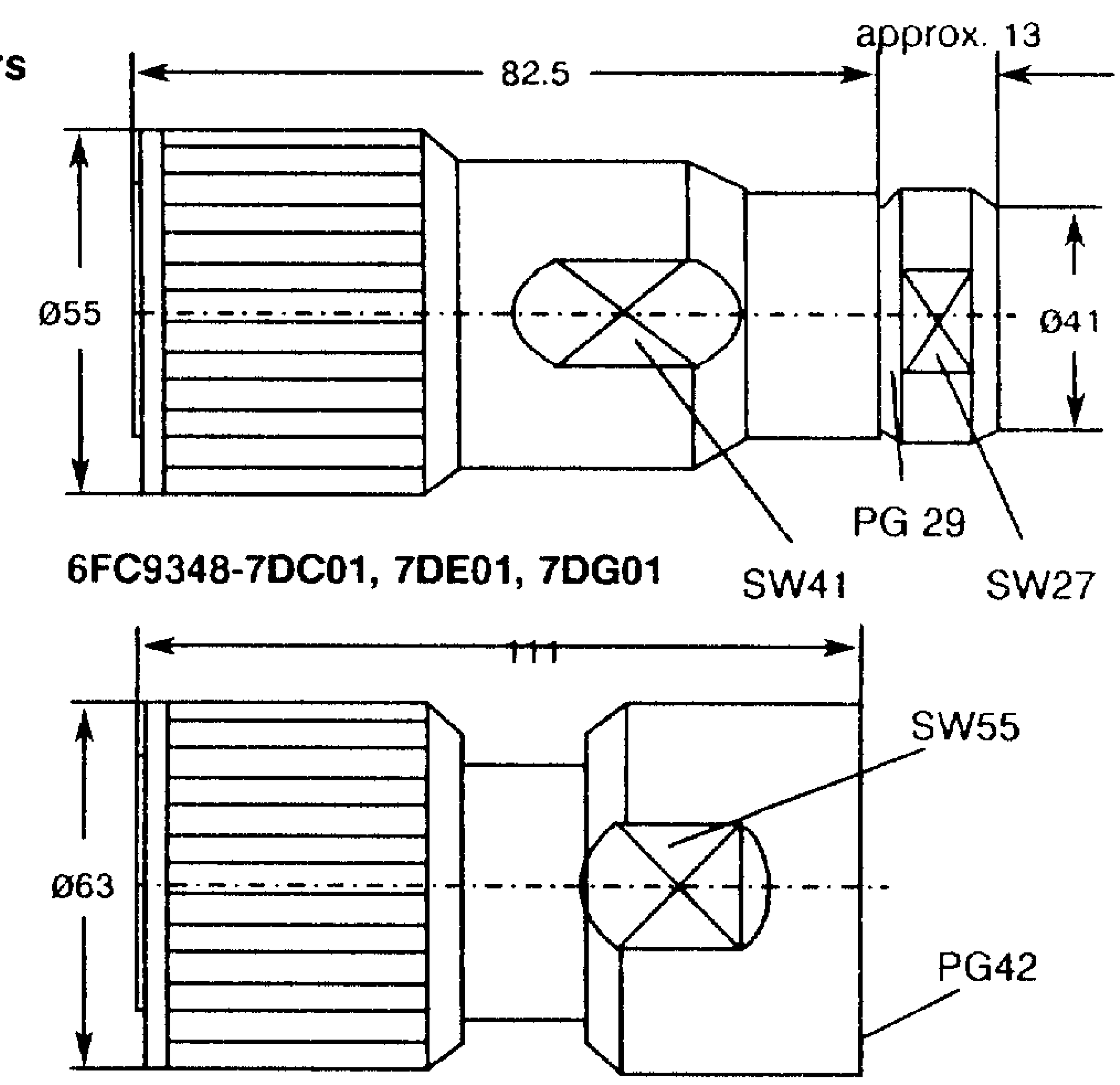
6FC9348-4□□ pre-assembled power cables (refer to table "Accessories, power cables")[1)]

1FT506□ to 1FT513□ servomotors



6FC9348-7DC and 6FC9348-7DM mating connectors

View of the connector pins of the motor flange socket



6FC9348-7DC01, 7DE01, 7DG01

6FC9348-7DH, 7DK, 7DL

1) *Conductors which are not used, e.g. brake conductors for motors without brakes, should be connected to protective ground PE; the screen should always be connected to PE.*

3 SIMODRIVE 611 transistor PWM converters

3.1 Drive system description

3.1.1 Application

The modular SIMODRIVE 611 transistor PWM converters have been developed to supply 1FT5 AC servomotors with a controlled 600 V DC link voltage and with fully regenerative braking. This allows the dynamic characteristics of these motors to be optimally utilized.

Depending on the module combination, drive units are available with rated currents from 3A to 80A, according to the number of axes required for a specific machine. The modules have various widths with a 50 mm basic grid dimension.

An autonomous system consists of an infeed/regenerative feedback module, depending on the required DC link power, and at least one feed module. A monitoring module and a pulsed resistor module are required instead of the infeed/regenerative feedback module if an existing DC link is to be used, e.g. SIMODRIVE 650/660, .

All of the power connections are located at the rear of the modules and the control leads in the upper module section. All modules are arranged next to each other. To complete the unit wiring, only the DC link jumpers and the equipment bus must be connected from module to module.

Main features

- Compact, modular design, low space requirements
- Feed modules can be freely combined to suit specific user applications
- Analog controls
- Cascaded closed-loop control with speed controller and secondary current controller
- Speed controller with separately adjustable proportional gain and integral action time
- Standard speed controller adaption, adjusted for proportional gain and integral action time
- Speed control range in the speed control loop > 1:10 000
- Axis-specific speed controller enable (floating inputs)
- Coded plug-in terminals for electronic connections
- Start-up facilitated by preset controllers
- Parameter board with passive components for permanent setting of customer-specific optimization parameters
- Monitoring of operating voltages, motor temperature, tachogenerator function, controller statuses and I^2t value for the power sections (axis-specific)
- "Travel to end stop" with adjustable current limit
- "Setting-up operation" with reduced power infeed
- Interface according to VDI 3422 for feed axes with mechanical clamping
- Protection against contact during start-up and service on live equipment in accordance with VDE 0106 and VBG4
- Power sections protected against permanent short-circuits and ground faults
- All retaining screws are vertical to the mounting surface and accessible from the front
- Captive mounting and connecting components
- Diagnostics using 7-segment display and individual fault signals available through the floating contacts
- Option boards for expanded main spindle functions

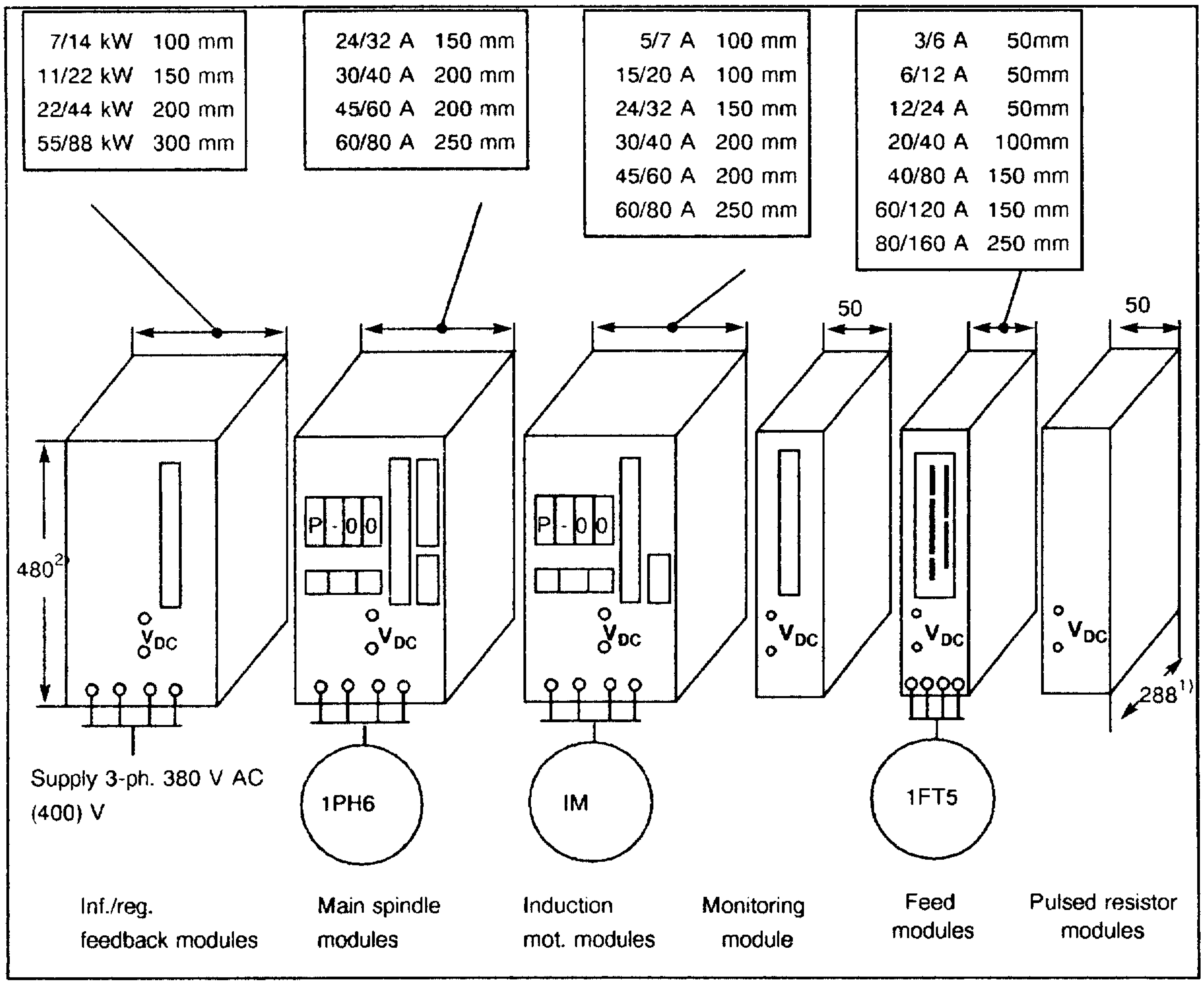
3.1.2 Design

The axis-modular SIMODRIVE 611 feed drives consist of autonomous, functional units which are individually available. Six different housing sizes with widths in a 50 mm basic grid dimension (50, 100, 150, 200, 250, 300 mm) are available for the various function modules, such as infeed/regenerative feedback unit, monitoring module, pulsed resistor- and feed modules. All modules consist of a painted sheet-metal enclosure with plastic front panel.

The modules have a uniform depth of 288 mm thus allowing SIMODRIVE 611 units to be installed in NEMA cubicles. Heightwise, the new modules fit into the existing range of SIMODRIVE transistor PWM converter systems.

All retaining holes are in a 50 mm grid thus ensuring cost-effective module mounting in cubicles. The mounting panel in the cubicle should be provided as standard with mounting holes in this grid pattern so that the modules can be freely combined and can even be replaced at a later date with higher-rated modules.

Module types of the drive system



SIMODRIVE 611 drive system

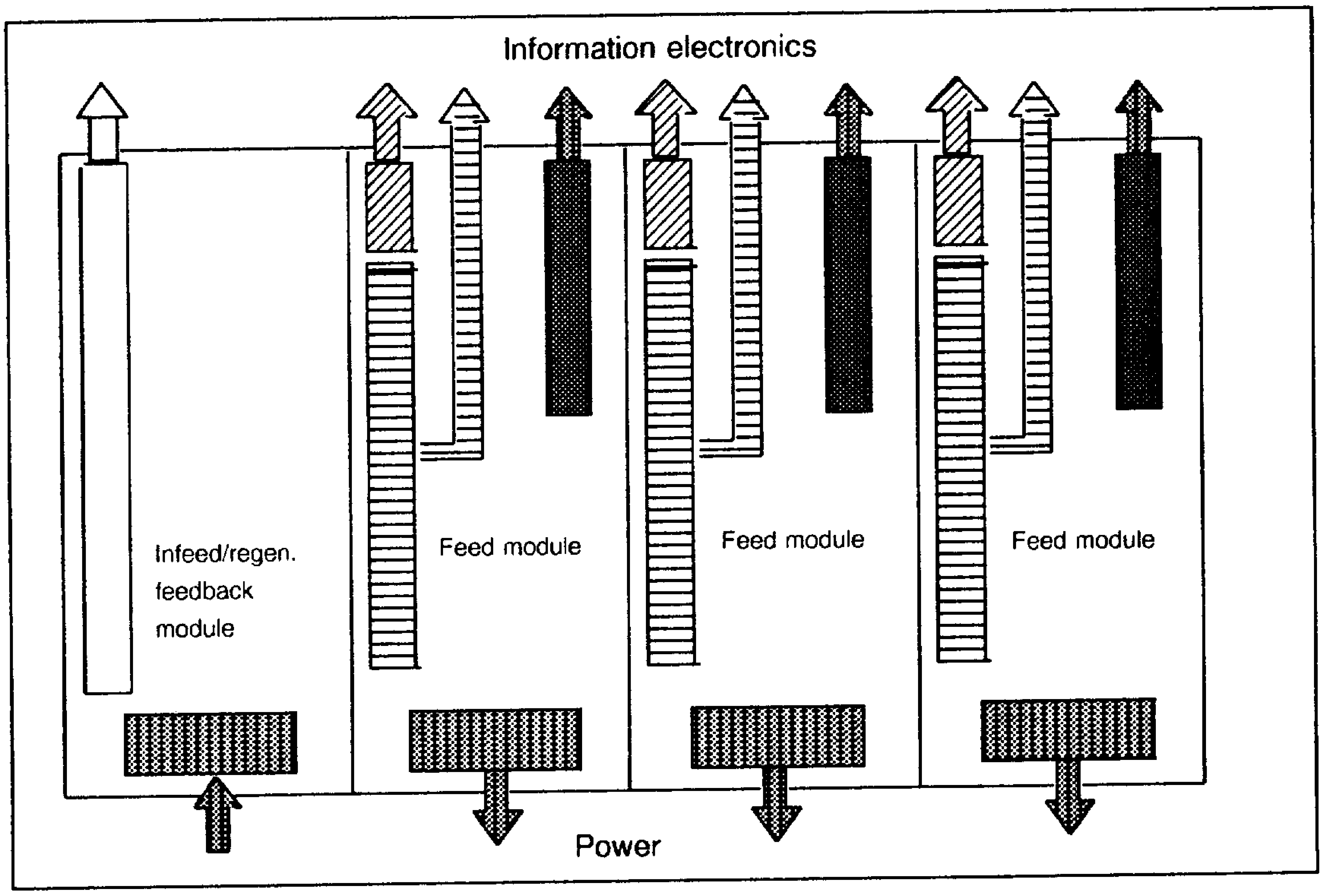
The power sections such as the infeed/regenerative feedback modules and feed modules are designed so that the power semiconductor heatsinks are located at the rear panel. It should be ensured that the air intake is unrestricted. The electronics are cooled by convection.

1) *All modules are 288 mm deep (without connector)*
2) *All modules are 480 mm high (including retaining lugs)*

Terminal concept

All connecting and control elements are accessible from the front panel. Only captive mounting and connecting elements are used, i.e. power terminals, coded plug-in terminals[1] for the electronics and DC link jumper bars are permanently attached to the module. The modules have elongated mounting holes at the rear, allowing them to be slotted onto the mounting screws. If the units are correctly installed, no installation or mounting components will drop down, even when a module from a unit combination has to be replaced. Coded terminals ensure that electronic connections are not interchanged.

All electronic connections are located in the upper section of the front panel, and power connections at the lower edge of the module. The module operating panel remains freely accessible and visible if the specified cable routing is adhered to. The 7-segment display and the parameter module with its potentiometers are located at the center. A slot for the optional modules is located to the right.



Connecting the supply cables

The DC link jumper bars are protected against contact with a cover plate according to VDE 0106 and VGB 4. The unit bus for power supply and module communications is also covered by the same plate. The line supply connections for the electronics power supply, infeed regenerative feedback unit and basic modules are also located under this cover.

The axis-modular SIMODRIVE 611 system includes a complete infeed/regenerative feedback unit as standard, which is always located to the left as the first module in the line-up. The degree of expansion of a drive group connected to an infeed/regenerative feedback module is dependent on the DC link power requirement, electronics power supply, as well as the gating power requirement of the individual axis modules. A maximum of seven axes can be connected to an infeed/regenerative feedback unit if the drive ratings are relatively low.

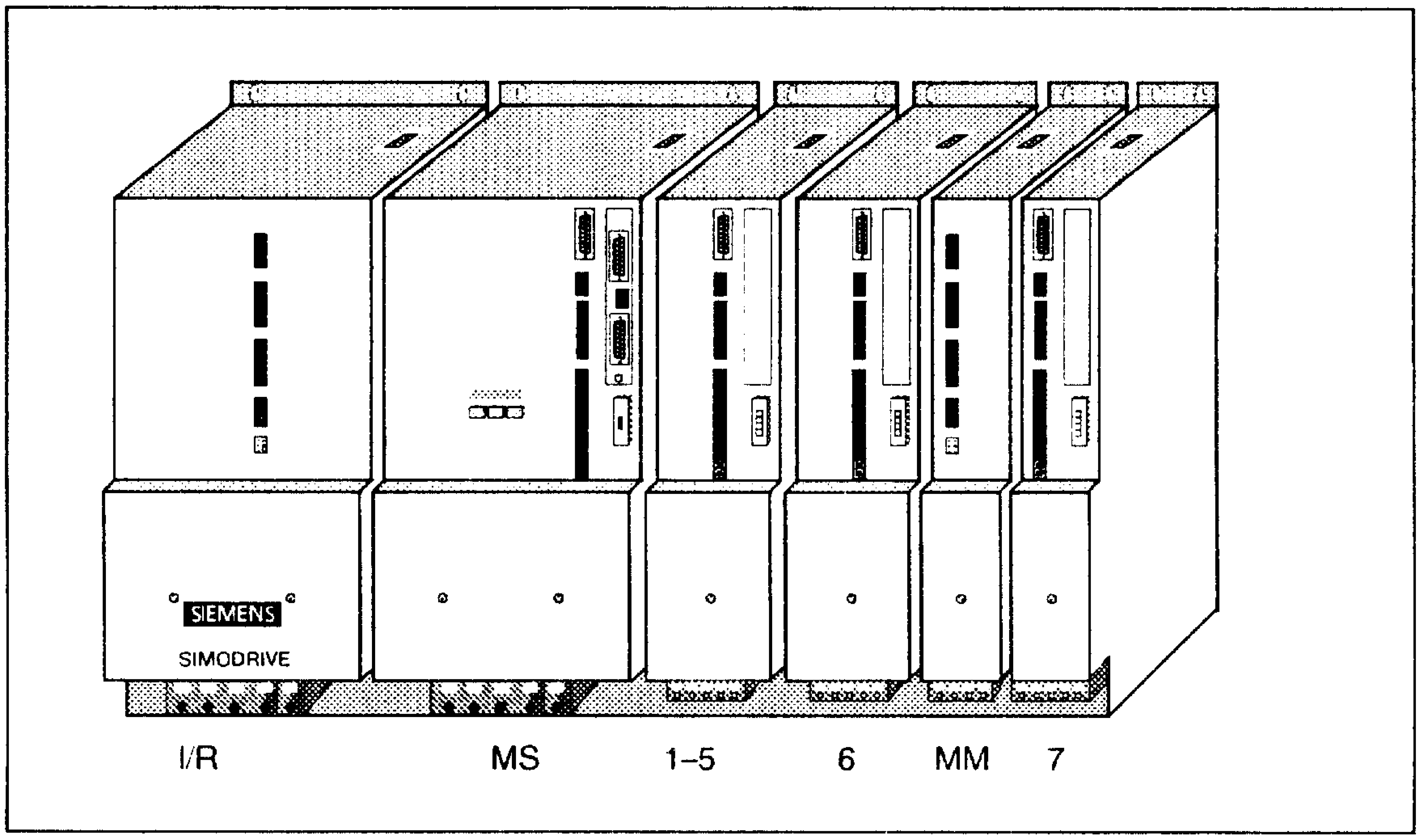
In conjunction with a SIMODRIVE 650/660 AC main spindle unit, the feed axes can also be supplied from this DC link. However, in this case, a monitoring module is required instead of the infeed/regenerative feedback module, and possibly a pulsed resistor module.

1) *Coding elements are not included with the modules*

3.1.3 SIMODRIVE 611 AC feed drives

The pure AC feed drives are based on the 1FT5□□□-□□□71-□□ AC servomotors. The converter unit consists of the infeed/regenerative feedback module (Section 3.4) with the correct rating, and the feed modules, with ratings matched to the 1FT5 servomotors (Section 3.2).
The infeed/regenerative feedback module can supply the controller-, gating and fan power supply for up to six axes. A monitoring module is required (Section 3.5) if additional axes are required, which can then supply an additional six feed axes. This monitoring module can be operated from the DC link or from its own supply. The feed modules connected to the infeed/regenerative feedback module or to a common monitoring module, form an autonomous monitoring group. A signaling and monitoring concept, matched to the machine tool, is necessary via the peripherals and evaluation circuit.

A pulsed resistor module (Section 3.6) can be used so that the drive can be braked in a controlled fashion even when the supply fails, and to be able to control the DC link during supply failures. For feed module operation, this pulsed resistor module should be operated with its own monitoring module, supplied from the DC link or it is necessary to automatically activate the changeover of the power supply input circuit to the DC link.



Example of a SIMODRIVE 611 feed drive with seven feed axes and a main spindle module

E/R = Infeed/regenerative feedback module
MS = Main spindle module
MM = Monitoring module
1–7 = Feed modules (1st to 7th axis)

3.1.4 Combined SIMODRIVE 611 AC main spindle drive with 1FT4 AC servomotor

For low-rating main spindle drives on small milling machines, machining centers or auxiliary spindles on lathes, a combination solution is possible using SIMODRIVE 611 feed drives and the main spindle drive.

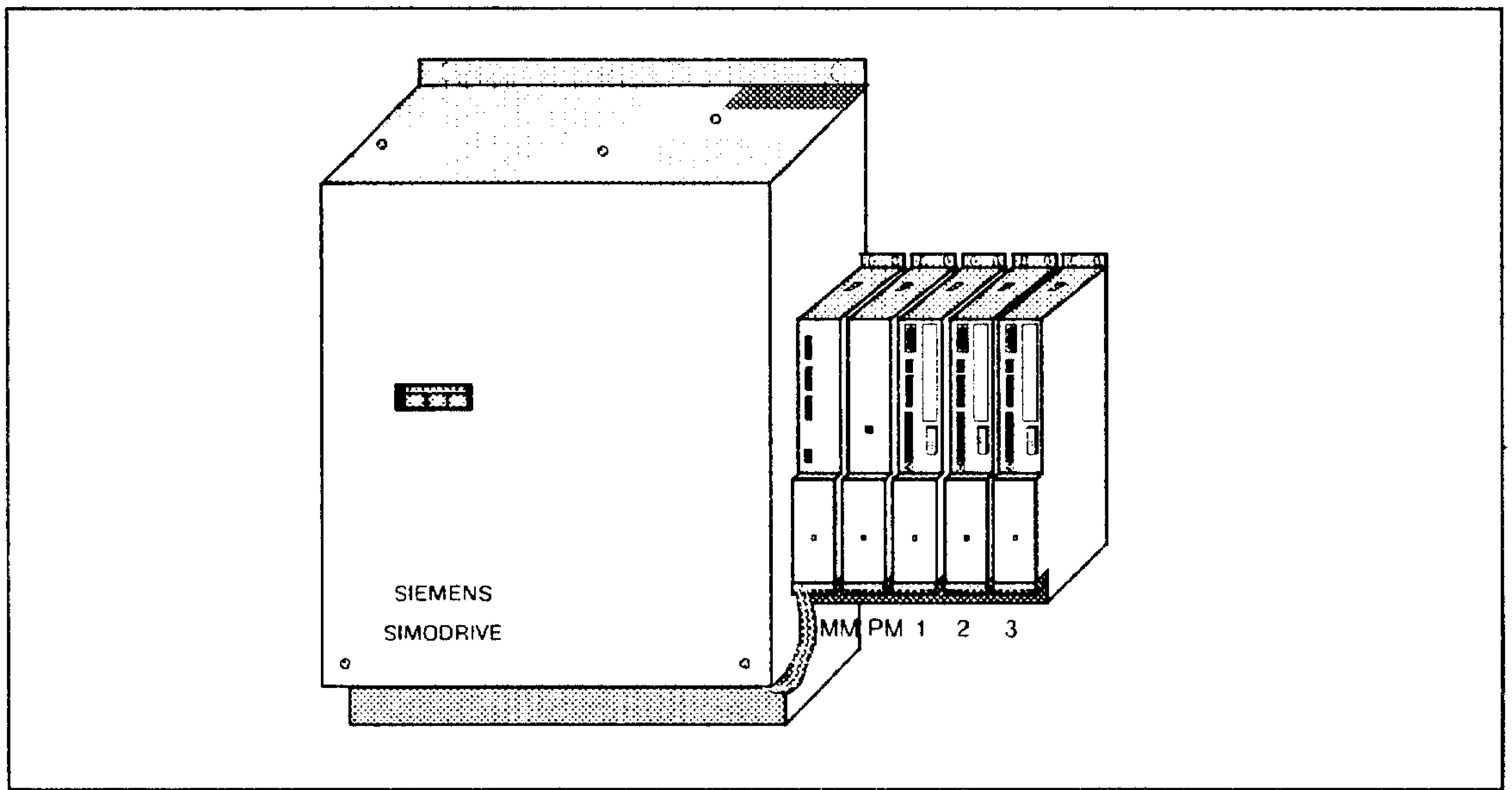
1FT4 AC servomotors (Section 2.2) are used as main spindle motors.
The standard feed module is extended as far as the functional scope is concerned, to a complete main spindle drive module by inserting the main spindle function option board (Section 3.7). A quasi-constant power range is simulated using the adjustable speed-dependent current limiting. Mechanical overloading of the machine tool by the drive is essentially eliminated.

3.1.5 Combination solution consisting of AC main spindle drive and SIMODRIVE 611 AC feed drive

A SIMODRIVE 611 feed drive system can be connected to the DC link on a standard SIMODRIVE 650/660 AC main spindle converter system. The power reserves can be used for the feed drives, as they have, in comparison to main spindle drives, a relatively low DC link power requirement.

The electronics and fan power supply of the feed modules is provided from a monitoring module (Section 3.5). A pulsed resistor (Section 3.6) might be necessary depending on the particular application.

SIMODRIVE 650/660 provides and executes the main spindle functions. 1PH6 induction motors are used as main spindle motors.



SIMODRIVE 611 AC feed drive system in combination with a SIMODRIVE 650/660 AC main spindle drive

MM = Monitoring module
PM = Pulsed resistor module
1-3 = Feed modules (1st to 3rd axis)

3.1.6 Type designation

The type designation (also the Order No.) consists of a combination of digits and letters. It is subdivided into three blocks, which are connected by hyphens.

The first block has seven positions and designates the motor type. Further design features are coded in the second block. The third block is provided for additional information and specifications.

6	S	C	6	1	1	.	-	.	A	A	0	0	-	Z

SIMODRIVE

Axis modules, 3-ph. 380 V AC (400 V)

Rating for infeed modules
Current for feed modules
0-0 = no current or no power
0-1 = 1 A or 1 kW
to
8-8 = 88 A or 88 kW

Function

AA = Feed module
E. = Parameter board
GA = Monitoring module
GB = Pulsed resistor module
P. = Option board
SA = Others
VA = Infeed/regen. feedback module, standard version

Filler position

Version

Customized version
(only specify as required)

All drive components such as modules and boards, as well as the parameter board, must be separately ordered.

3.2. Feed modules

3.2.1 System integration

The feed modules are used for controlling the individual 3-phase AC servomotors. A module is required for each feed axis. All modules are centrally supplied with electronic voltages via a bus system, whereby the infeed/regenerative feedback unit provides the DC link and central electronics power supply.

The feed module controls the speed and current of the feed drive. The inverter generates a speed-proportional and load-independent corrected voltage from the constant DC link voltage at the input. The feed modules are autonomous regarding control, enabling functions and diagnostics.

All feed module ratings can be combined as required in a drive group. However, the infeed/regenerative feedback unit rating must be taken into account as well as the limits of the power supply for the gating and electronics (if required, the gating and electronics power supply can be handled by an additional monitoring module).

The mechanical design is matched to the SIMODRIVE 611 module group. The modules are always located to the right of the infeed/regenerative feedback unit and monitoring module.

The following feed module ratings are available (3 A; 6 A; 12 A; 20 A; 40 A; 60 A; 80 A).

3.2.2 Design

The feed modules are autonomous units with their own enclosure. Mounting points are arranged in a 50 mm grid at the rear of the housing.

Four feed module widths are available, which are dependent on the controlled current (50 mm, 100 mm, 150 mm and 250 mm).

Each module consists of a grey, painted sheet-metal housing with plastic front panel. DC link jumper bars and motor terminals are protected against contact according to VBG4 and VDE 0106. Coded plug-in terminals[1)] for the open-loop and closed-loop control signals are located in the upper module section.

This coding prevents similar interface leads from being interchanged if several modules are located next to each other. This is impossible for the module itself due to the different connector pin number.

The operator panel at the center of the unit remains freely accessible when the incoming and outgoing cables are routed as sepepcified.

The 7-segment display for indicating operating statuses and faults and the parameter board are also located here. This board includes all setting elements and mounting locations, which must be accessible at start-up, or which must be adapted to the customer's machine. It is inserted from the front.

Power supply distribution and signal transfer between the individual modules is established by a ribbon cable.

The heat from the feed module power section is dissipated using a heatsink at the rear of the unit. All modules above 12 A are cooled using an external fan.

The cubicle should be designed so that air intake and outlet are not restricted. The open-loop and closed-loop control sections are cooled by natural convection.

Each feed module has an option slot for additional customized solutions as well as supplementing the main spindle functions. This slot is also accessed from the front.

The axis modules are enclosed units and can be safely handled as far as the ECB regulations are conccerned.

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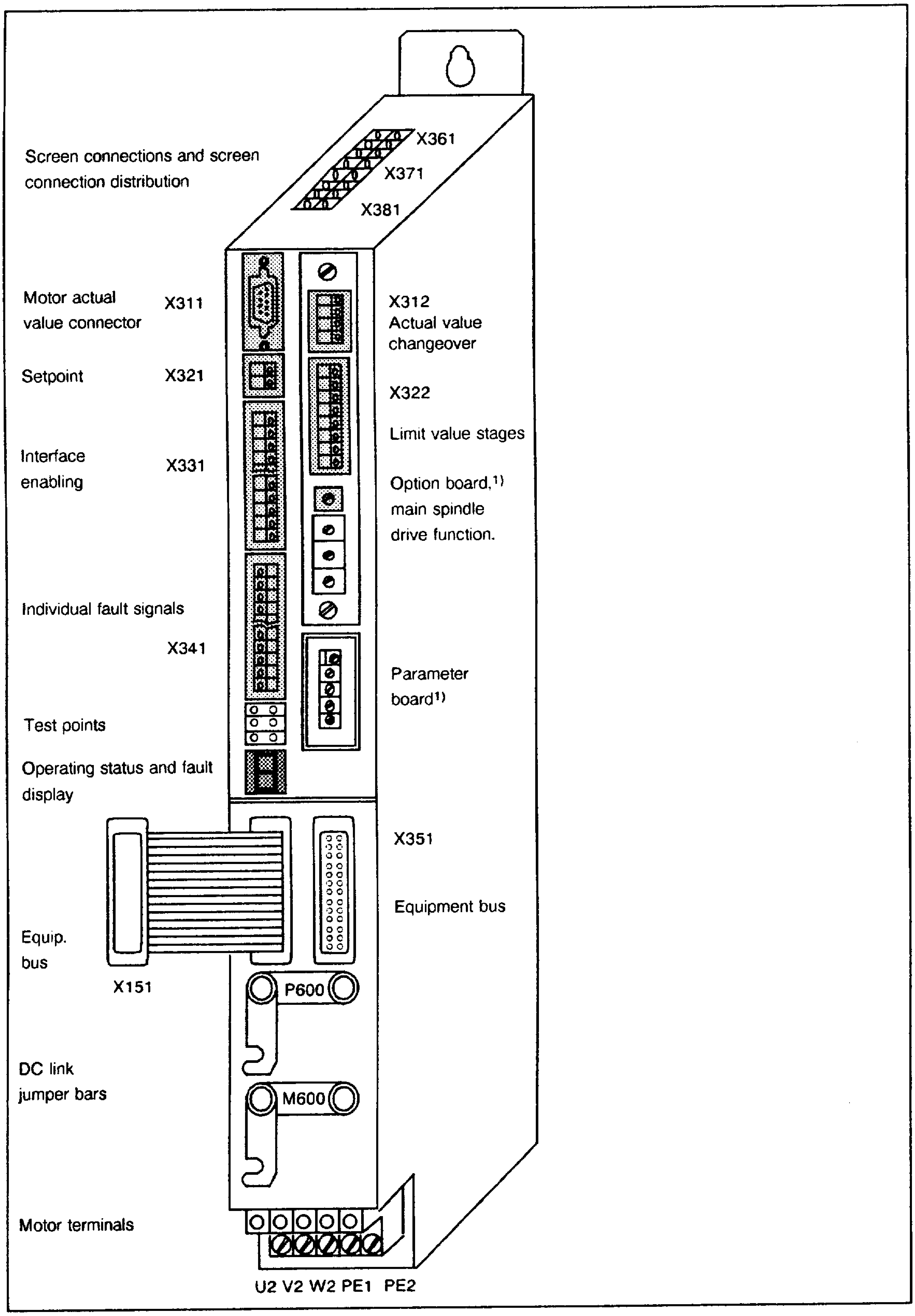
1) Coding elements are not included with modules



6SC611□-□AA00-Z feed module

1) *The board is not included with the feed drive module and must be ordered separately.*

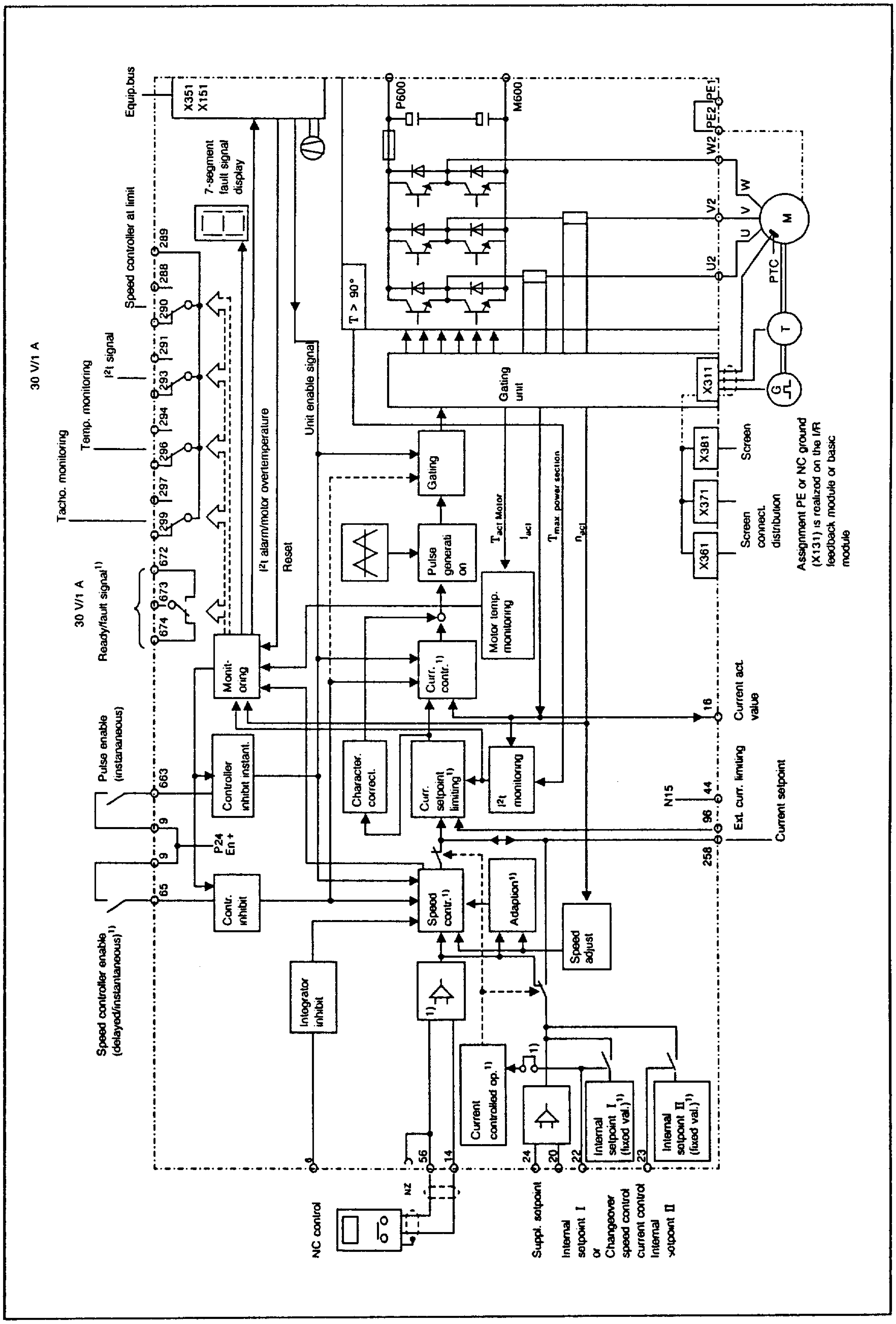
3.2.3 Mode of operation

3.2.3.1 General information

Feed modules control the speed and current of feed drives. The inverter, as power controlling element, generates a variable amplitude square-wave voltage from the controlled DC link voltage at its input. This is realized using PWM modulation.

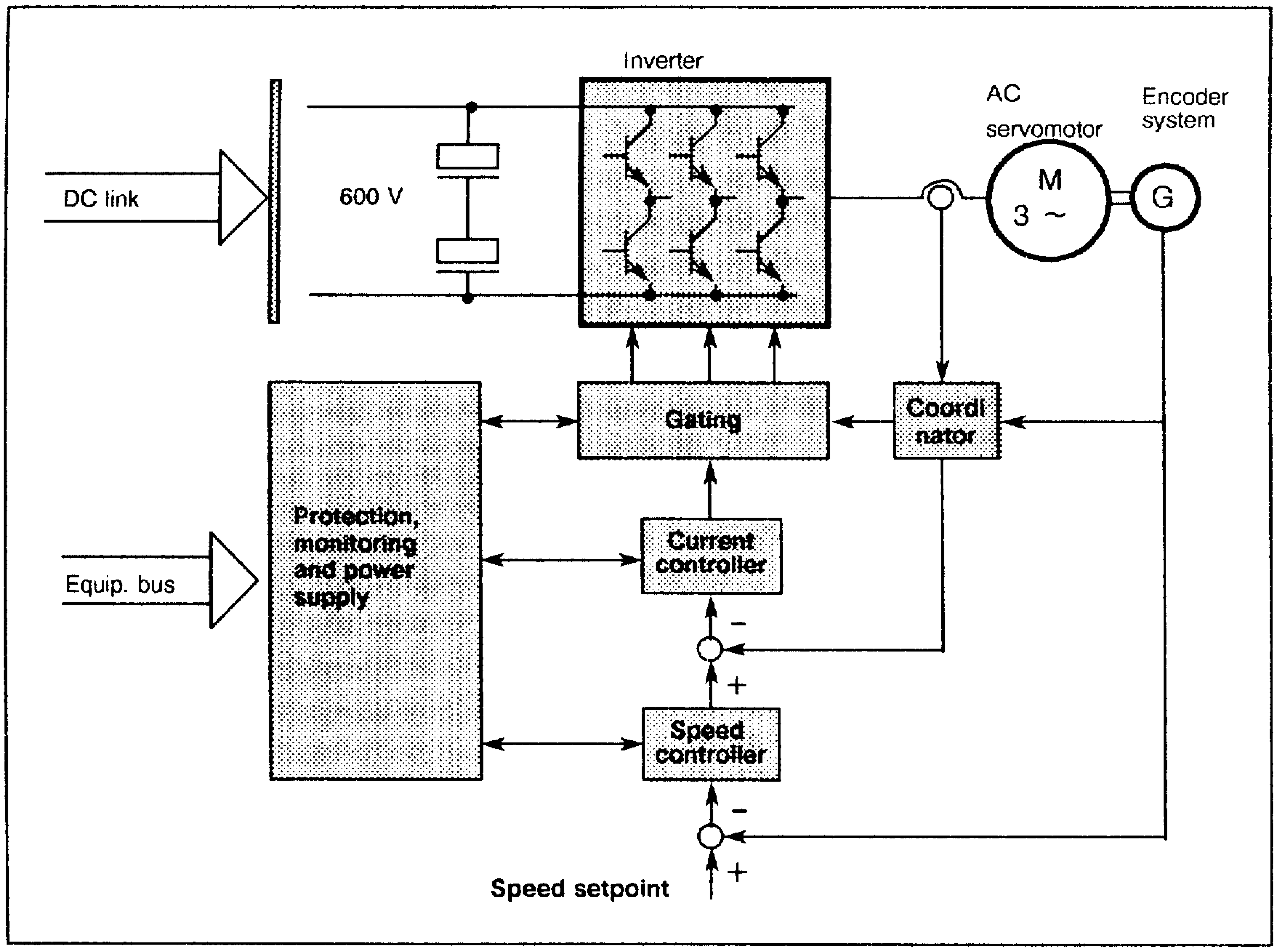
The feed module includes the following functional units:

- Inverter power section
- DC link
- Current and speed control with speed controller adaption and special control functions
- Enable circuitry
- Axis-specific monitoring
- Diagnostics
- Parameter board with all of the necessary points for controller adjustment
- Slot for the option board
- Screen connections



Block diagram of the SIMODRIVE 611 PWM converter feed module

1) Can be changed on the parameter board.



Mode of operation of a feed module

3.2.3.2 Inverter power section

SIMODRIVE 611 transistor PWM converters are designed for a 600 V DC link voltage. An infeed/regenerative feedback unit (separate module) supplies the controlled DC link voltage.

The inverter generates the terminal voltage at the servomotor windings for the required motor speed and torque from the constant DC link voltage using pulse width modulation. The rotor position encoder system switches the current to the correct phases.

The motor energy fed back into the DC link during regenerative braking is injected back into the line supply through the infeed/regenerative feedback unit.

The power electronics are isolated from the open-loop and closed-loop control electronics through the electrical isolation of the gating circuit components.

The inverter power components are designed so that they can briefly supply twice the rated current for dynamic operations. This current limit is available for a maximum of 200 ms in a 10 s operating cycle.

A heatsink and I^2t monitoring circuit protects the power sections from thermal overload.

3.2.3.3 Closed-loop control

The open-loop and closed-loop control system described here is analog, and consists of two cascaded control loops. These include the speed controller and secondary current controller; the speed controller is equipped as standard with a speed controller adaption function.

A high degree of operational reliability is achieved through the compact arrangement of electronic control components on one board. Signal connections between the boards are made at signal points which are immune to noise. The closed-loop control and electronic parameters are located on a parameter board which can be inserted from the front for transferring machine and user-specific settings, for duplicating series machines as well as for troubleshooting. This board only has passive components and is not included with the feed module.[1)]

Speed controller

The speed controller has PI characteristics and the K_P, T_N parameters, "speed drift"and tachogenerator adjustment can be parameterized using the potentiometers on the parameter board. In order to improve dynamic performance at very low speeds, the feed modules are equipped as standard with speed controller adaption. This adapts the control loop to the controlled system by modifying the integral action time T_N and proportional gain. The adaption operating range can be varied.

A differential amplifier is connected at the speed setpoint input as standard. The speed actual value from the brushless 1FU tachogenerator is fed, together with the rotor position encoder signals and temperature monitoring signals, in one signal cable. This cable is inserted into the feed module. The control actual value inputs are designed for tachogenerator voltages of 40 V at rated motor speed, and can be adapted for tachogenerator systems <40 V on the parameter board.

- **Speed controller integrator inhibit function** (terminal 6)

  The speed controller integrator can be short-circuited using an external signal. This is realized by the feedback capacitor being rapidly discharged and the overshoot characteristics, caused by the speed controller integral component, improved. The function can be enabled by connecting +15 V DC to terminal 6 on the control board.

Current controller

The current controller has PI characteristics. The control parameters must be matched to the connected servomotor during start-up. Further, the current limit can be adapted to the particular application and the current setpoint can be limited. This allows functions such as travel to end stop to be realized, even with a time limit.

The current controller gain is set using the coding switch on the parameter board. The settings are defined for 1FT5 AC servomotors. The coding is listed in the adaption tables of the Installation Guide (Order No. 6ZB5 420-0AT02-0AA0).

- **Current-controlled operation without speed controller**
  - Current setpoint input via the supplementary setpoint differential input, terminals 20/24.

    For current-controlled operation during start-up, when several drives operate in parallel through a rigid coupling, or for pure torque-controlled drives, the current setpoint can be entered via the terminals of differential input 20/24.

---

1) *The parameter board must be ordered separately.*

If the relevant axis is to be operated with current control, the speed controller on the parameter board can be inhibited using switch S2/10 (ON). The selection can also be made externally by connecting P24 V to terminal 22, if R14 is short-circuited (0Ω) on the parameter board. The current setpoint can then be entered via terminals 20/24, if the axis-specific controller enable signals are available. In this case, an internal fixed value 1 can be simultaneously injected as current setpoint, if it is available.

Further, the current controller can be used as P controller or as PI controller in the current-controlled operating mode. This selection is made using resistor R1.

R1 = 0 Ω	without I component[1]
R1 = open	with I component[1]

Start-up is best executed with the P-controller function.

A current setpoint in the range ± 10 V DC can be input at terminals 20/24 of the differential input, corresponding to the torque direction.

The current setpoint I* of ± 10 V corresponds to the converter current limit, set using the coding switches.
The current setpoint limits, input on an axis-specific basis via terminal 96, remain effective.

- Parallel operation (master/slave function).
- For parallel operation, frequently a speed-controlled master drive is provided with one or several, secondary, current-controlled drive axes.

The current setpoint of the speed controller output from the master drive is fed in parallel to the current controller of the slave axis. The feed modules are equipped with a master/slave function which can be activated for this purpose.

Terminals 258 are used as connecting points. Terminal 258 in the master axis is used as current setpoint output, and in the slave axes, terminal 258 is used as the current setpoint input.

The current setpoint limits in the slave axes are ineffective and the current setpoint limiting of the master axis is effective. The speed controller in the slave axes is de-coupled using resistors R42/R44.

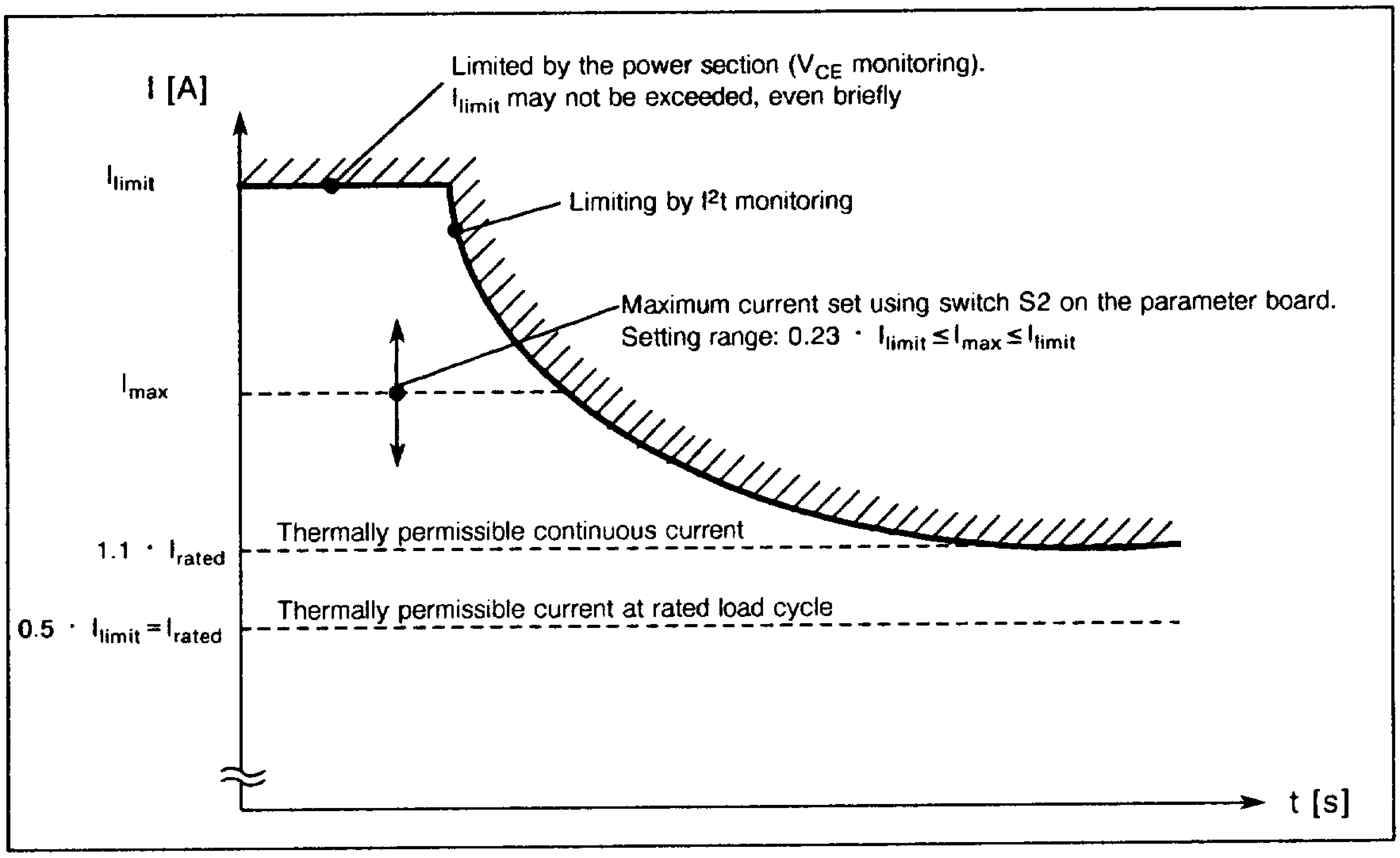
Master axis	Slave axis	
0 Ω	Open-circuit	R42[1]
0 Ω	0 Ω	R44[1]

1) on the parameter board

Current limit

The power sections of the transistor PWM converter are thermally designed to meet the characteristic torque requirements of a feed drive and the associated currents.

There is an absolute current limit value I_{limit}, which may not be exceeded, even briefly. This results in a thermally permissible rated current of $0.5 \cdot I_{limit}$ for the usual feed drive load cycle (refer to Technical Data for rated load cycle). In addition to the absolute current limit I_{limit}, there is a thermal limit curve which is defined by the I^2t monitoring function.



Effective current limits

- **Converter current limit**

  The PWM converters are set as standard for a maximum current limit of 200 % of the rated current. This current limit is available for dynamic operations for a maximum of 200 ms in a 10 s load cycle.

  The converter current limit can be reduced using a coding switch on the parameter board. This also changes the current actual value normalization. The setting is specified as a percentage referred to the absolute converter current limit of $2 \cdot I_{rated}$.

  The time, for which the current limit can be used, is dependent on the duration of the load cycle and magnitude of the converter current limit which has been set. The monitoring timer can be modified by changing a resistor which is located on the parameter board.

  The following formula is valid for the monitoring time:

  $$t\,[s] \approx R54\,[M\Omega] \cdot 0.55$$

  Prerequisite: The monitoring time is not cancelled using R32 or as a result of the "travel to endstop" function.

- **I^2t monitoring**

The I^2t monitoring function provides thermal overload protection for the PWM converter power sections. If the rated motor current I_0 is the same as the rated converter current in the particular system configuration, the motor and supply cables are also protected.

Calculating the I^2t value and off time for a specific operating cycle.

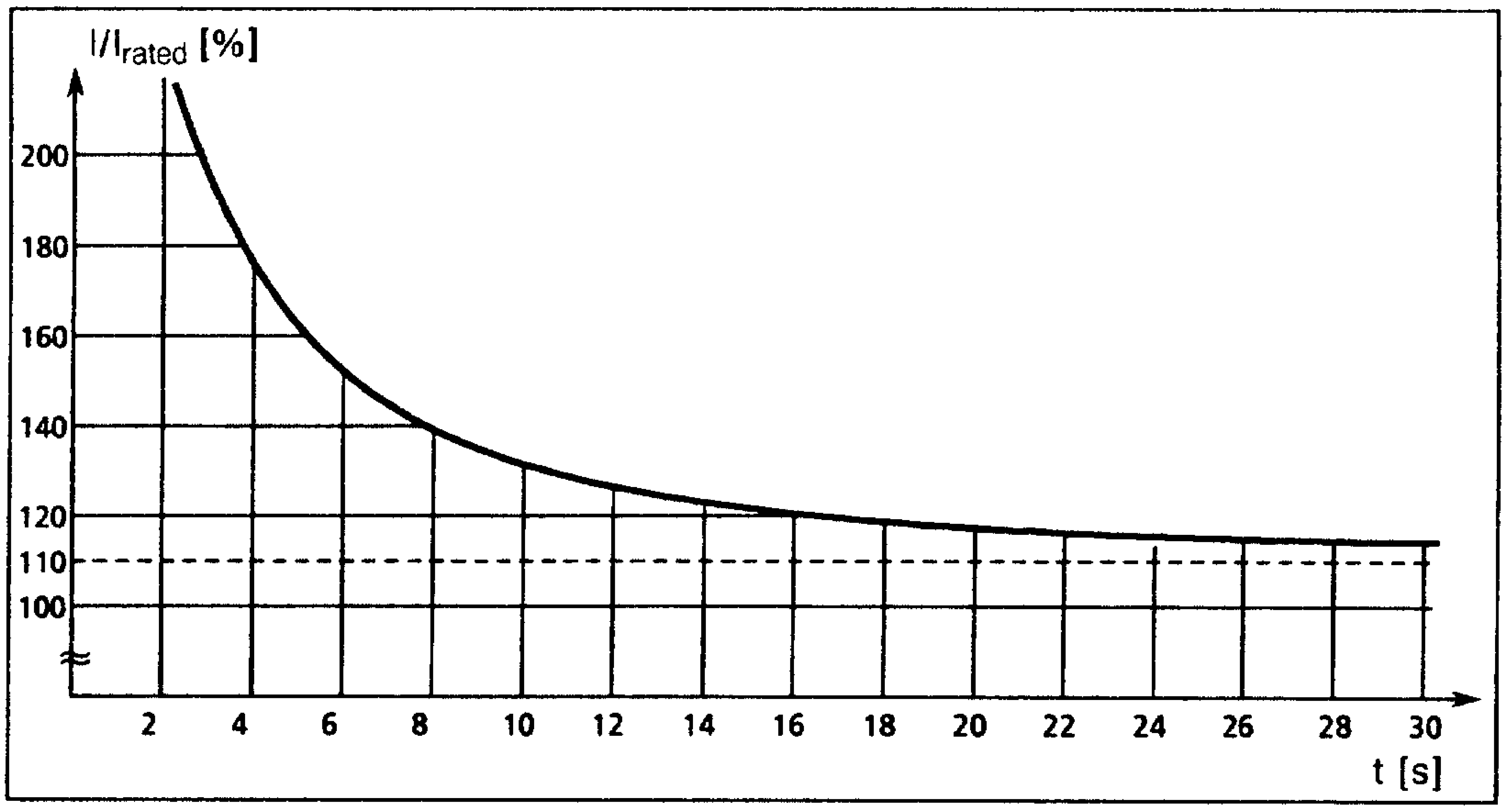
- As a general rule, the RMS current is calculated to correctly select the power section.

$$I_{RMS} = \sqrt{\frac{I_1^2 \cdot t_1 + I_2^2 \cdot t_2 + \ldots I_n^2 \cdot t_n}{\Sigma t_1 \ldots t_n}}$$

$I_{RMS} = 1.03 \cdot I_{rated}$ for a nominal duty cycle

- If there is a considerable deviation between the actual operating cycle and the nominal duty cycle, i.e. long overload periods combined with intervals where the current is less than I_{rated}, then each case must be checked as to whether the I^2t monitoring of the power section responds in a partial duty cycle.

The overload- and reduced loading periods, referred to the power section rated current, are sensed and summed using an integrator circuit. The converter current limit is internally reduced when the I^2t value has been reached. The fault memory is set, after the internal converter current limit has fallen below the value $\leq 0.8 \cdot I_{limit}$[1]. An I^2t alarm, as group signal for all axes, is output approximately 200 ms before the current is reduced for a specific axis, via terminals 5.1 to 5.3 at the infeed/regenerative feedback unit, and the monitoring module. The response times, for the I^2t values for the different constant overloads, matched for the particular power sections, are illustrated in the following diagram.



I^2t characteristic: thermally permissible duration of the overcurrent condition (without pre-loading)

1) I_{limit}: *current limit set using the coding switch*

The following calculation can be used to check as to whether a specific operating cycle is thermally permissible for a particular feed module. The duty cycle is subdivided along the time axis into steps having the same current amplitude. The load steps are integrated up over time. The integrator voltage excursions **ΔU** are calculated for the load steps obtained from the operating cycle. The voltage elevations **ΔU** are summed, with sign, and in the correct chronological order.

$$\Delta U \equiv t \left\{2.2 - \left[2\left(\frac{I}{I_{rat.}}\right)^2\right]\right\}$$

ΔU = Voltage excursion [V]
t = Time [s]
I_{rated} = Power section rated current [A]
I = Output current [A] (actual current)

In the steady-state range, with no overload, the integrator is at is quiescent limit of + 14.2 V. This limit cannot be exceeded in the recovery phase of the operating cycle. During loading the integrator output signal changes according to the voltage excursions **ΔU**. The fault memory is set if a total excursion of ≤ –14.5 V is obtained at its integrator output as a result of the summation. The fault memory response threshold has a tolerance of ± 10 %.

- **Current setpoint limiting**

  In addition to the feed module current limit via the current actual value, the current can also be limited using the current setpoint circuit. The "travel to endstop" function is provided for this purpose.

  "Travel to endstop" function

  The function is selected by connecting a voltage to terminal 96.

  –15 V is preferably used as control voltage. However, positive voltages up to + 15 V can also be used. Terminal 44 (-15 V) is physically located next to terminal 96 in the converter. The PWM converter current setpoint limiting is reduced corresponding to the external input. The speed controller 200 ms monitoring is no longer effective when terminal 96 is energized (factory setting).
  There are two methods for entering the current limit:

  - The current setpoint limit is **permanently set in the PWM converter.**

    In this case, resistor R12 must be mounted on the parameter board.

  - The current setpoint limiting is **variably entered externally.**

    In this case, a variable DC voltage in the range from ± 0.8 V DC to ± 9.5 V DC must be applied to terminal 96. The input resistance of terminal 96 is 12 kΩ.

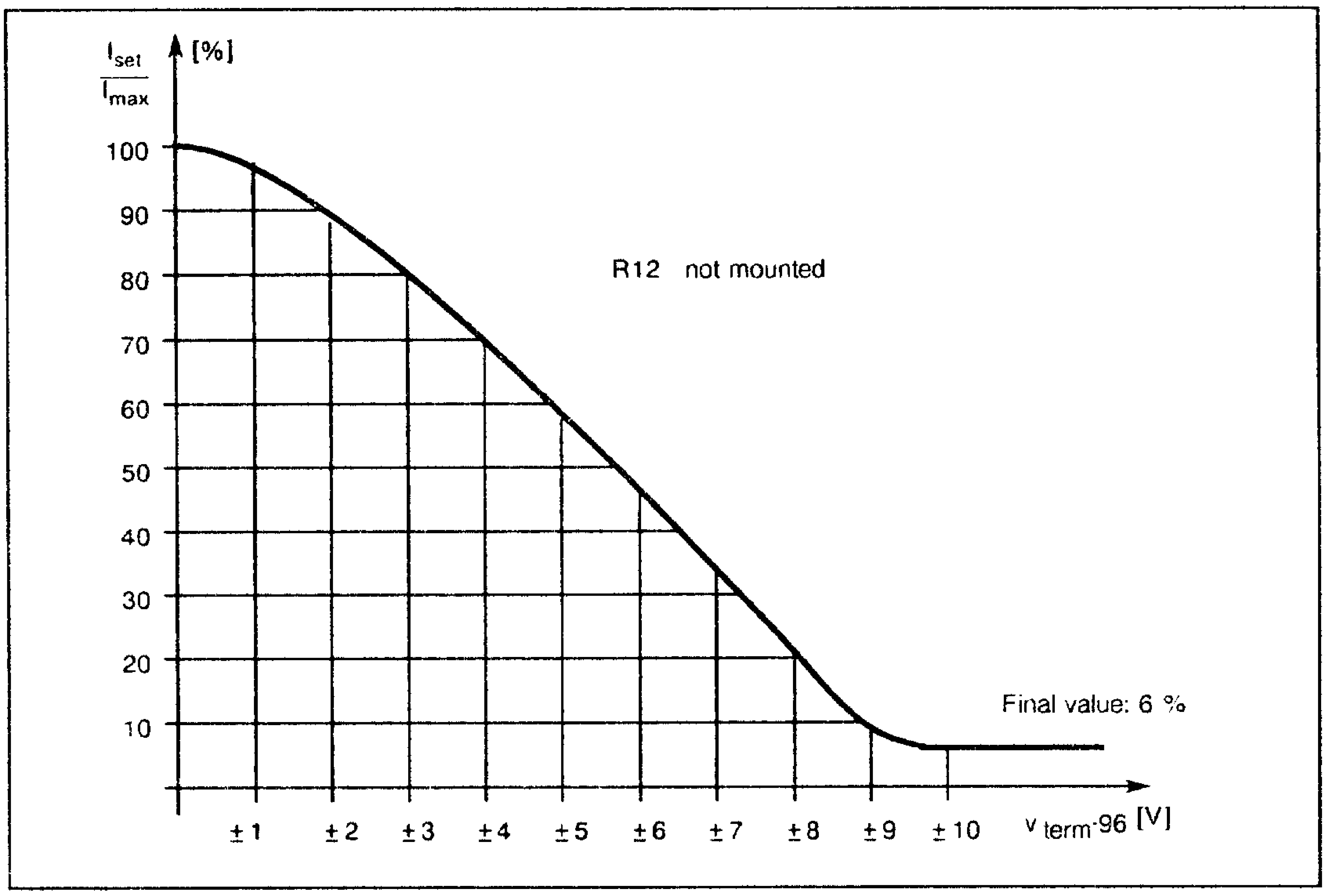
    ± 33 V must **not** be exceeded.

    The reference quantity for the percentage value is defined using the coding switch on the parameter board for the converter current limit I_{max}.

Resistor R32 is used to enable/disable the speed controller 200 ms monitoring.

R32 = 0 Ω	Monitoring active[1]
R32 = Open-circuit	Monitoring disabled[1] (factory setting)

Only the I^2t monitoring is effective when the speed controller 200 ms monitoring is disabled. After the I^2t timer has expired, the permissible current is limited to $I_{max} = 1.1 \cdot I_{rated.}$ By changing R2, the permissible current can be limited to lower values, immediately after the monitoring time "speed controller at end stop" has expired.



Current setpoint limiting as a function of the voltage at terminal 96

(the input resistance of terminal 96 ≥ 9.1 kΩ)

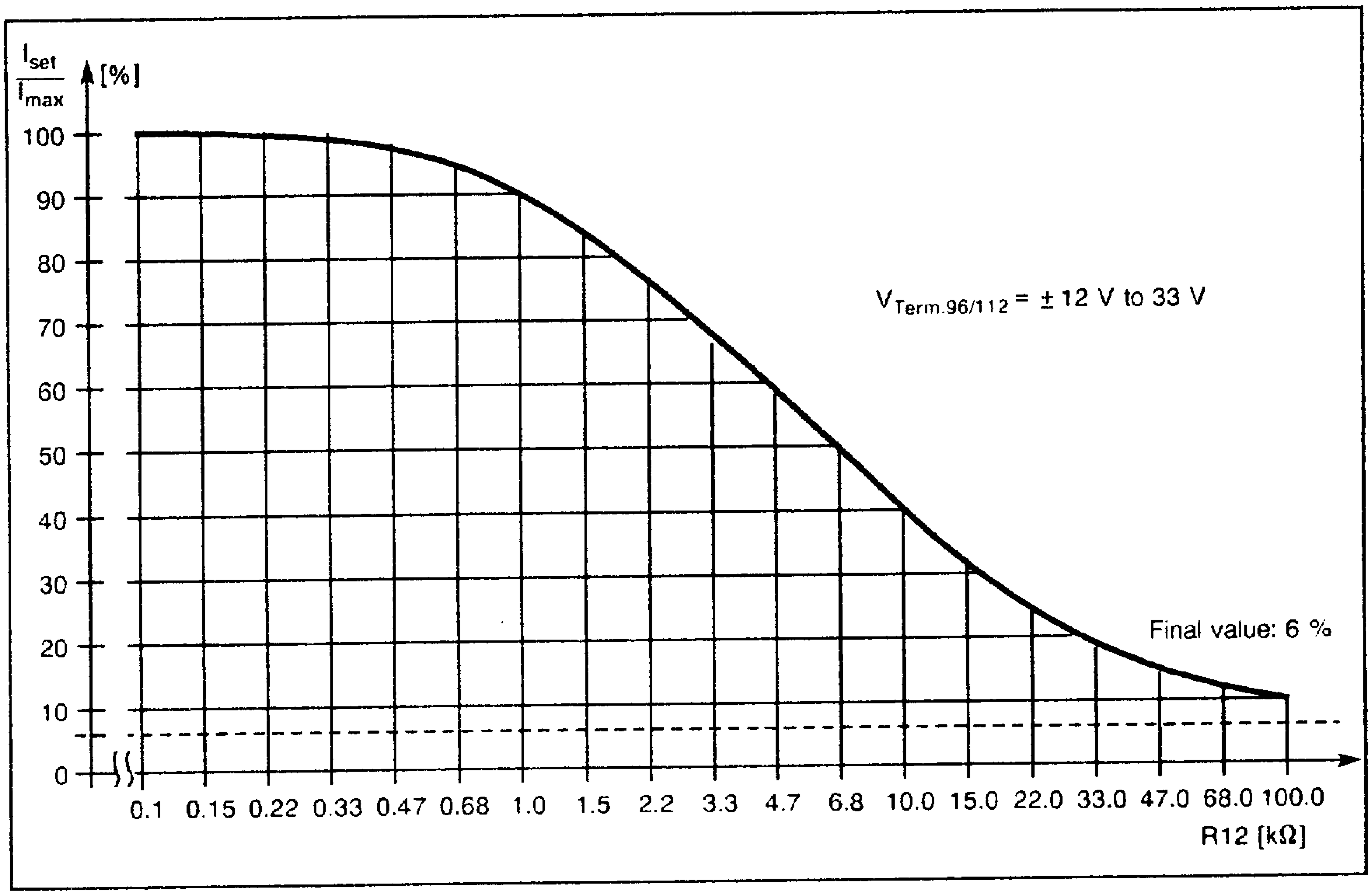
1) *on the parameter board*

- **Central current setpoint limiting via terminal 112**

  Setting-up operation is selected by opening the connection between terminal 112 and terminal 9 (Section 3.1.5). This has the result, that the current setpoints of all feed modules, which are connected through the same equipment bus, are limited.

  - Limiting via R12 according to the following diagram, terminal 96 is open-circuit (voltage is internally applied through the converter bus).

  Condition as supplied: R12 not mounted,
  Terminals 112 and 9 jumpered
  Terminal 96 open-circuit



Current setpoint limiting as a function of R12 on the parameter board

3.2.3.4 Enable circuit

When the drive unit is switched-on, an initializing pulse is first generated in the infeed/regenerative feedback module or monitoring module, which resets the feed module signals into a defined condition. The units can only be enabled after the initializing pulse (duration approx. 1 ms) has disappeared.

The feed modules are enabled according to heirarchy. An internal axis module enable is not possible without the infeed/regenerative feedback unit being centrally enabled.

When enabling the feed module, the axis-specific pulse enable must be provided at terminal 663 and then the speed controller enable at terminal 65.

The enable signal inputs are electrically isolated through optocouplers.

- Terminal 663, axis-specific pulse inhibit

  The pulses are enabled when +24 V DC (+ 12 to 30 V) is applied. Enable and inhibit are instantaneous. The drives coast down unbraked when the signal is withdrawn.

- **Terminal 65, axis-specific speed controller enable**

  The controller and pulses are enabled instantaneously, if +24 V DC (+12 V to 30 V) is connected. The axis speed setpoint is set to zero, as standard, and the controller and pulses inhibited after approx. 200 ms, when the enable signal is withdrawn.

  By mounting R13, the controller and pulses are inhibited instantaneously when the speed controller enable signal is withdrawn. The drive coasts down unbraked.

- **Enable voltages**

  The terminals can be energized in various ways. The terminals can be energized either through contacts or using positive logic. The following is valid for terminals 663 and 65: Closed contact to terminal 9 or H signal corresponds to controller and pulse enable.

  The internal 24 V power supply or an external voltage in the range +12 V to +30 V can be used as control voltage. Terminals 663 and 65 are internally fed through optocouplers.

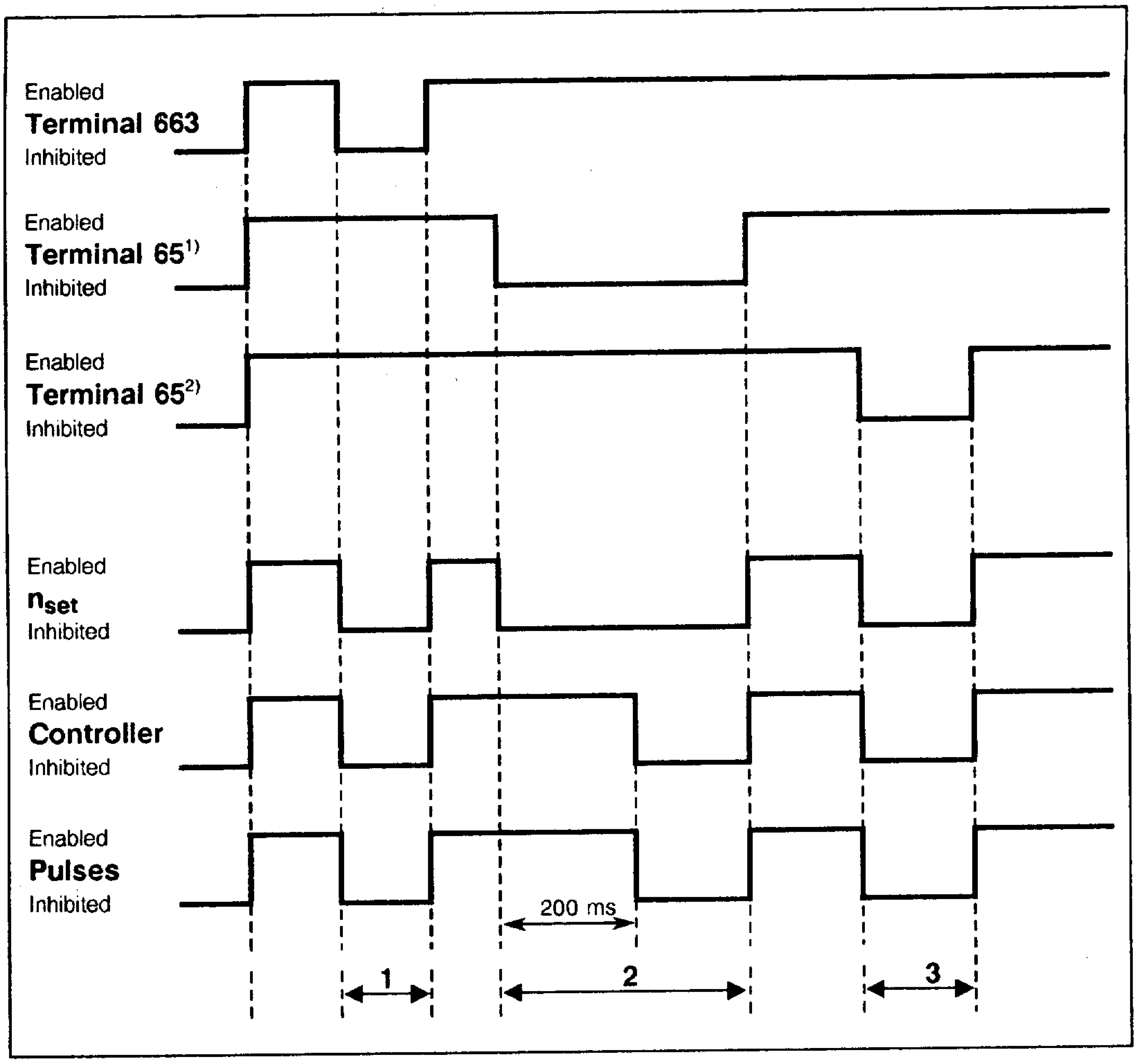
  - Using the internal 24 V power supply

    Terminal 9 is always located next to enable terminals 663 and 65. The internal +24 V power supply is available as standard at terminal 9. This voltage can be looped through an external contact of the interface control.

  - Using an external 24 V power supply

    The external power supply reference potential is connected to the internal reference potential through terminal 19. Electrical isolation is provided by the optocoupler inputs in the feed module.

    Thus, it is possible to energize the terminals, floating, from a PLC.



Enable signals

1: Terminal 663 (pulse enable) is inhibited.

The feed module is immediately inhibited and the drive coasts down unbraked.

2: Terminal 65[1] (axis-specific speed controller enable) is inhibited.

The feed module is braked with $n_{set} = 0$, and inhibited after 200 ms.

3: Terminal 65[2] (axis-specific speed controller enable) is inhibited.

The feed module is immediately inhibited and the drive coasts down unbraked.

The pulse and drive enable signals must always be present from the infeed/regenerative feedback module or monitoring module before the feed modules can be enabled.

For infeed/regenerative feedback modules, version .01, the start terminal (terminal 48) must also be enabled.

1) Parameter board R13 open (standard)
2) Parameter board R13 0 Ω

3.2.3.5 Axis-specific monitoring and diagnostics

SIMODRIVE 611 feed modules are equipped as standard, with comprehensive diagnostics. The parameters and quantities critical for operation are monitored for detailed evaluation of operating statuses and faults. Messages and signals are provided for the operator or the interface control for further processing, on the 7-segment display and via floating relay outputs.

All messages and signals are internally stored in the memory. If fault messages and signals are to be maintained with the load circuit disconnected or during power failure, the control power supply in the infeed/regenerative feedback unit must be fed from an independent, fail-safe supply, or a DC power supply ≥ 500 V DC, assuming of course that it conforms to all of the machine safety regulations.

- **Tachogenerator and rotor position encoder monitoring**

  The tachogenerator monitoring responds, if one or two tachogenerator conductors are missing, short-circuited, or are defective (minimum speed required), and an axis-specific controller and pulse inhibit is initiated. If all three tachogenerator conductors are missing, the tachogenerator monitoring does not respond, and in this case, the 200 ms monitoring function becomes active. The rotor position encoder monitoring responds, if the rotor position encoder is defective or the rotor position encoder cable is missing or interrupted. Axis-specific controller and pulse inhibited are initiated. The controller and pulse inhibit can be cancelled again using the central RESET signal after the fault has been removed.

- **Speed controller monitoring**

  When the speed controller is at its limit for longer than the selected time (200 ms as standard), the monitoring circuit responds, i.e. controller and pulses are inhibited. The time is dimensioned, so that the motors are protected from dangerous overload conditions but reliable direction of rotation reversal is still possible from maximum speed. Adaption is possible for larger moments of inertia. The following are sensed by the monitoring function: Stalled drive, defective speed controller, excessive operation or braking along the current limit and travel to end stop. The signal causes an axis-specific controller and pulse inhibit, or if the monitoring function is disabled, the current is reduced.

- **I^2t limiting and I^2t monitoring**

  The I^2t limiting protects the PWM converter from thermal overload. The RMS current of the power section is monitored. Further, temperature monitoring sensors are mounted on the module heatsink. These are also entered into the same fault memory. The current limit is continuously reduced to the rated converter current when the monitoring function responds. If the fault memory is set from the heatsink temperature ($T_K > 90$ °C), the current limit is reduced to 6% I_{rated}. The signal has no further effect in the feed module. A signal is fed to the infeed/regenerative feedback unit from the feed module approx. 200 ms before the current is reduced. A group signal, I^2t alarm is output via terminals 5.1 to 5.3.

- **Motor temperature monitoring**

  A temperature sensor (PTC thermistor) is mounted as standard in the servomotors. The response temperature is +155 °C ±5 °C. The "motor overtemperature" signal is also fed to the infeed/regenerative feedback unit as group signal and is effective at terminals 5.1 to 5.3. This signal has no further effect in the feed module. The appropriate measures must initiated in the higher-level open-loop control system.

- **Operating status display**

  A single 7-segment display is used to visualize operating statuses and possible faults. Various statuses are clearly indicated to operating and start-up personnel using this display. This simplifies diagnostics and faults can be quickly identified and removed.

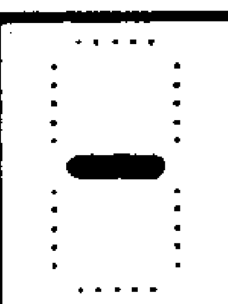
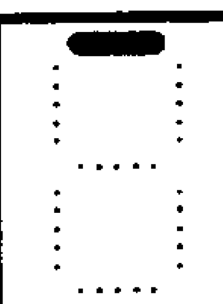
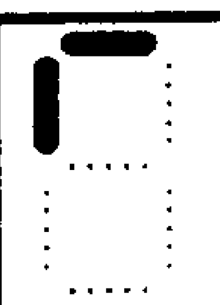
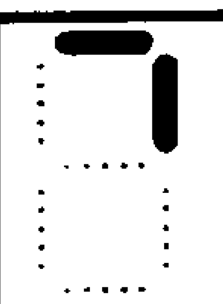
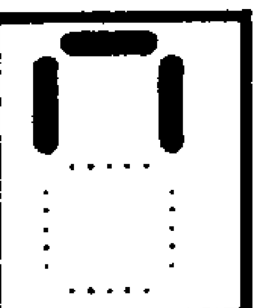
  Operating status display (character display)

  The various operating statuses are indicated using the four upper display segments. One of the segments is always lit, indicating the following:

  - Parameter board inserted
  - Axis-specific pulse enable at terminal 663
  - Axis-specific speed controller enable at terminal 65

  The following character combinations can be displayed depending on the individual statuses.

- **Operating display**

					
Parameter board inserted	no	yes	yes	yes	yes
Pulse enable, term. 663	–	no	no	yes	yes
Sp. contr. enable, term. 65	–	no	yes	no	yes

- **Axis-specific ready signal**

  Each feed module has a specific ready signal. It is available as potential-free relay output. The changeover contact with terminals 672; 673; 674 is rated at 30 V/1A. The "axis-specific ready" signal is a group signal and includes the following status signals:

  - Tachogenerator O.K.
  - Rotor position encoder O.K.
  - Speed controller monitoring <200 ms
  - Parameter board inserted
  - Axis-specific pulse enable available at terminal 663
  - Axis-specific speed controller enable available at terminal 65

  The relay pulls-in when **all** status signals are available. The relay drops-out, if **one** of the status signals changes.

  The feed modules are supplied with the "ready" configuration as standard.

  The "ready" signal can be changed over to the "fault" signal by removing resistor R33 on the parameter board. The "fault" signal is also available as group signal and consists of the following fault signals:

  - Tachogenerator defective (or tachogenerator cable)
  - Rotor shaft encoder defective (or rotor position encoder cable)
  - Parameter board missing
  - Speed controller monitoring >200 ms

  The relay drops-out, if **one** of the fault signals is available.

Fault display (digital display)

Contrary to operating statuses, for fault displays, all 7-segment display segments are used. Six different monitoring signals and drive axis signals are evaluated. Combinations serve to localize the fault. The first initiating fault is always kept on the display. The fault is displayed for a specific axis.

If an axis-specific fault occurs in an axis, the other axes remain operational. If the defective axis is not absolutely necessary for the process or machining, then it can be inhibited and the remaining axes still remain operational. A group drive signal or central storage is not realized and must be provided by the user if required (e.g. in the PLC).

The fault signal is axis-specific.

Fault	1	2	3	4	5	6	7
I^2t monitoring	■				■		
Rot. pos. encoder (monit.)		■					
Speed controller at limit					■	■	■
Tacho. monitoring				■			
$I_{act} = 0$							■
Motor overtemperature			■				
Effect		Pulse cancel.		Pulse cancel.	Pulse cancel.	Pulse cancel.	Pulse cancel.
Signal to – I/R feedb. mod.	Term. 5.x	--	Term. 5.x	--	--	--	--
– feed drive mod.	term. 291	Term. 297	term. 294	Term. 297	T.288T.291	Term. 289	Term. 288

A combination of fault signals is also displayed for more detailed localization.

Digit 5 display: I^2t monitoring and speed controller at its limit have responded. The fault lies in the drive mechanics and its transmission elements or the selected motor is too small, as the power section is continuously overloaded and speed controller is at its limit.

Digit 7 display: Speed controller at its limit has responded and no current is flowing in the power circuit. Possible fault causes are:

- Motor feeder cable missing or interrupted
- Fuses in the power section have blown
- Defective power section

- **Axis-specific fault signal output**

In order to further process the signals in the NC or interface section, the following individual potential-free signals are available as standard.

The fault signals

- Rotor position encoder + tachogenerator monitoring
- Speed controller at its limit
- I^2t of the power section
- Motor overtemperature

are available as outputs with relay contacts. A single-pole changeover contact is available for each signal. All fault signal contacts of a feed module are connected together at a common center point contact and are fed to a terminal (also refer to the terminal description 3.10). The contact rating is 30 V DC/1A.

- **RESET**

  If a fault indicated in an axis is removed, then the fault memory must be reset before the unit is re-started. This is realized using the "RESET" signal or by the initializing pulse at switch-on.

  The RESET signal is issued centrally to the infeed/regenerative feedback module or the monitoring module via terminal R. A dynamic signal change to 0 V must occur at this terminal.

  The central RESET signal only addresses those feed modules where a fault memory is set. The other axes remain unaffected by the acknowledgement and continue to operate.

- **Screen connections**

  The screen connections for the signal leads are located on the upper side of the module as coded plug-in terminals. This four-pin connector is located under the cable bundle routing for the signal leads. Two, two-pin screen bus connectors for wiring to adjacent modules are located behind. The rotor position encoder housing (flange-mounted socket) X311 and the four-pin plug-in terminal, are electrically connected with the screen bus connector.
  The selection as to whether ground or NC ground is used for screening is made at the infeed/regenerative feedback unit.

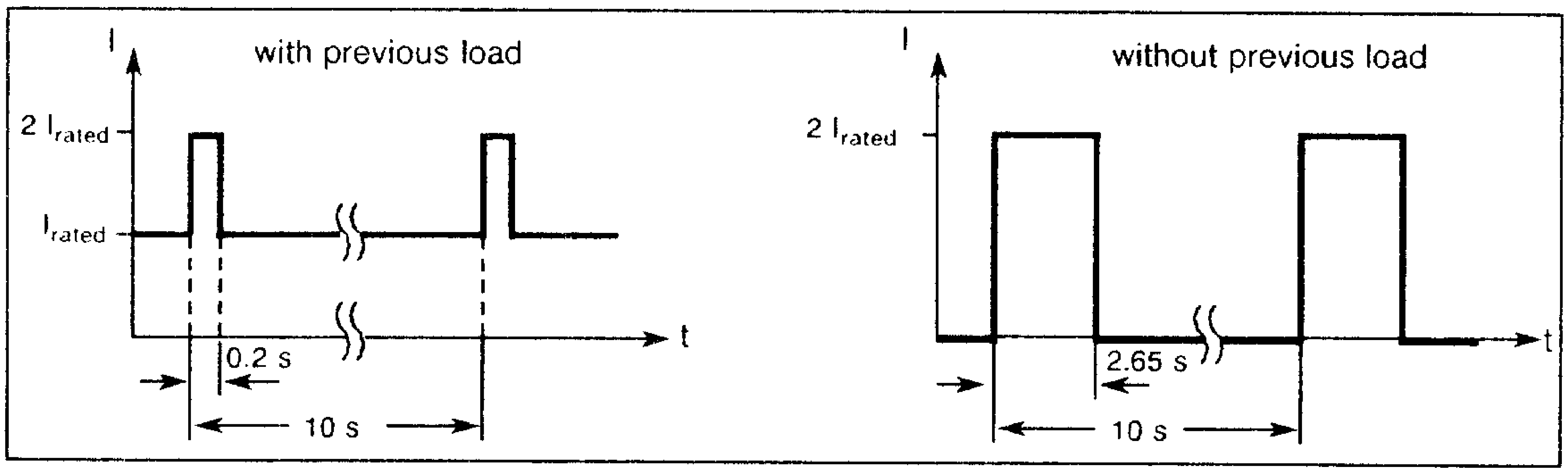
- **External fans**

  Feed modules ≥ 12 A are equipped with external fans for cooling the power sections. The fans are supplied internally. The required 28 V is fed to each module via the unit bus from the infeed/regenerative feedback module or the monitoring module.

3.2.4 Technical data

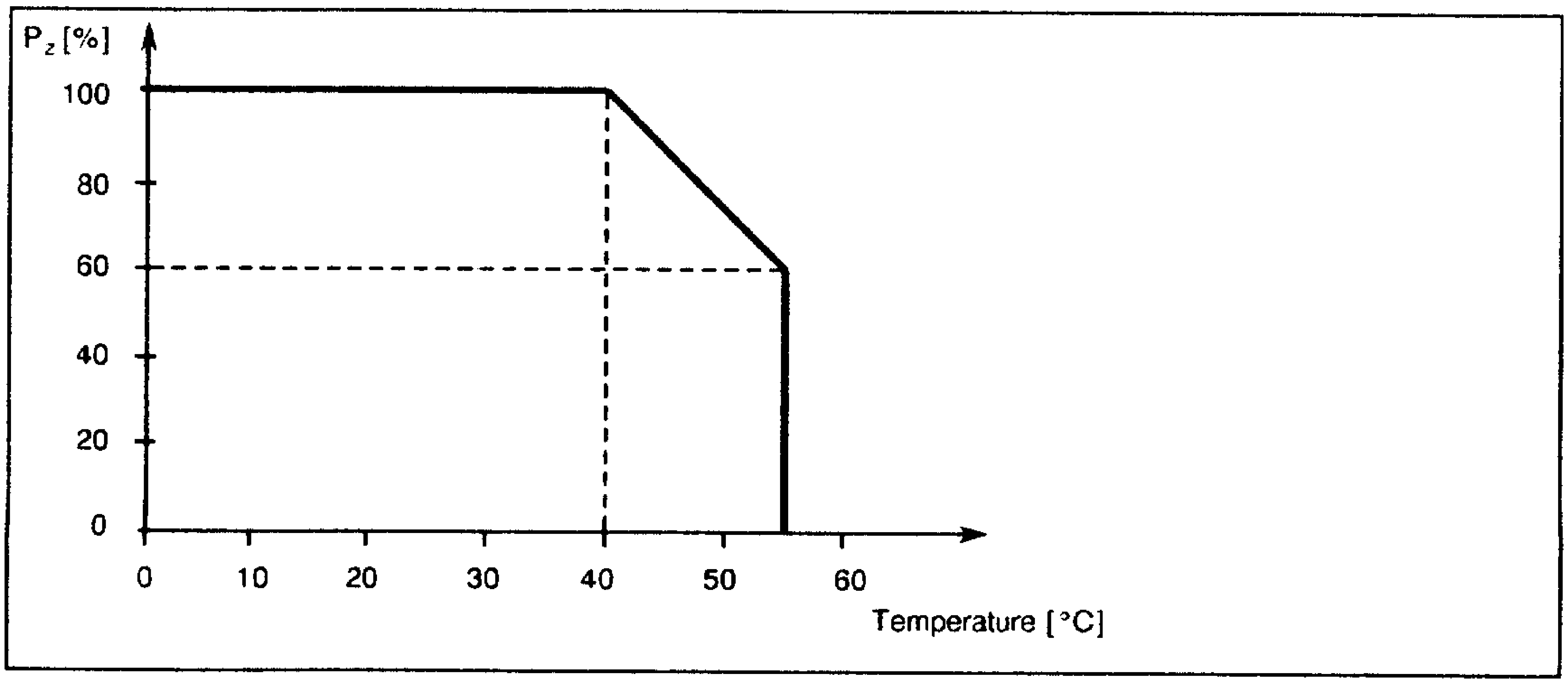
Order No. 6SC61	0-3AA00	0-6AA00	1-2AA00	2-0AA00	4-0AA00	6-0AA00	8-0AA00
Supply voltage	600 V DC						
Output frequency	0 Hz to 400 Hz						
Rated output current	3 A	6 A	12 A	20 A	40 A	60 A	80 A
Short-time limiting current	6 A	12 A	24 A	40 A	80 A	120 A	160 A
Power loss	25 W	50 W	100 W	170 W	340 W	500 W	680 W
Cooling type	Self cooled	Self cooled	Force cooled	Force cooled	Force cooled	Force cooled	Force cooled
Weight	6 kg	6 kg	6 kg	14 kg	16 kg	18 kg	16 kg

Nominal load cycles for axis modules when operated with the short-time limiting current:



Permissible ambient temperature
in operation — 0 °C to 40 °C (up to 55 °C with de-rating)
during transport and storage — –25 °C to 85 °C

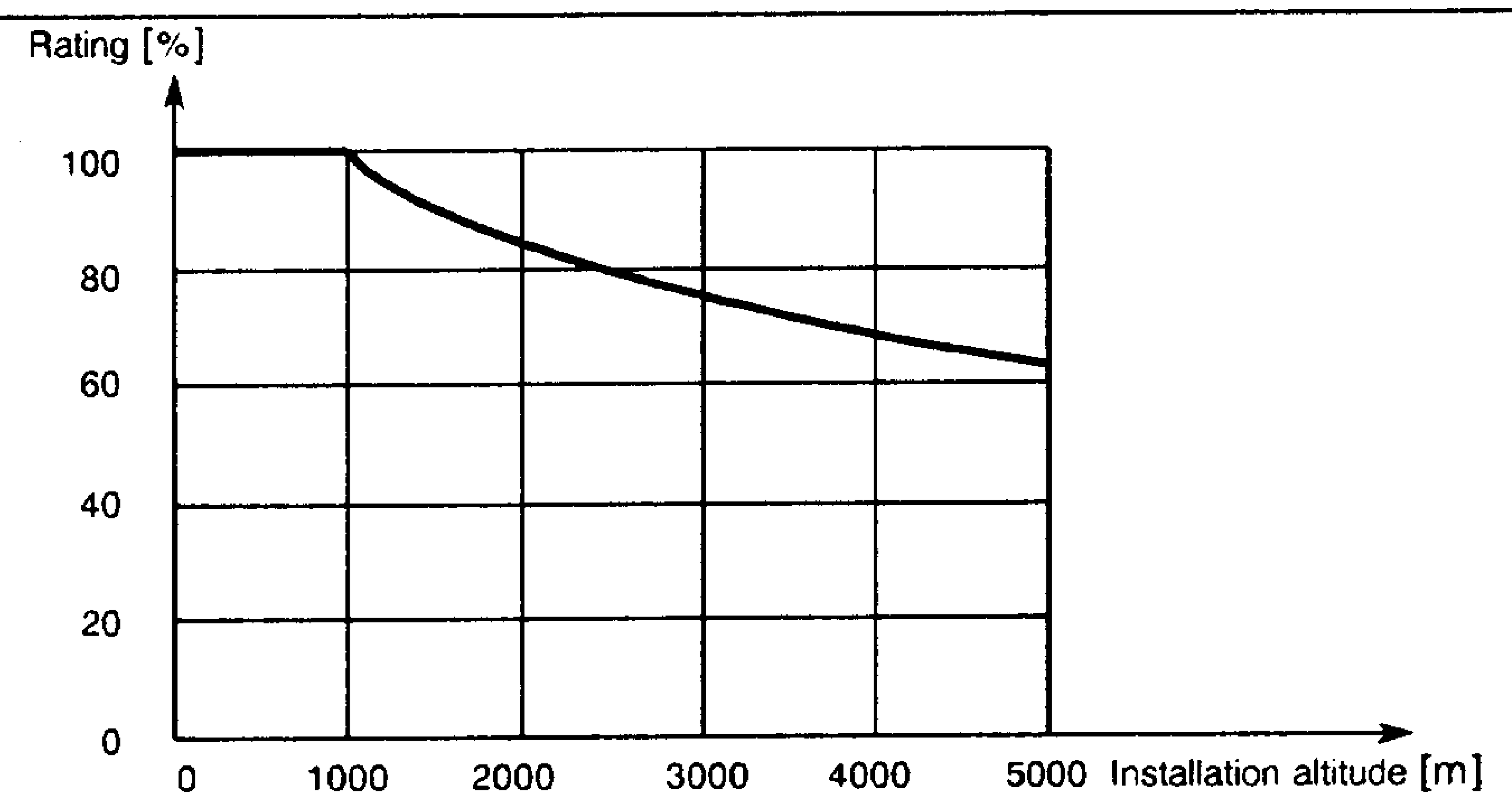
De-rating for increased air intake temperature:



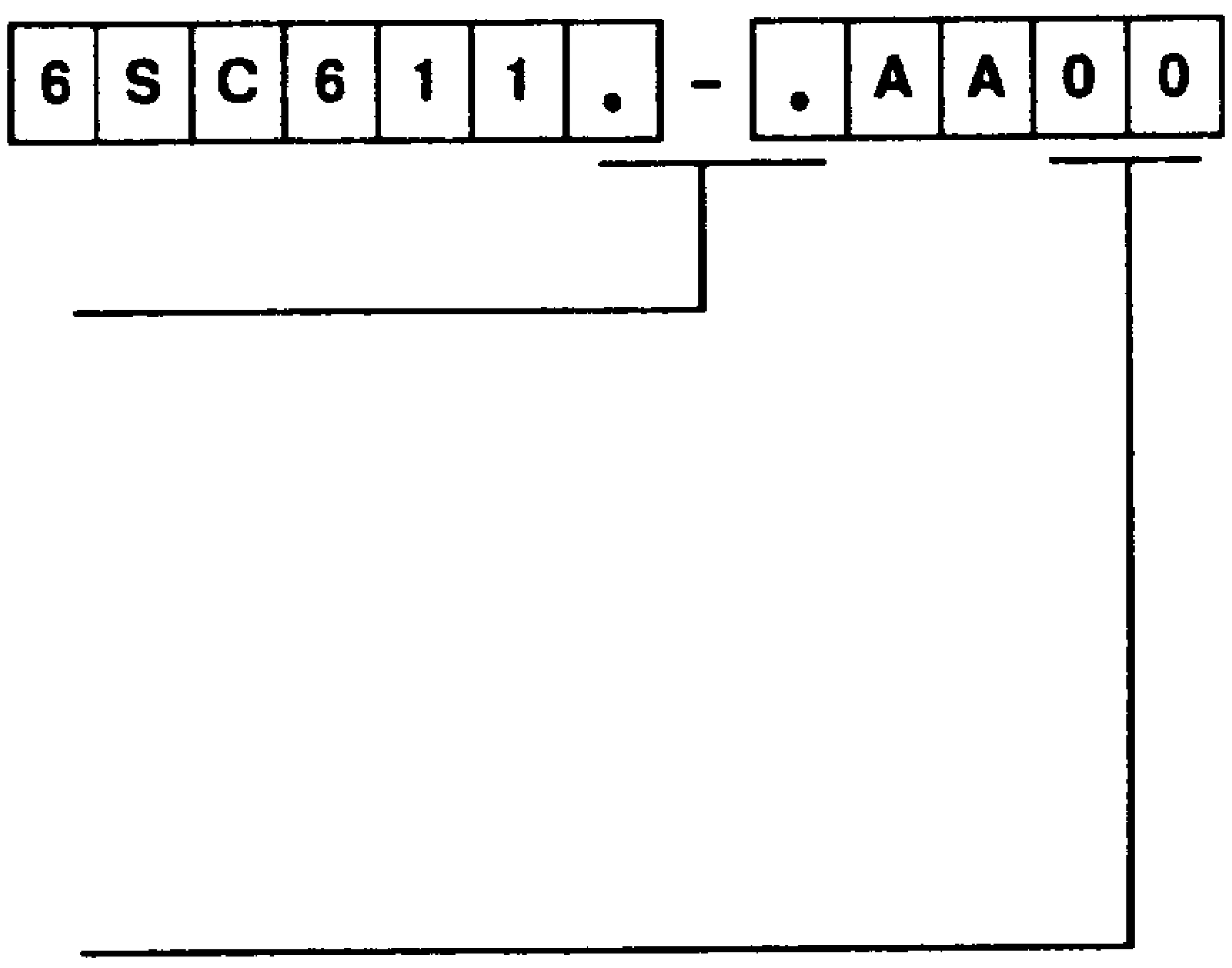
Insulation	Group C acc. to DIN VDE 0110/11.72380 V
High-voltage test	Converters are tested acc. to VDE 0160/5.88
Degree of protection	IP 00 acc. to DIN 40050 and IEC 144
Permissible relative humidity	Class F acc. to DIN 40040 Mean annual average ≤75 % 30 days continuously per year 95 % occasionally on remaining days 85 %

Installation altitude

The specified loads for rated- and limiting DC current refer to installation altitudes up to 1000 m above sea level. The drive must be de-rated, according to the diagram below, for installation altitudes above 1000 m.



3.2.5 Type designation



Feed module current rating

0-3 = 3 A
0-6 = 6 A
1-2 = 12 A
2-0 = 20 A
4-0 = 40 A
6-0 = 60 A
8-0 = 80 A

Version

3.3 Parameter board

3.3.1 System integration

The parameter board is required to use the feed module. All adjustments, necessary for start-up, can be made on the parameter board. All necessary adjusting points, and additional ones, which have been determined from many years of experience, have been made accessible on this board. The parametetr board is inserted from the front into the compartment provided in the feed module.

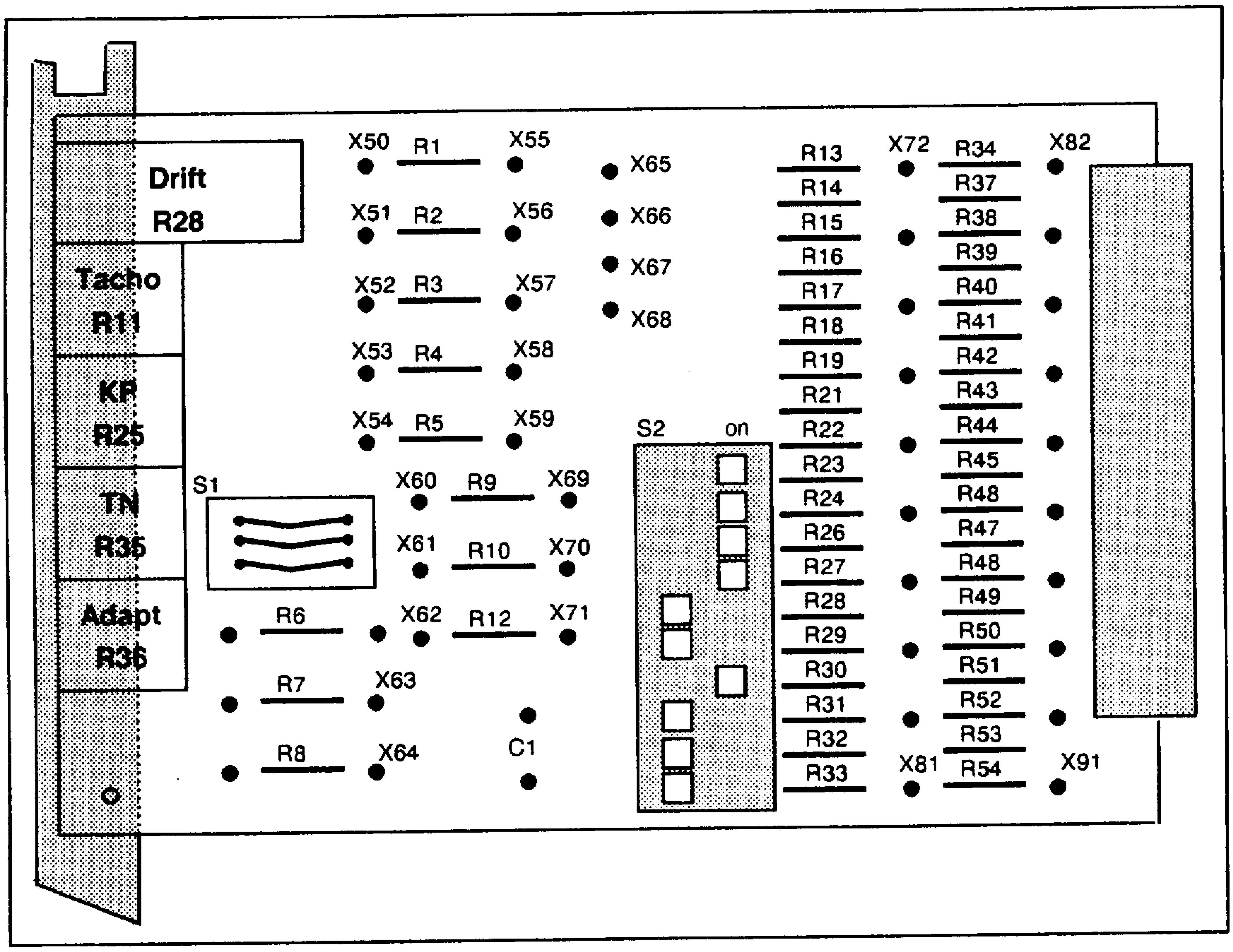
Adjustments, which can be made while the drive is switched-on, can be carried-out externally with the board inserted. Adjustments, which are only permissible when the unit is de-energized (no-voltage condition) can only be carried-out when the parameter board is withdrawn.

It is not permissible to withdraw the parameter board when the unit is operational, as the drive can then no longer be controlled. When the parameter board is withdrawn, instantaneous pulse inhibit is issued for the respective axis and the fault memory set. The feed module is only ready again after central reset with the parameter board is inserted, or after the internal initializing pulse is output at switch-on.

The parameter board is not included with the feed module and must be ordered separately.

3.3.2 Parameter board design

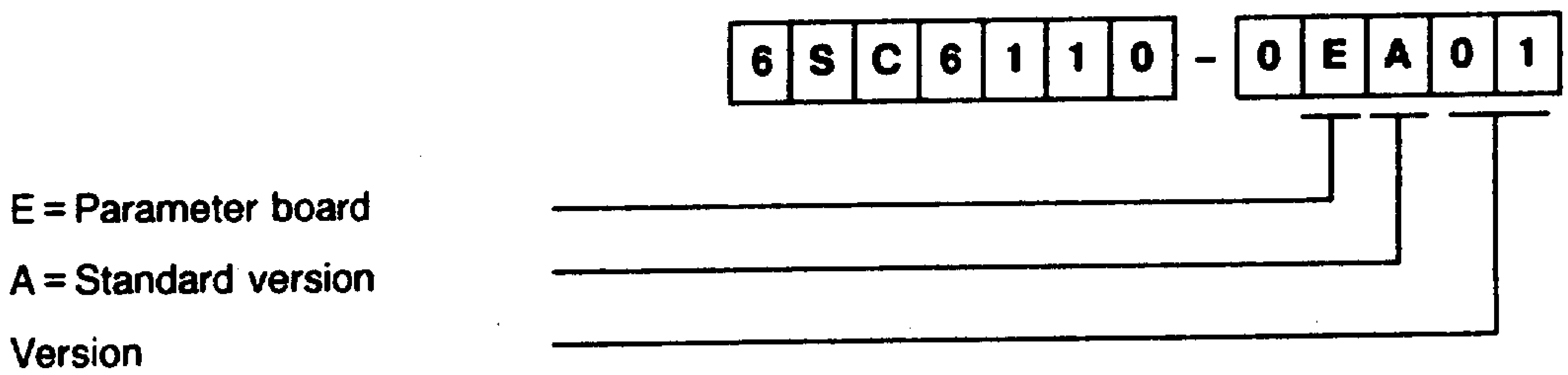
The parameter board includes continuously adjustable components such as potentiometers, coding switches, solder pins for adjustments in stages, and components on soldering eyelets for permanent function selection. Only highly reliable passive components are used on the module so that the machine-specific adapted parameter board can be used in the replacement unit if the feed module has to be replaced. New start-up is not required.



Parameter board design

Potentiometers are located on the front of the board, which can be adjusted during start-up with the board inserted. Coding switches for the current limit, current controller gain, rough adjustment of the tachogenerator voltage, direction of rotation reversal, changeover for speed controllers and current controllers are located on the board. Fixed settings use components mounted on solder pins or, where adjustments are seldom required, soldering eyelets. Modes and functions are selected using resistors on soldering eyelets which can be easily removed.

3.3.3 Type designation



 6ZB5 420-0AS02

3.4 Infeed/regenerative feedback modules

3.4.1 System integration of the infeed/regenerative feedback modules

The infeed and regenerative feedback modules are used for feeding the DC link. They are required for applications with AC feed drives and for combination solutions using SIMODRIVE 611 main spindle drives and the main spindle drive option, which are based on a feed module with option board to expand the functional scope to that of a main spindle drive.

In the regenerative braking mode, the kinetic energy fed-back into the DC link is injected into the line supply. This also provides the power supply for the operating functions of all of the feed modules in a drive system.

Up to seven additional modules can be operated from this power supply via the equipment bus (e.g. one infeed/regenerative feedback module and seven feed modules). A monitoring module must be connected-up after the seventh module if additional modules are to be used.

The mechanical design is adapted to the SIMODRIVE 611 module family. The infeed/regenerative feedback modules are located as the first module to the left in the drive group.

The infeed/regenerative feedback modules are available in four ratings.

3.4.2 Design

The infeed and regenerative feedback modules are autonomous units in their own housing. They have mounting points on the back panel in a 50 mm grid.

Each module consists of a zinc-plated or painted sheet-metal housing with a plastic front panel. DC link jumper bars and supply voltage terminals for the auxiliary power supply are covered so that they cannot be touched. The complete module is protected against accidental contact in accordance with VBG4 and VDE0106.

The unit is operated and connected-up at the front. For standard operation, the module is connected to the line supply through power terminals. The screen connection distribution is realized using plug-terminals on the upper side of the module.

The module is cooled using a force-ventilated heatsink for the power electronics, located at the rear of the unit. The cubicle design must ensure that the air intake and discharge are not restricted. The open-loop control and electronic sections are cooled by self-convection up to the 22 kW infeed/regenerative feedback unit.

The infeed/regenerative feedback unit supplies the open-loop and closed-loop control of the axis modules as well as all of the module fans. Captive elements establish the connection between the axis modules and adjacent modules. Insertable standard jumper bars are used for the DC link and ground connection. Power supply distribution and signal transfer between modules is realized using a ribbon cable.

The user can code the plug-in terminals[1)] of the signal connections. This prevents leads from being interchanged in a module line-up. The connecting cables cannot be interchanged on the module itself due to the different pin numbers.

The infeed/regenerative feedback unit includes the necessary power contactor and the DC link pre-charging circuit.

Additional commutating reactors are required for operation. The commutating reactor is part of the function scope of the infeed/regenerative feedback module which is located externally. Only the types specified in Section 4 should be used. These must be separately mounted in a cubicle together with the semiconductor fuses.

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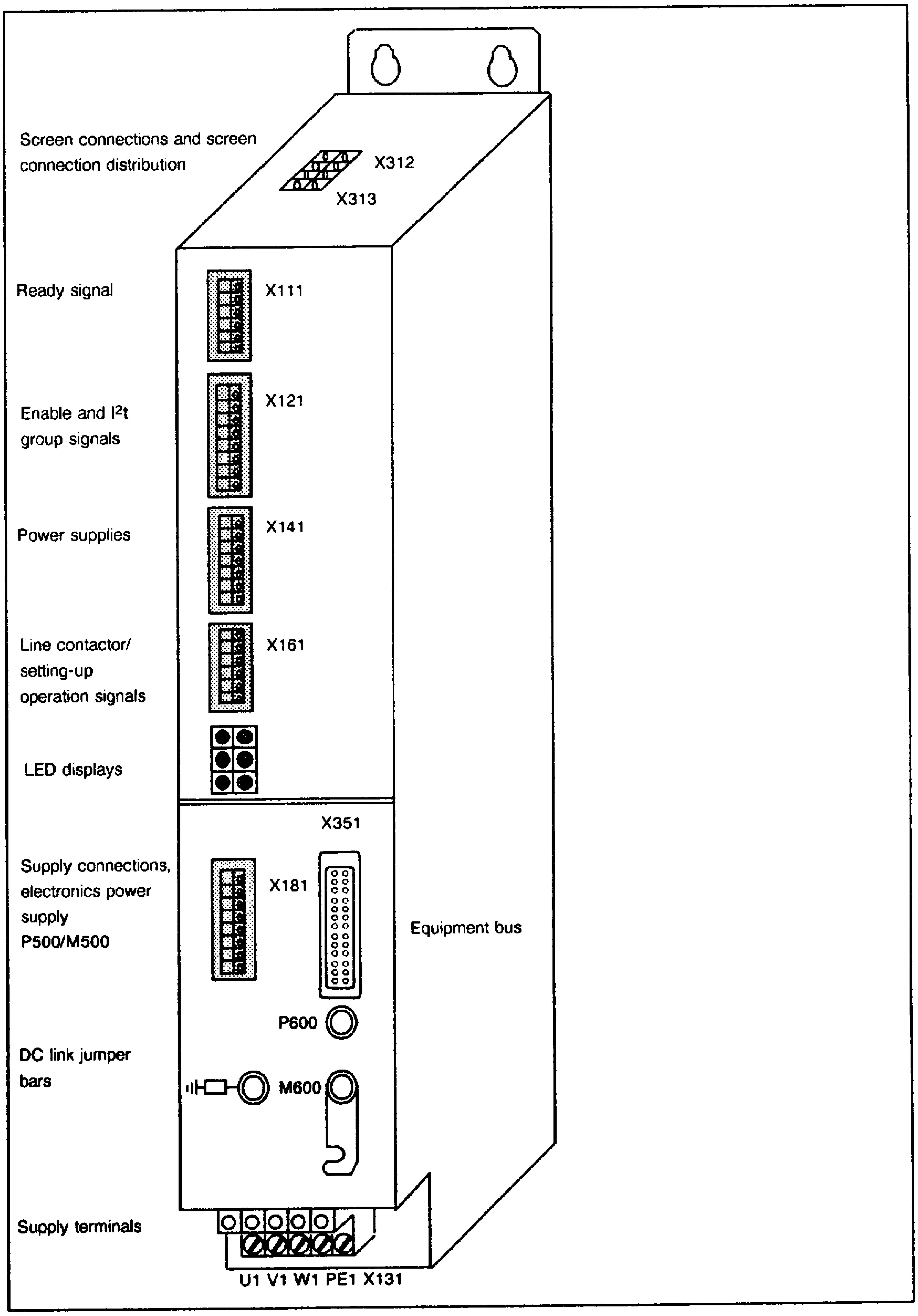
1) Coding elements are not included with the modules.



6SC611□-□VA01 infeed/regenerative feedback module (standard design)

3.4.3 Mode of operation

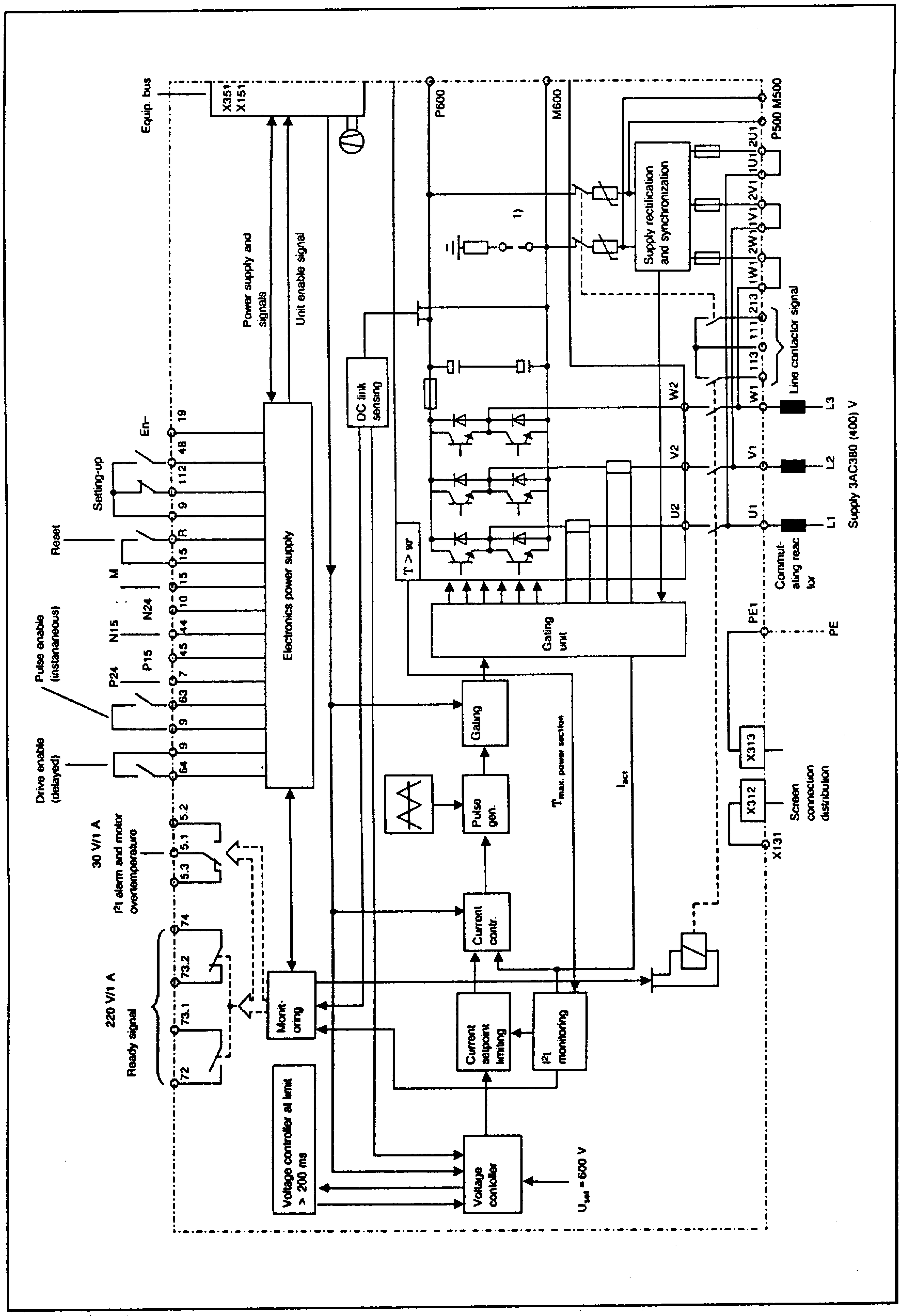
The infeed/regenerative feedback module supplies the controlled DC link voltage after the unit has been switched-on and the appropriate enable signals are available. It is not necessary to adjust the DC link control.

The module has an integrated inrush current limiting function and automatically controls the pre-charging sequence. When the pre-charging sequence has been completed, the integrated line contactor is energized. The DC link is then supplied via the free-wheeling diodes and has the same voltage amplitude as the rectified line voltage. The voltage controller is enabled and the DC link voltage controlled to 600 V if termnal 63 is energized.

The time between switching-in the pre-charging circuit until the statically controlled DC link voltage level is attained is dependent on the ratings and number of feed modules. This sequence is generally completed in less than one second for the majority of system configurations.

The infeed/regenerative feedback unit consists of the following function blocks:

- Commutating reactor (external)
- Power section for rectification and regenerative feedback
- Charge current limiting and power contactor
- DC link voltage control
- Power supply for the open- and closed-loop control and all module fans
- Central monitoring
- Enable circuitry
- Setting-up operation
- Screen connection distribution



Block diagram of the infeed/regenerative feedback module

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1) *Open when supplied*

3.4.3.1 Assignment of fuses and commutating reactors

Permissible fuses	7/14 kW	11/22 kW
Wickmann	35ET 35 A/660 V	45ET 380 V/45 A
Jean Müller	500 cüf1/35 A/660 V	500 cüf1/50 A/660 V
Bussmann	170L2013 40 A/660 V	170L2013 50 A/660 V
Siemens	5SD450 35 A/500 V 3NE8003 35 A/660 V	5SD460 50 A/500 V 3NE8017 50 A/660 V

Permissible fuses	22/44 kW	55/88 kW
Wickmann	90 ET 380 V/90 A	180 MT 180 A/660 V
Jean Müller	500 cüf1/100 A/660 V	500 cüf1/200 A/660 V M1cüf1/200 A/660 V
Bussmann	170L2017 100 A/660 V	170L2022 200 A/660 V
Siemens	5SD520 100 A/500 V 3NE8021 100 A/660 V	5SD 550 200 A/500 V 3NE8725 200A/660 V 3NE3225 200 A/1000 V

I/R module	7 kW	11 kW	22 kW	55 kW
Reactor	4 EP 3803-2DS	4EP 4003-8DS	4EP 4100-0DS[1]	4EU3081-2EA00

The commutating reactors must be externally mounted, and are used to limit the noise fed-back into the line (harmonics), and are also functional components of the step-up converter. The recommended fuses for cable and equipment protection must also be externally mounted.

3.4.3.2 Power section for rectifier and converter

The DC link supply infeed is realized using the combination of a 6-pulse, uncontrolled diode bridge and a controlled step-up converter. The ideal V_{DI} DC voltage is stepped-up to the rated value of 600 V using a chopper circuit. The commutating reactors are, in this case, used as energy storage devices. The step-up converter also provides sufficient control reserve for the 600 V DC link voltage, even for supply undervoltage conditions as specified in the data sheet.

For regenerative operation, the drive kinetic energy, fed-back into the DC link from the drive, is injected back into the line supply.

Matching transformers, either autotransformers or transformers with separate windings, must be provided for supplies which deviate from the specified 3-ph. 380 V AC (400 V). Refer to Section 5.14 for the specification of these transformers.

The line contactor is only enabled after the DC link voltage has reached a value exceeding 270 V.

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1) *Replacement type for 4EU 2481-4BA00 which is no longer available*

3.4.3.3 Enable signals

Various controller enable levels are available. The pulse enable (terminal 63) and the drive enable (terminal 64) act centrally on all PWM converter modules. Terminal 48 is provided as terminal for the start signal.

- **Pulse enable, terminal 63**

  This terminal has the highest priority. If a +24 V DC voltage (+12 V to +30 V) is applied to terminal +G0 -X121:63, the transistor pulses of all power sections in the infeed/regenerative feedback unit are enabled, and the feed modules pre-enabled. The enable and inhibit signals are instantaneous and act simultaneously on all modules. The drive coasts down to standstill when the signals are withdrawn. The step-up converter is enabled via this terminal. The DC link voltage is controlled to 600 V.

- **Drive enable, terminal 64**

  The feed modules are enabled if terminal 63 is enabled, and +24 V DC (+12 V to +30 V) is applied to terminal 64. The enable signal acts instantaneously and simultaneously on all modules.

  After the signal has been removed (voltage at terminal 64: < +4.5 V), the speed setpoint for all axes is set to zero, and after the axis-specific timer stages have expired (approx. 200 ms as standard) all controllers and pulses are inhibited.

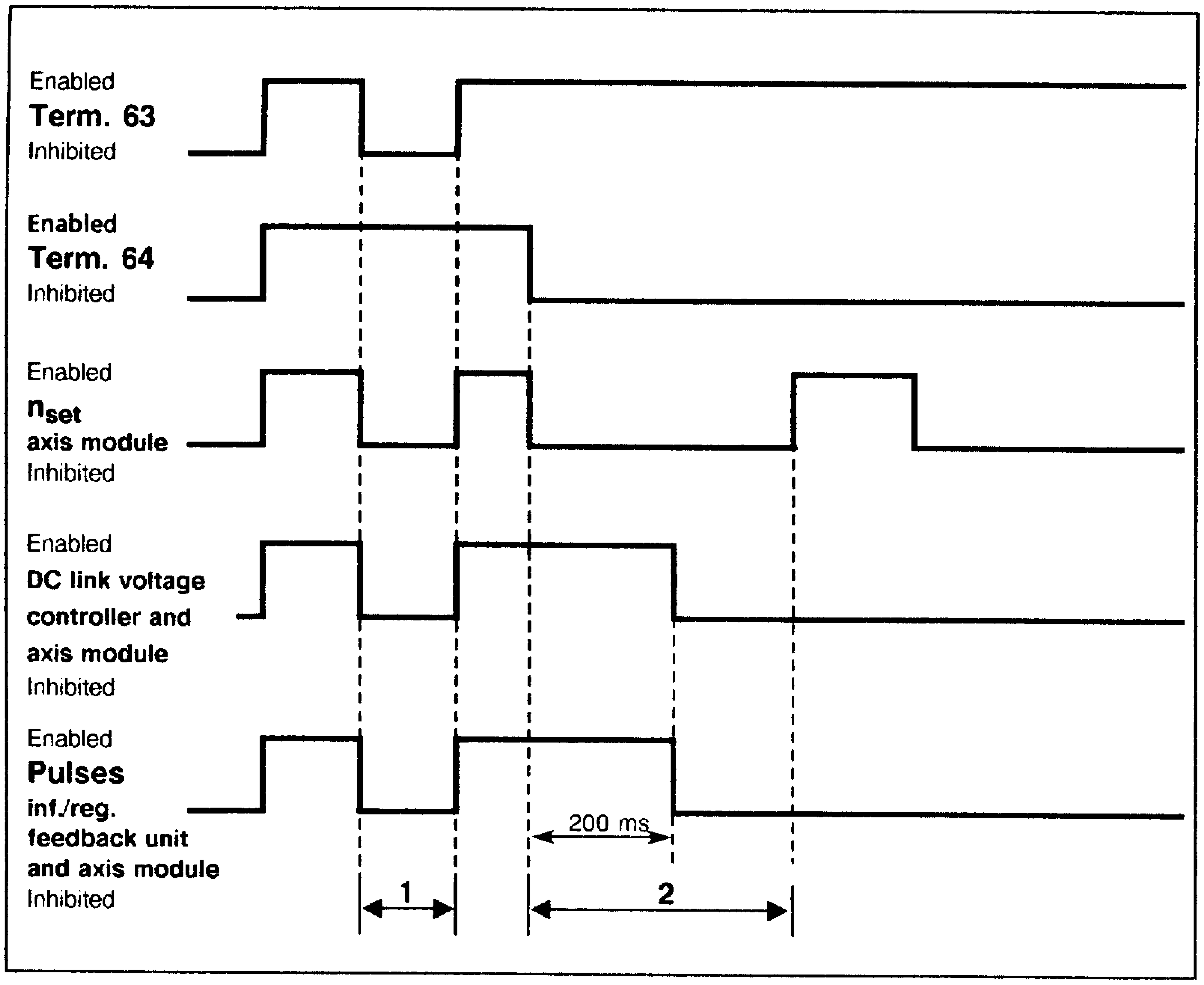
- **Start signal, terminal 48**

  A defined switch-on and switch-off sequence is initiated via terminal 48.

  If terminal 48 is used, terminals 63 and 64 can be directly connected to terminal 9. If terminal 48 is enabled, the pre-charging sequence is internally initiated.

  Once the DC link is charged, the line contactor is switched-in, and the internal enable signals output.

  If terminal 48 is de-energized, the internal enable signals are first inhibited and then the DC link is electrically isolated from the supply by opening the main contactor.



Enable signals for the infeed/regenerative feedback unit and basic module

1: Terminal 63 (pulse enable and step-up converter enable) is de-energized

All modules of the PWM converter are immediately inhibited and the drives coast down unbraked.

2: Terminal 64 is inhibited (preparatory drive enable signal).

All modules of the PWM converter are braked with $n_{set} = 0$, and inhibited after 200 ms.

The switch-on/switch-off sequence must not be observed if terminal 48 is used.

3.4.3.4 Mode of operation of the central monitoring and signals

Parameters, which are critical to operation, are monitored in the infeed/regenerative feedback module

- DC link voltage
- Controller power supply (± 15 V level)
- 5 V voltage levels
- Supply undervoltage and supply phase failure.

The internal prerequiisites for the unit ready signal are avaialble if all of these parameters are within the permissible operating range. The DC link voltage control is enabled as soon as the external enable signal is available via terminal 63 (pulse enable). The group signal energizes the "ready" relay after terminal 64 (drive enable) has been activated. The signal is available, floating, at terminals 72/73.2 and 73.1/74. The contact ratings are 1A 250 V AC or 1A 30 V DC.

- **Ready signal**

  The ready relay is energized at terminals 72 to 74 of connector X11 on the infeed/regenerative feedback or monitoring module, if the following conditions are fulfilled:
  - The internal initializing pulse has expired
  - There are no fault signals present on the monitoring - or infeed/regenerative feedback module
  - Terminals 63 and 64 of connector X121 and terminal 48 or connector X161 are energized

  With the exception of a supply fault, the ready signal is effective for all connected axes. If a supply fault occurs, the pulses in the infeed/regenerative feedback module are inhibited.

- **I^2t alarm and motor overtemperature signals**

  If any axis has an overload condition, including the infeed/regenerative feedback module (current setpoint is reduced approximately 200 ms later), the connected motor develops an overtemperature condition or the heatsink monitoring responds (feed module or infeed/regenerative feedback module), a group signal is output for all axes via terminals 5.1 to 5.3 of connector X121.

  The signal itself only has an effect in the equipment, if the heatsink monitoring has responded. In this case, the current setpoint of the applicable module is immediately reduced to 6%. If the alarm is issued because the current setpoint of a particular axis is reduced to the I^2t characteristic, the axis must not be shutdown (speed controller at limit) if the power at the machine is reduced.

- **"Contactor ON" signal**

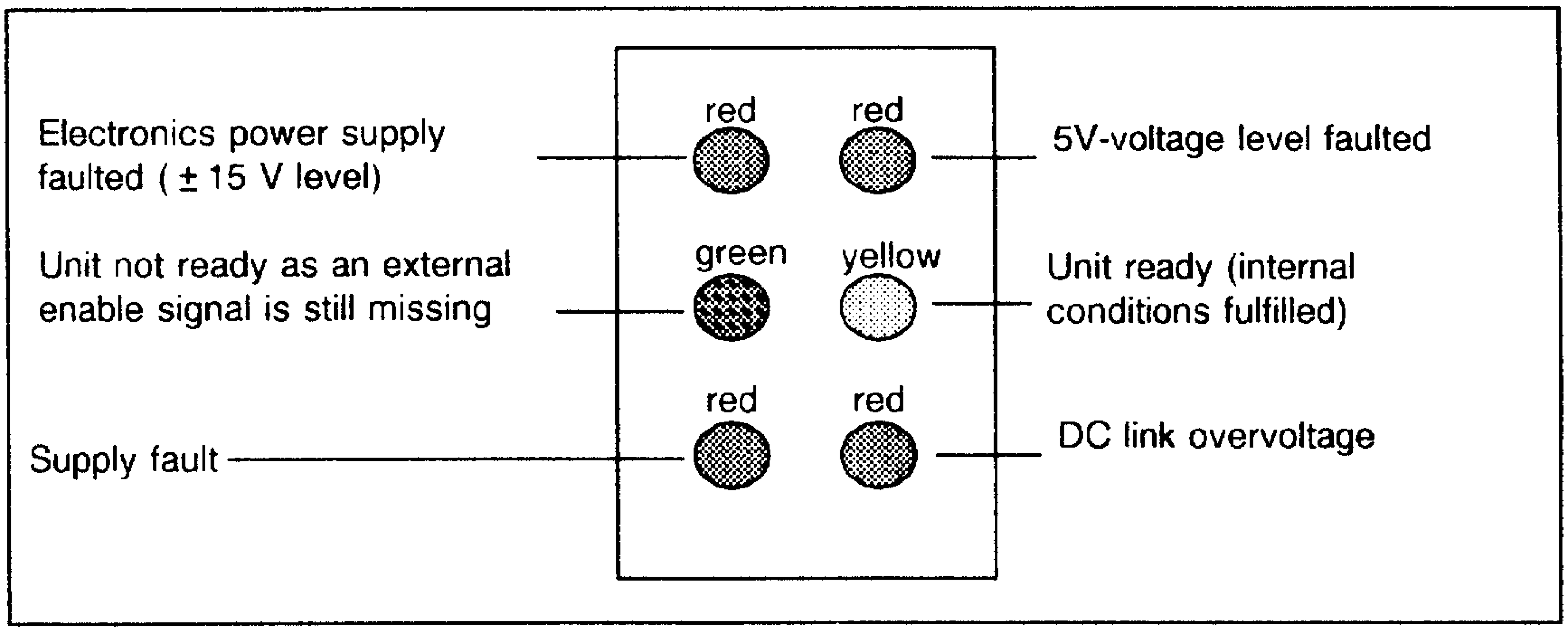
  The integrated line contactor[1)] has a signal contact fed-out through terminals 111 and 113 of connector X161. A signal is output via these terminals when the pre-charging sequence has been completed and the contactor has pulled-in.

  Condition: Setting-up operation has not been selected.

  The signal contact of the pre-charging contactor is fed-out via terminals 213 (from infeed/regenerative feedback module, version .01) of connector X161, and signals when the contactor has pulled-in and the DC link is being charged (pulse inhibit).

1) *As far as safety is concerned, when engineering the drive it should be carefully considerd as to whether this contactor, driven electronically, provides sufficient electrical isolation according to EN60204. If required, an additional, appropriately dimensioned line contactor should be connected in series (refer to Section 3.4.6 Technical data).*

The signal statuses of the monitoring circuits are displayed using LEDs on the front panel of the infeed/regenerative feedback module. The LEDs are lit, or the ready LED goes dark, when the specified signal statuses are reached.



Infeed/regenerative feedback module LED displays

- **Fault signal storage**

  If the auxiliary power supply is operated independently from the power infeed from a fail-safe supply network, it is possible to store the fault signals in the unit. In order that the charging current limiting function can be simultaneously used, the setting-up function must be energized using terminal 112, depending on the condition of the supply. The charging circuit must be isolated from the DC link in the infeed/regenerative feedback module when the supply network fails. This is achieved by opening terminal 112 in the setting-up mode. When the supply returns, terminal 112 must be connected to terminal 9 (P24). The DC link is then pre-charged as standard. The power infeed and auxiliary power supply must be connected-up with the same phase sequence.

  In this mode, the jumpers at X181 must be removed!

3.4.4 Calculating the infeed power

3.4.4.1 Dimensioning the continuous infeed power

The necessary continuous infeed power can be calculated using the following chart if precise machine data is not available. If the precise speeds and coincidence factors of the machine are known, these should be included in the calculation.

Number of feed axes per range	1	2	3	4	5	6
Coincidence factor per range (K_I. K_{II}. K_{III})	1	0.63	0.5	0.38	0.33	0.28

Range for P_{calc} 1)	Axis desig.	Motor Order No. with all options	n_{rated} RPM	M_0 Nm	I_0 A	I_{rated} (module) A	P_{calc} 1) kW	$\frac{n}{n_{rated}}$	$P_{calc} \cdot \frac{n}{n_{rated}}$ kW	
Range I ≤ 1.8 kW	1									
	2									
	3									
	4									
	5									
	6									
							Total for range I: P_I =			$\cdot K_I$ [ ] = [ ]
Range II 1.8 kW to 8.8 kW	1									
	2									
	3									
	4									
	5									
	6									
							Total for range II: P_{II} =			$\cdot K_{II}$ [ ] = [ ]
Range III ≥ 8.8 kW	1									
	2									
	3									
	4									
	5									
	6									
							Total for range III: P_{III} =			$\cdot K_{III}$ [ ] = [ ]

Overall total for ranges I. II. III	$P_I + P_{II} + P_{III} = P$	
DC link power:	$1.1 \cdot P = P_Z$ in kW	

The infeed circuit must be able to provide the calculated continuous power. The required peak power can also be supplied when all axes have a maximum overload factor of 1:2. If the peak power is not sufficient due to the machine duty cycle, a pulsed resistor module must be included for the dynamic regenerative peak powers, a setpoint ramp used for braking, or the infeed power increased.

An axis used as main spindle should have its own range when calculating the DC link power.

1) $P_{calc} = 0.105 \cdot M_0 \cdot n_{rated} \cdot 10^{-3}$ [kW]

3.4.4.2 Dimensioning the peak regenerative power

The expected peak regenerative power is calculated using the following formula:

$P_{calc\,II}$: $K1 \cdot V_{DC\ link} \cdot I_{max} \cdot n/n_{rated}$

$K1$: Adaption factor takes into account the efficiency and the ratio $EMF/V_{DC\ link}$ (0.6)
I_{max} : Peak current set at the axis
$V_{DC\ link}$: DC link voltage (600 V)
n/n_{rated} : Maximum axis velocity referred to the motor rated speed.

$\Sigma P_{calc\,II}$ should be calculated for all axes which are simultaneously braked. This calculated power must be less than the infeed/regenerative unit peak power which is available:

6SC6110-7VA01 = 14 kW
6SC6111-1VA00/01 = 22 kW
6SC6112-2VA00/01 = 44 kW
6SC6115-5VA01 = 88 kW

3.4.4.3 Checking the permissible power supply rating

The power supply in the infeed/regenerative feedback unit and monitoring module is dimensioned for a power which is determined according to the following table. The number of all the modules should be entered and the evaluation factor of the individual modules multiplied by the number of modules. In both ranges, the total of the products must not exceed 8 or 11[1].

Module	Electronics			Power section		
	Eval. factor, individual module	Number of modules	Product	Eval. factor, individual module	Number of modules	Product
3/6 A	1			0.7		
6/12 A	1			0.7		
12/24 A	1			0.7		
20/40 A	1			1		
40/80 A	1			2		
60/120 A	1			3		
80/160 A	1			3.5		
7/14 kW	0.5			1		
11/22 kW	0.5			1.5		
22/44 kW	0.5			3		
55/88 kW	0.5			6		
Option	0.5			–		
Main spindle						
5/7 A	0.5			3.5		
15/20 A	0.5			4.0		
24/32 A	0.5			5.0		
30/40 A	0.5			5.5		
45/60 A	0.5			7.0		
60/80 A	0.5			8.5		
Pulsed resistor	–			–		
		Sum of the products **max. 8**			Sum of the products **max. 11**[1]	

1) *For infeed/regenerative feedback unit and monitoring module, version .01: maximum sum of the products is 17 (exception: the infeed/regenerative feedback modules 6SC6110-7VA01 and 6SC6111-1VA01 have 13 power section points)*

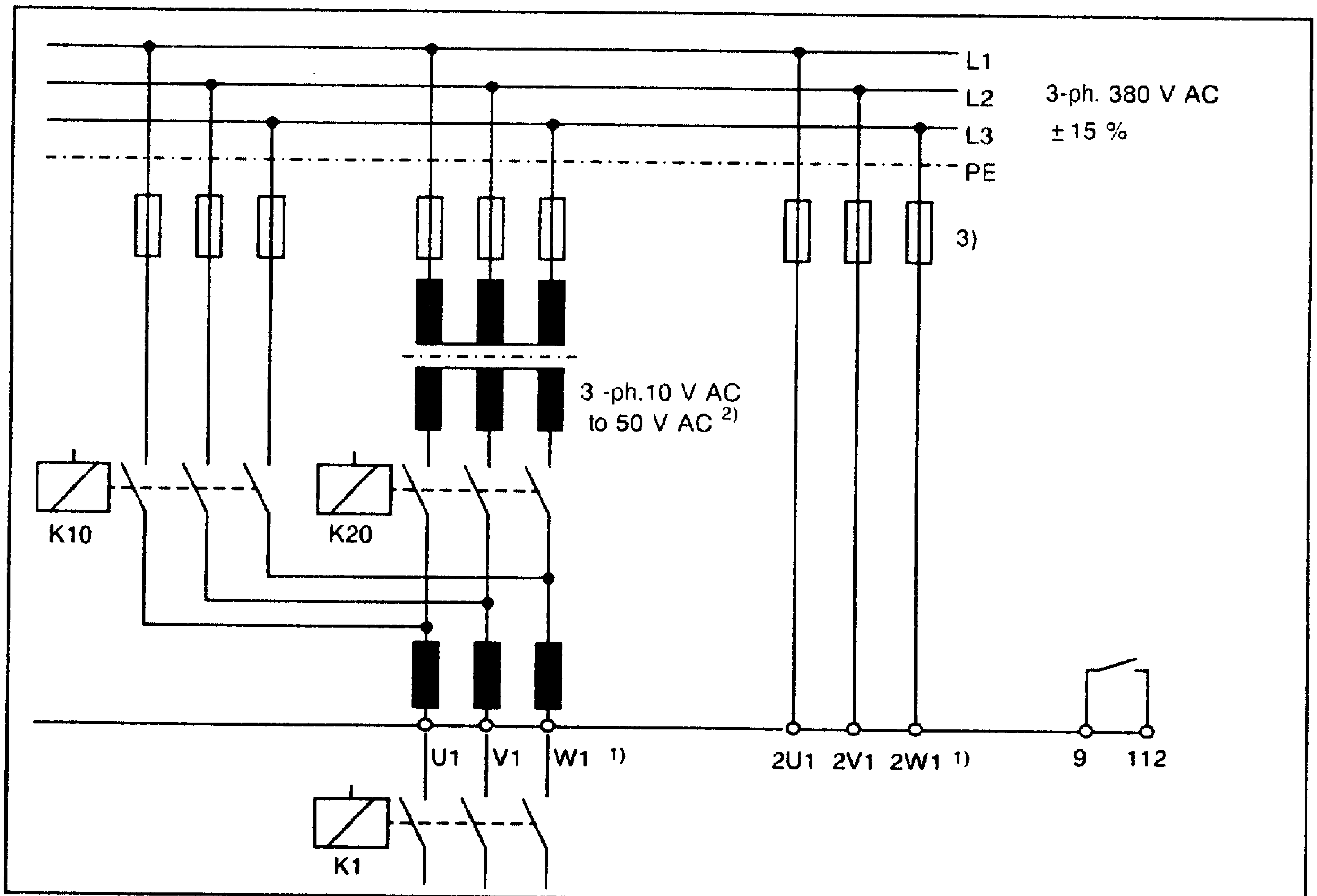
3.4.5 Engineering notes for setting-up/supply buffering

3.4.5.1 Reduced velocity (setting-up operation)[4]

Terminal 112 of connector X161 on the infeed/regenerative feedback module is provided for the "reduced velocity" operating mode (VDI 2853, Section Part 3.1.2.1.1). Under normal operating conditions, it must be continuously energized (terminal 9) and controls the DC link pre-charging.

If the axes are to be operated with a reduced DC link voltage, terminal 112 must be disconnected. The electronics power supply must be maintained via connector X181 and the reduced AC voltage (e.g. 3-ph. 15 V AC) can be connected at the main terminals U1, V1, W1. The internal pre-charging contactor is then energized at supply ON after the power supply voltages have been established, and the DC link is immediately pre-charged through the transistor module free-wheeling diodes. The "K1 ON" signal (terminal 111/113) ensures that this operating point has actually been reached, and this checkback signal is used in the higher-level open-loop control. The supply voltage, connected at connector X181, is internally isolated from the DC link using a contactor. The "speed controller at limit" monitoring function is disabled for all axes. The infeed/regenerative feedback unit voltage controller remains inhibited. Simultaneously, the maximum current setpoint of the axes is internally limited to 6%. The required maximum current setpoint should be set using resistor R12 according to the characteristic in the diagram, refer to Section 3.2.3.3.

- When an isolating transformer is used, the system must be grounded as described under Section 3.9.2, i.e. M600 must be connected with ground potential via the bus link on the infeed/regenerative feedback unit.



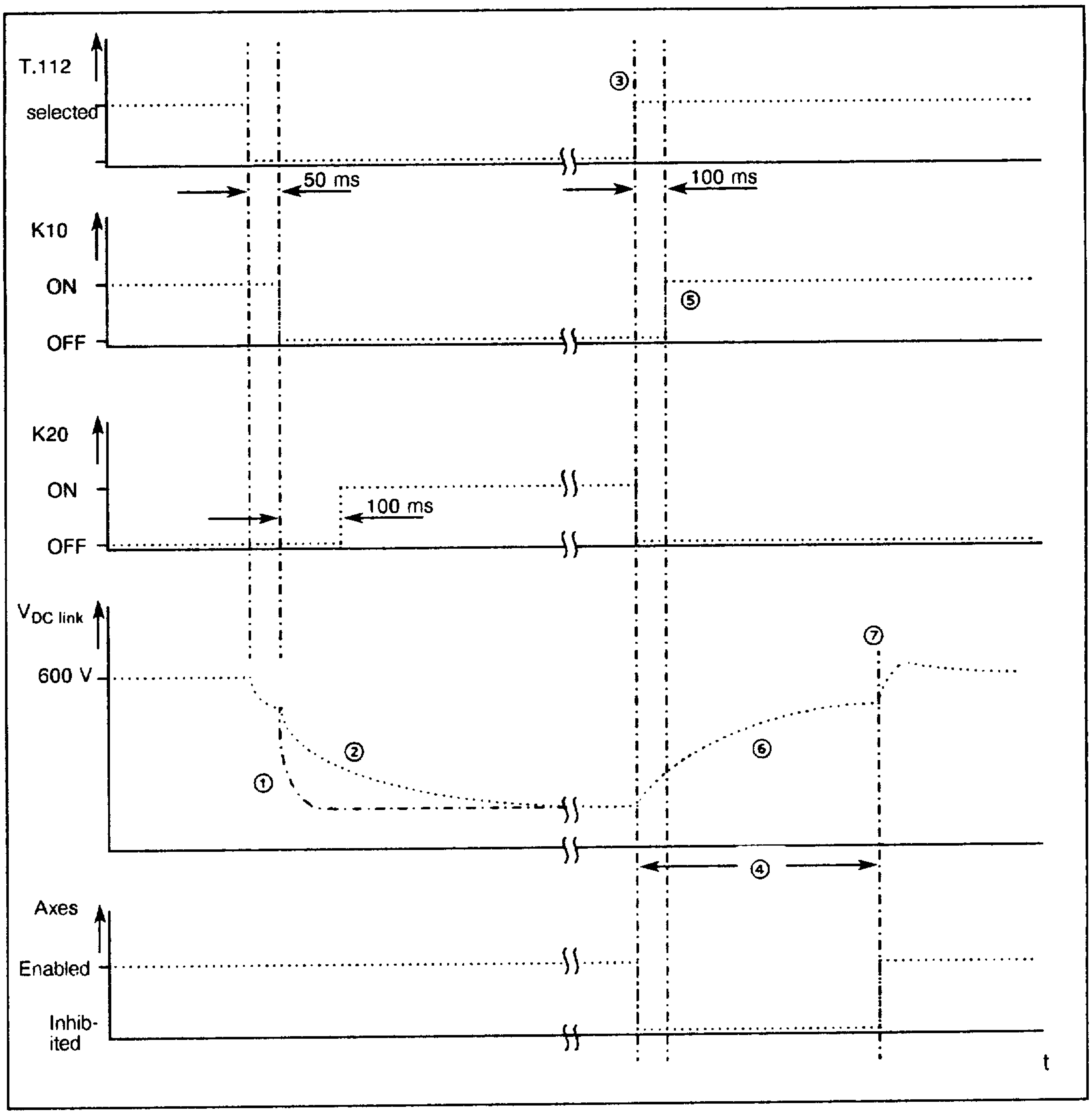
Recommended connection

1) *Ensure the same phase sequence. For infeed/regenerative feedback units, version .01, the phase sequence is of no importance*

2) *Autotransformer or available DC voltage (e.g. 24 V) possible*

3) *6.3 A, slow-acting*

4) *With respect to machine safety, it should be carefully considered whether additional appropriate monitoring methods are necessary to reliably limit the setting-up speed range.*



Enable signal timing for setting-up operation

① Fast discharge using a pulsed resistor module possible (terminal 50)
② DC link discharge time approximately 4 min. without power drawn (axes inhibited)
③ Internal contactor drops-out (K1)
④ DC link charged through the integrated pre-charging circuit
⑤ Not permissible that K10 is energized as long as terminal 112 is not energized.
⑥ DC link charging time dependent on the degree of expansion <1 s
⑦ Internal contactor is switched-in (K1)

3.4.5.2 Maintaining the power supply during supply failures (from infeed/regenerative feedback unit and monitoring module, version .01)

It is possible to maintain the power supply, even when the external supply fails, through terminals P500, M500. To realize this, an electrical connection must be established between P600 and P500 and M600 and M500.[1)]

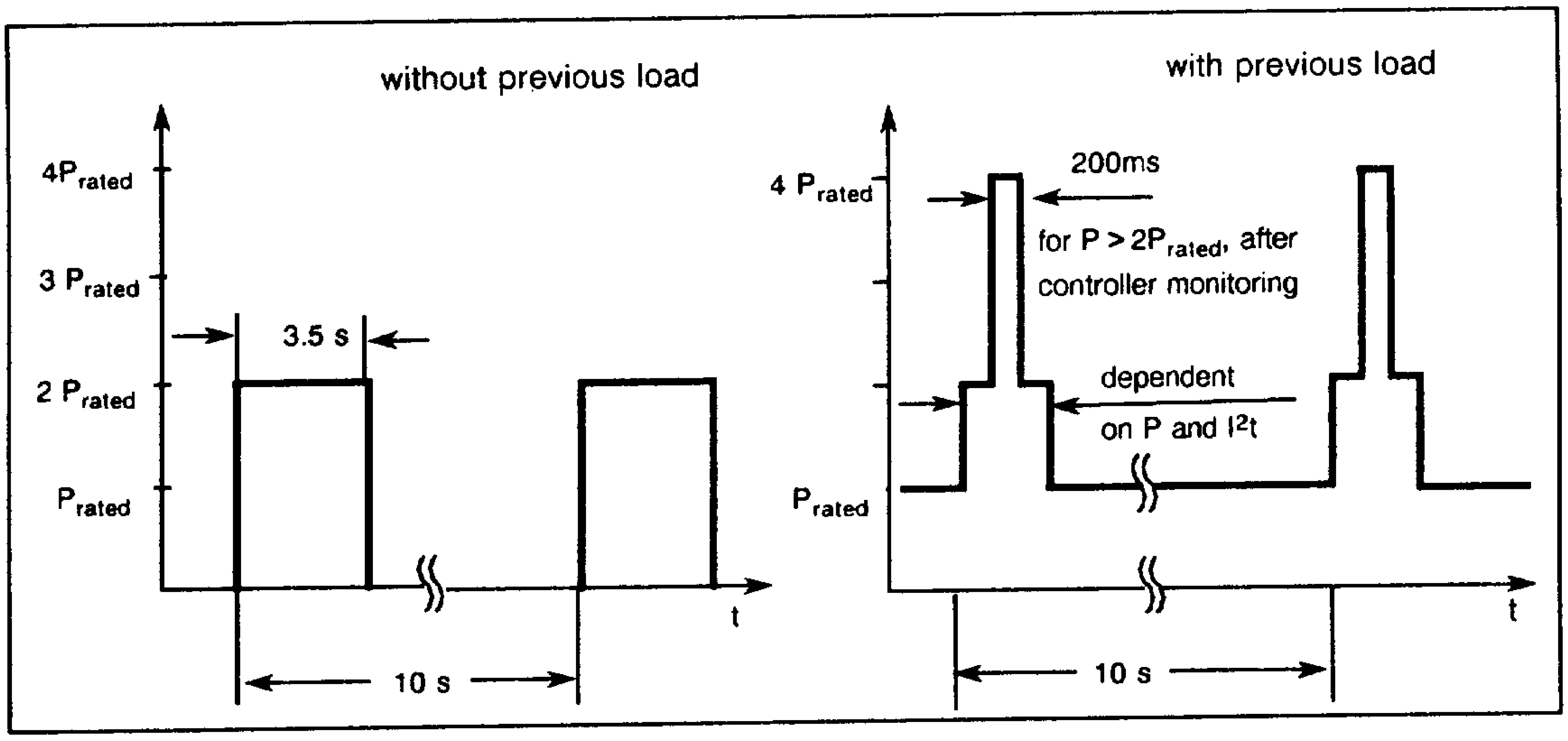
When the supply fails, the power supply is taken from the DC link, as long as the DC link voltage is above 200 V. This time can be used to return the axes, as the supply fault only influences the infeed unit. The duration and type of the possible return travel is a function of the energy stored in the DC link as well as the kinetic energy of the individual axes which can be used as a result of braking. In any case, the power supply rating of approximately 350 V A in the DC link must be available so that operation is at all possible. Please note, that regenerative feedback is no longer possible, and it might be necessary to use a pulsed resistor module, to prevent a DC link overvoltage condition which would lead to a fault trip.

1) *As far as safety is concerned for normal operating conditions, careful consideration should be given as this connection could possibly represent a bypass to the supply contactor so that electrical isolation is no longer guaranteed. If required, fail-safe isolation should be incorporated in this circuit.*

3.4.6 Technical data

Order No.	6SC6110-7VA01	6SC6111-1VA00/01	6SC6112-2VA00/01	6SC6115-5VA01
Supply voltage	3-ph. 380 V AC (−15 %) 3-ph. 400 V AC (+10 %)			
Rated frequency	50...60 Hz ±2.5 Hz			
Rated infeed power	7 kW	11 kW	22 kW	55 kW
Supply current (at rated supply voltage)	11 A	17 A	34 A	85 A
Incoming fuse trip I^2t at 400 V AC	35 A $I^2t \leq 400\ A^2s$	40 A $I^2t \leq 600\ A^2s$	80 A $I^2t \leq 5000\ A^2s$	200 A $I^2t \leq 22000\ A^2s$
Output voltage	600 V DC			
Output current	11.5/23 A	18/36 A	36/72 A	90/144 A
Efficiency during rated operation	approx. 95 %			
Power loss	150 W	230 W	510 W	1400 W
Cooling type	Forced ventilation	Forced ventilation	Forced ventilation	Forced ventilation
Weight	10 kg	13 kg	17 kg	30 kg
Connecting cross-section acc. to VDE 0113	2.5 mm^2	4 mm^2	16 mm^2	50 mm^2
Recommended line contactor [1)]	3TB41	3TB43	3TB46	3TB48

Rated duty cycle for infeeds with a short-time limiting power:

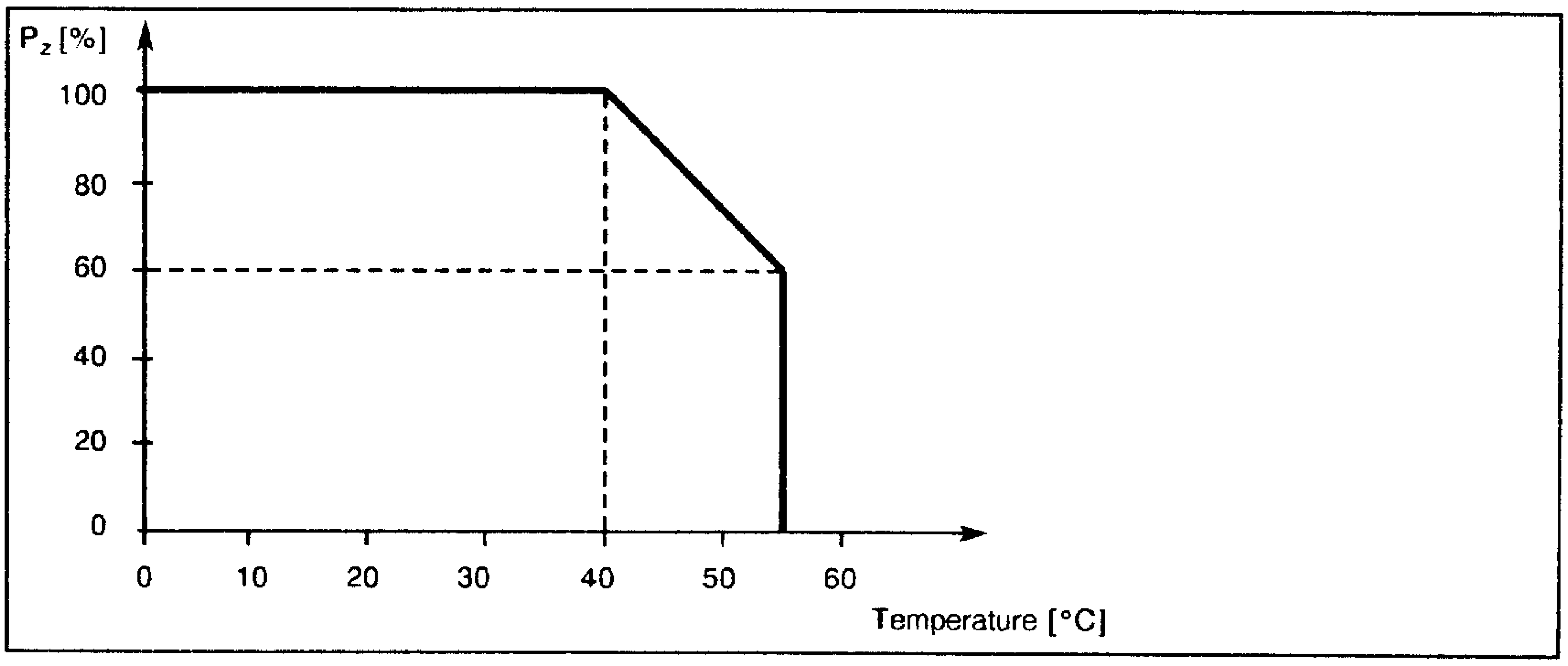


Continuous regenerative power	7 kW	11 kW	22 kW	55 kW
Peak regenerative power	14 kW	22 kW	44 kW	88 kW

1) *If required due to the control specifications (refer to Section 3.4.3.4)*

Permissible ambient temperature In operation	0 °C to 40 °C (up to 55 °C with de-rating)
During transport and storage	–25 °C to 85 °C

De-rating at increased air intake temperature:

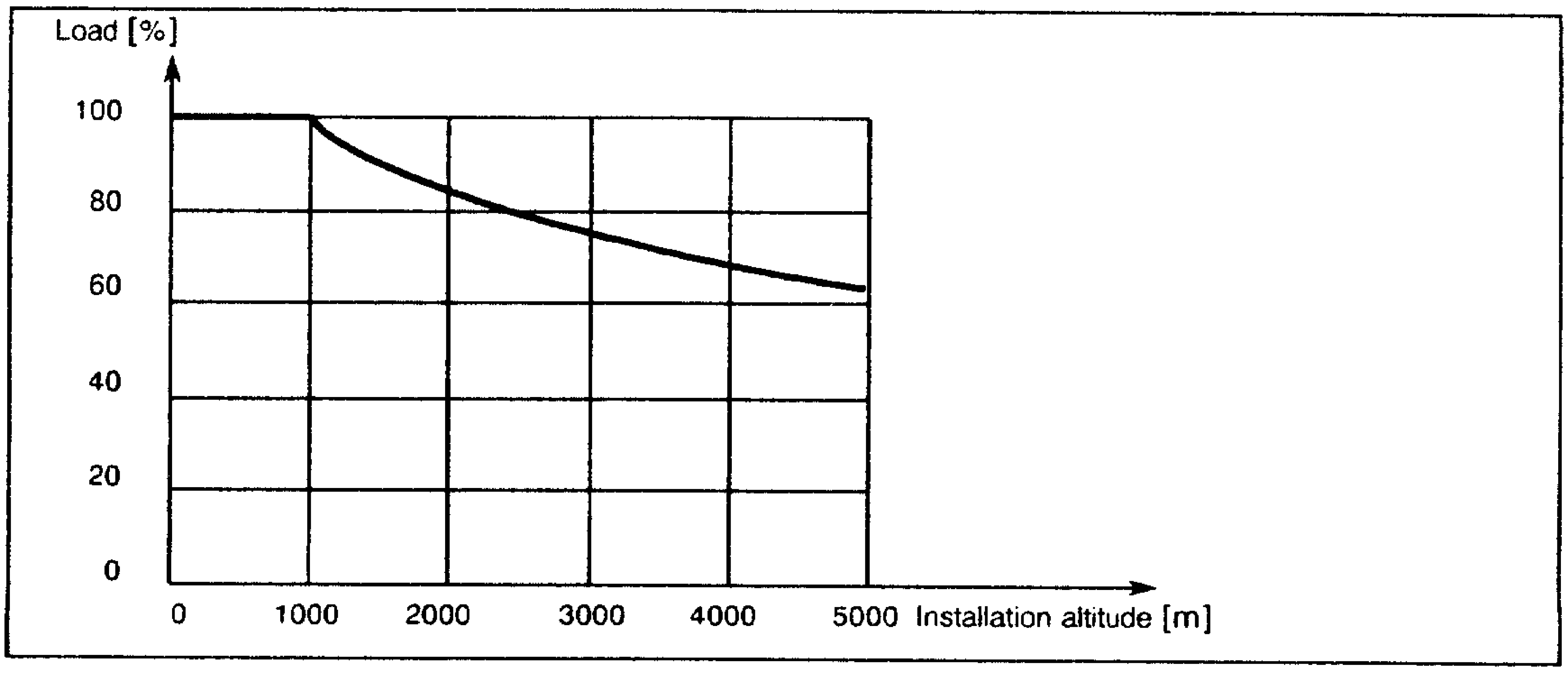


Duration of the supply interruption acc. to VDE 0160

Insulation	Group C acc. to DIN VDE 0110/11.72380 V
High-voltage test	Units are tested acc. to VDE 0160/5.88
Degree of protection	IP 00 acc. to DIN 40050 and IEC 144
Permissible relative humidity	Class F acc. to DIN 40040 Annual mean value ≤75 % 30 days continuously per year 95 % Occassionally on remaining days 85 %

Installation altitude

The specified values for the rated- and limiting DC current refer to installation altitudes up to 1000 m above sea level. The converters must be de-rated for installation altitudes above 1000 m.



3.4.7 Type designation

6	S	C	6	1	1	.	–	.	V	A	0	1

Rated infeed power

0-7 = 7 kW
1-1 = 11 kW
2-2 = 22 kW
5-5 = 55 kW

Type

A = Standard type

Version

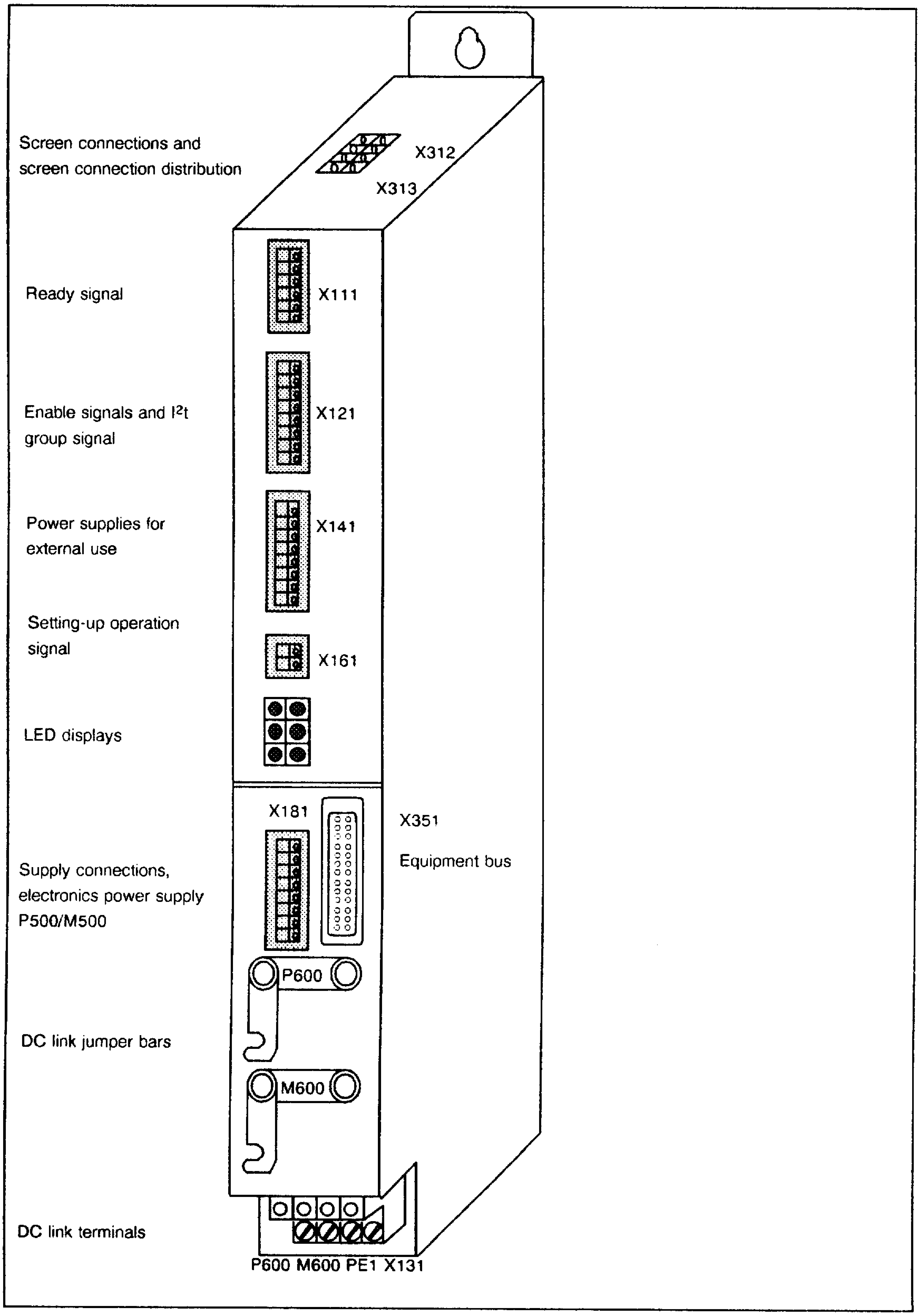
3.5 Monitoring module

3.5.1 System integration

The monitoring module is a base module and includes the electronics power supply and the central monitoring functions which are necessary for feed module operation. The monitoring module is always required if more than seven modules are operated in a group, or if the DC link is to be connected to a SIMODRIVE 650/660 main spindle drive.
The mechanical design is harmonized with the SIMODRIVE 611 module group. A maximum of eight additional feed-main spindle [1] or induction motor modules [1] can be connected to the right of a monitoring module, depending on the power supply rating requirement (electronic points and gating points).

1) *refer to dedicated Description 6ZB5 420-0AJ02-0BA2*

3.5.2 Design



6SC6110-0GA01 monitoring module

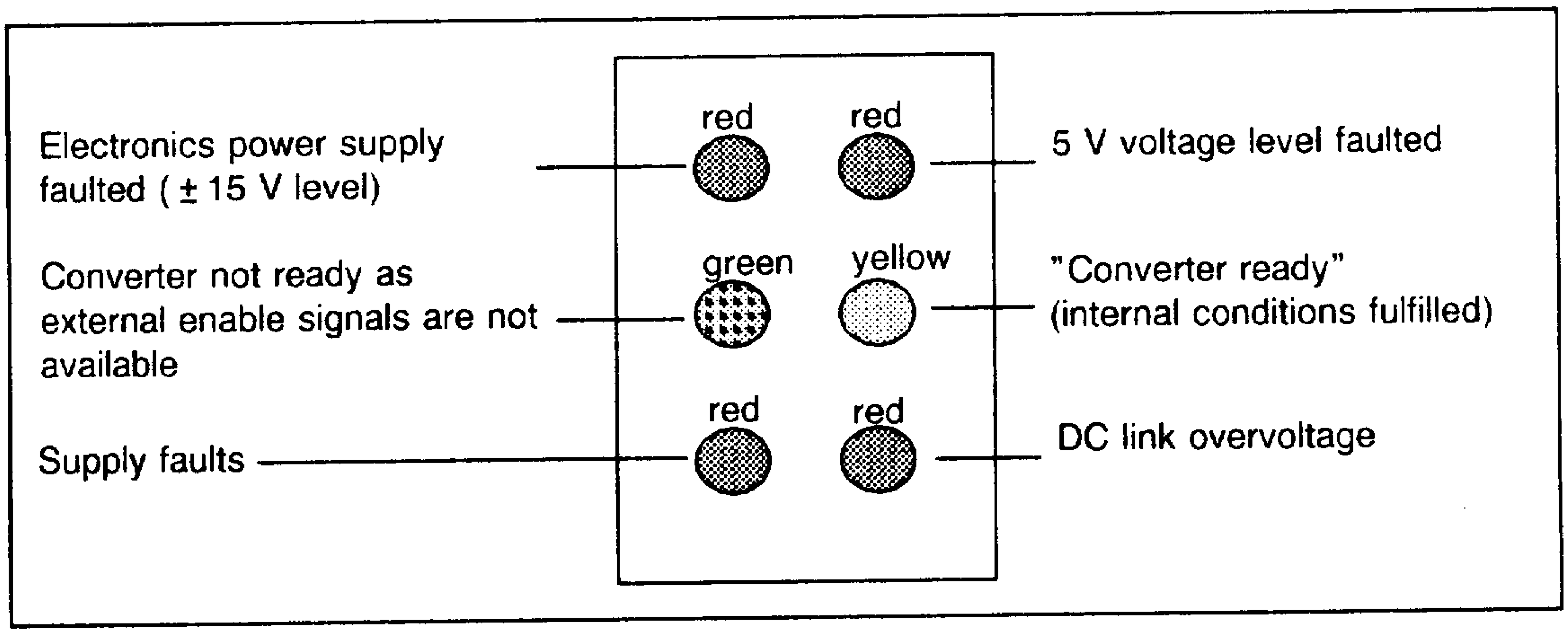
3.5.3 Mode of operation

Parameters, critical to operation, are monitored in the monitoring module

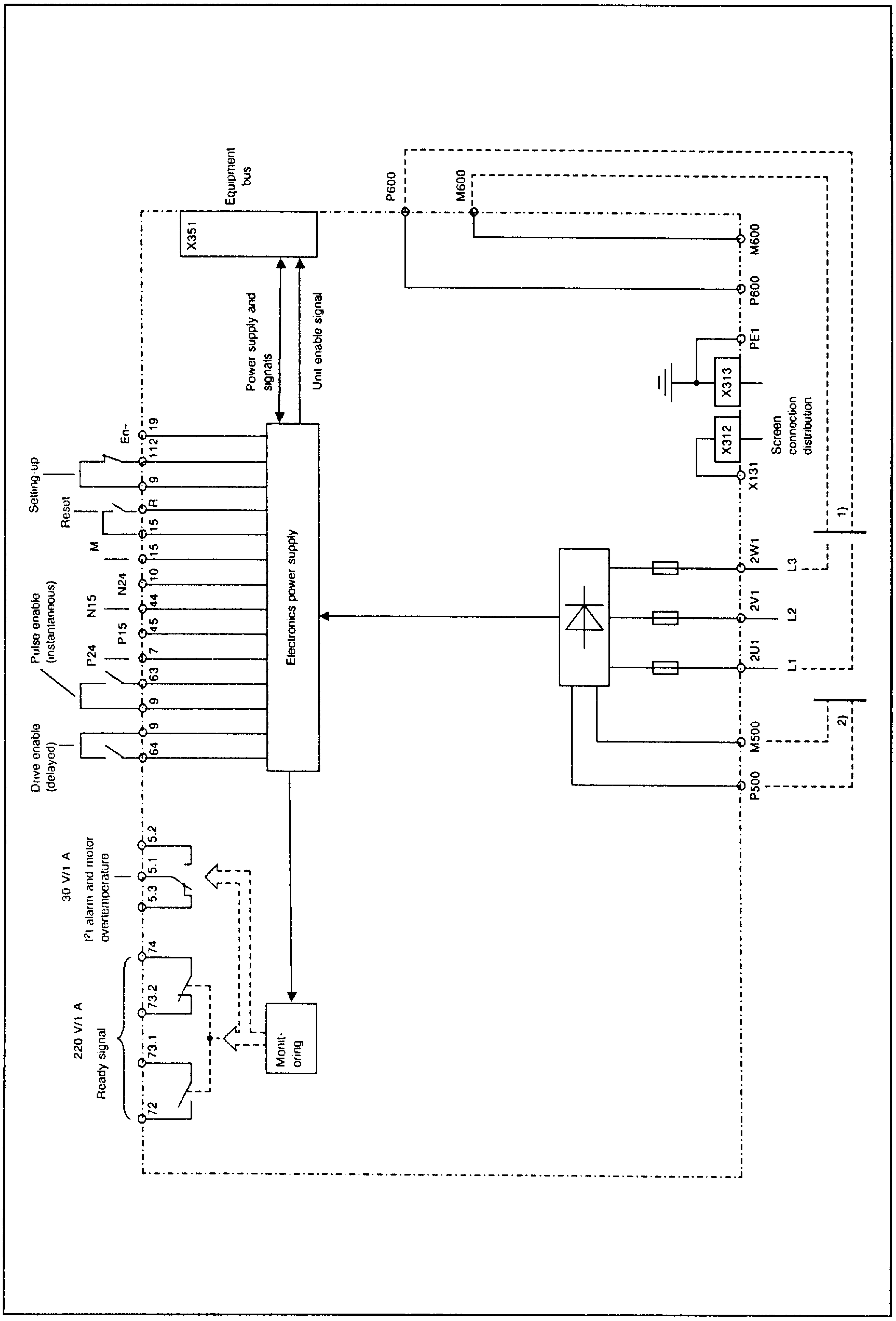
- DC link voltage
- Controller power supply (± 15 V level)
- 5 V voltage level
- Supply undervoltage and supply phase failure

The internal prerequisites for the "converter ready" signal are available if the parameters are within the permissible operating range. The monitoring unit is enabled, as soon as the external enable signals have been issued via terminals 63 (pulse enable) and 64 (drive enable). The group signal energizes the "ready" relay, and is available, floating, via terminals 72/73.2 and 73.1/74. The contact load capability is 1A 250 V AC or 1A 30 V DC. The feed modules are simultaneously enabled.

The monitoring circuit signal statuses are displayed on LEDs on the monitoring module front panel. The LEDs are lit when the specified signal statuses have been reached.



LED displays of the monitoring module



Block diagram of the monitoring module

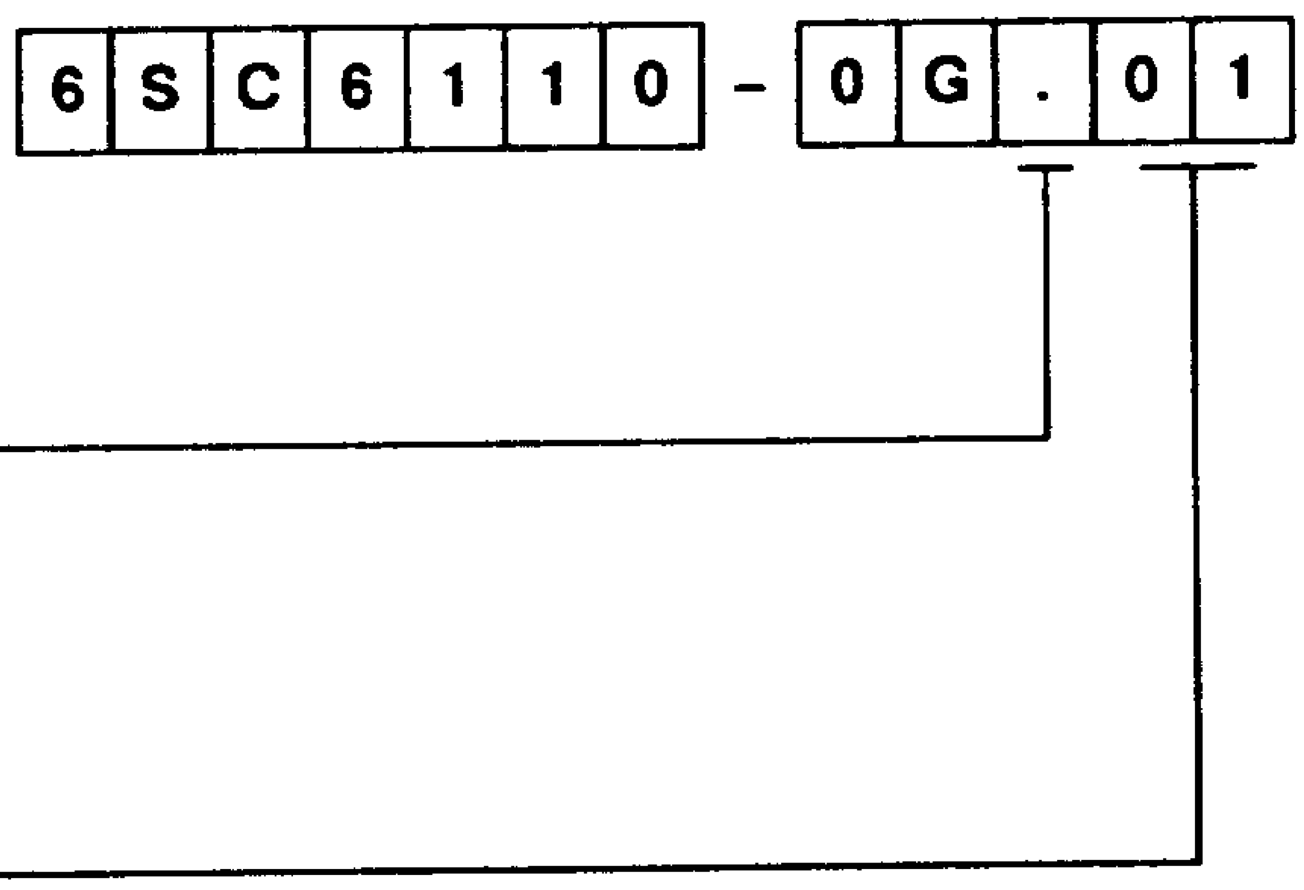
---

1) Alternative operational infeed from the DC link
2) Infeed, which is only effective during supply failure

3.5.4 Technical data

Type	6SC6110-0GA00
Rated supply voltage (2U1, 2V1, 2W1)	3-ph. 380 V AC –15 %...3-ph. 400 V AC + 10 %
Rated frequency	50...60 Hz ±5 Hz
Alternatively, rated DC link supply voltage	600 V DC
Power loss	70 W
Cooling	Self-cooled
Permissible ambient temperature in operation during transport and storage	 0 °C...40 °C –25 °C...85 °C
Insulation	Group C acc. to DIN VDE 0110/11.72 380 V
High-voltage test	Converters are tested acc. to VDE 0160/5.88
Degree of protection	IP 00 acc. to DIN 40050 and IEC 144
Permissible relative humidity	Class F acc. to DIN 40040 Annual mean value ≤75 % 30 days continuously per year 95 % Occassionally on remaining days 85 %
Weight	4 kg

3.5.5 Type designation



Basic module version

A = Monitoring module

B = Pulsed resistor module

Version

3.6 Pulsed resistor module

3.6.1 System integration

The pulsed resistor module is used to limit the DC link voltage. DC link energy which is not fed back into the line supply is converted into heat using this module. The pulsed resistor module is required to reduce the short-term DC link voltage spikes occuring in the thyristor converter dead time when the feed axes are operated on a DC link from the SIMODRIVE 650/660 main spindle converter.

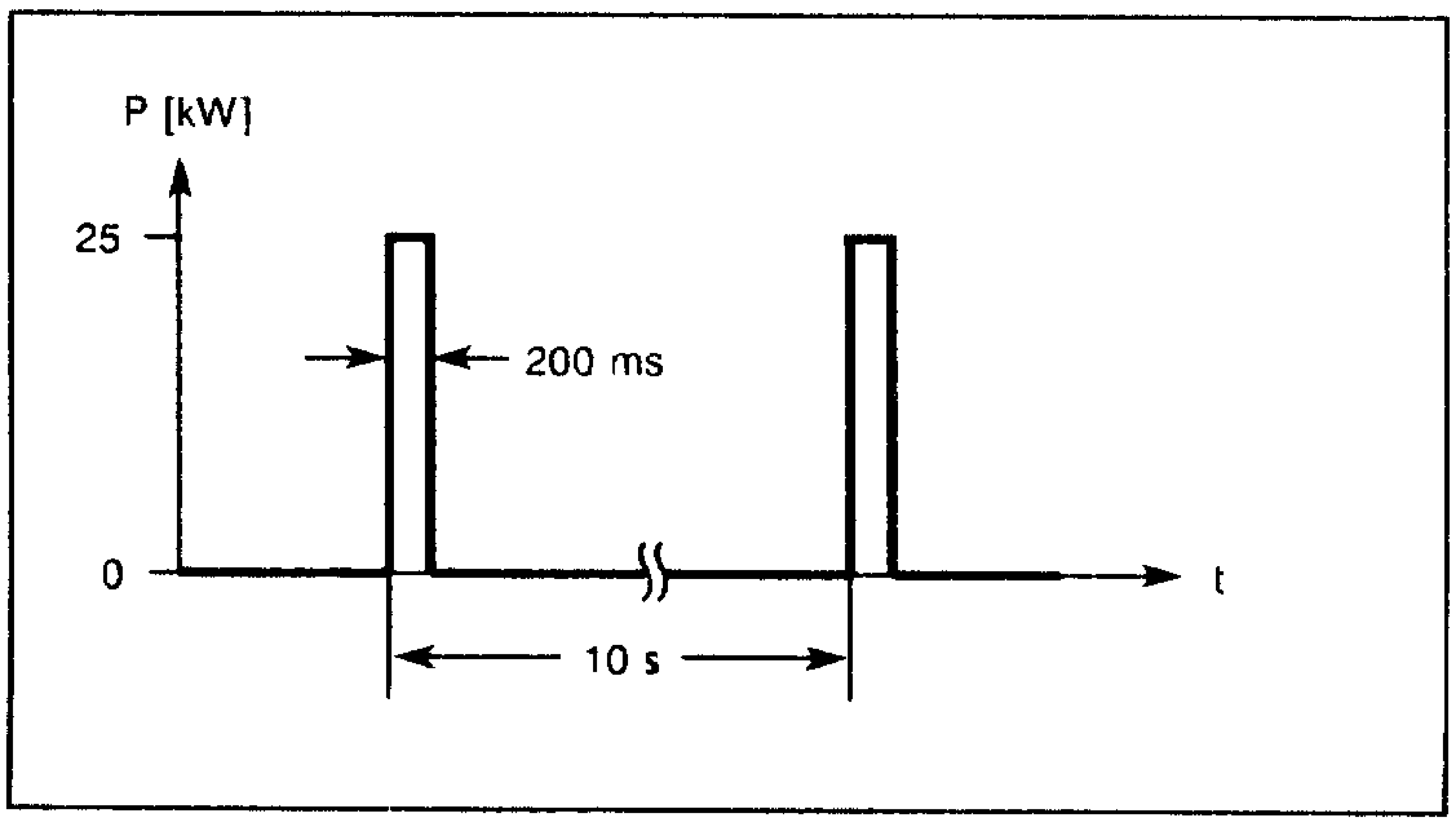
The drive can be run down in a controlled fashion until the monitoring voltage limits have been attained even when line voltage failures occur. However, in this case, an infeed/regenerative feedback module, version 6SC611□-□VA01 or an additional monitoring module is required where the auxiliary power supply is derived from the energy stored in the DC link.

For infeed/regenerative feedback module 6SC611□-□VA01, refer to Section 3.4.5.2 for the arrangement of terminals P500/M500.

For the monitoring module 6SC6110-0GA01, terminals 2U1 and 2W1 are connected to the DC link power connection.

The pulsed resistor is incorporated in the module. An external resistor can also be used, which must be mounted at a position in the cubicle which is not sensitive to heat. In this case, the jumper at terminals R1/R2 should be opened and an external resistor connected to terminals R1 /R3.

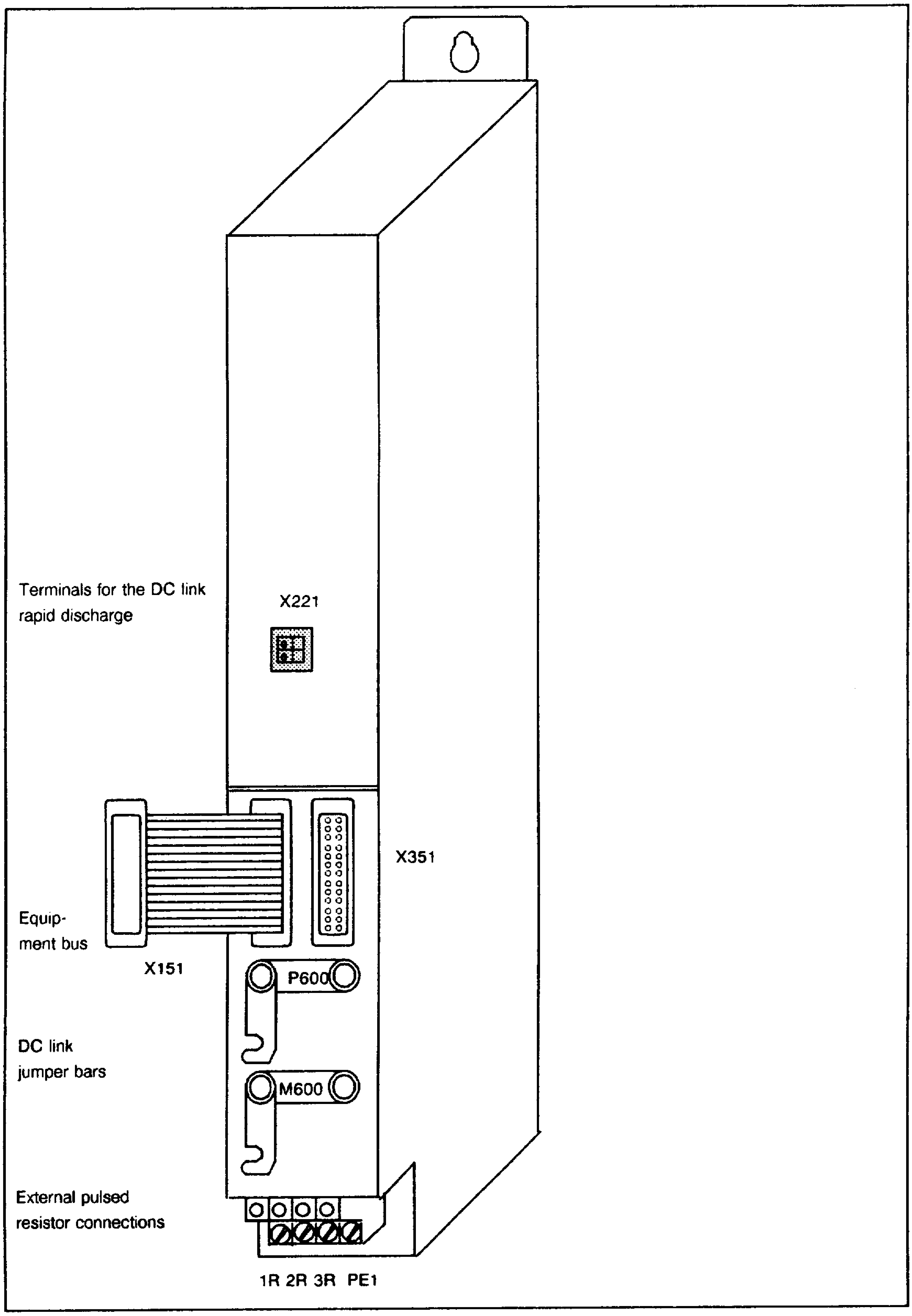
The pulsed resistor module has a 0.3 kW rating for continuous operation and a peak rating of 30 kW. Several pulsed resistor modules can be operated in parallel if the rating of one individual pulsed resistor module is not sufficient.



Permissible duty cycle for the pulsed resistor module

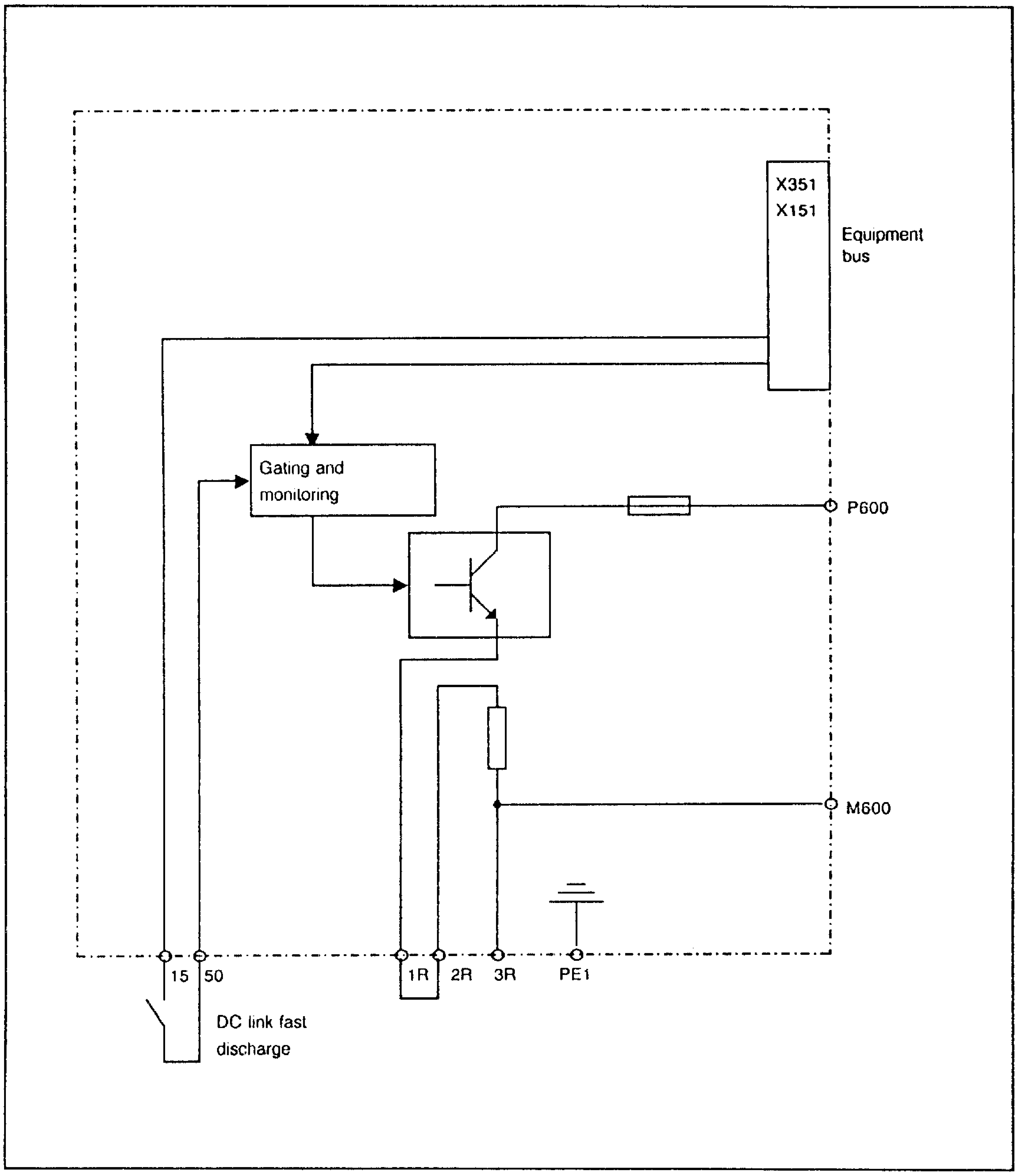
The pulsed resistor module is controlled from the infeed/regenerative feedback module via the equipment bus. This limit value stage in the infeed/regenerative feedback unit/monitoring module switches the pulsed resistor module on when the DC link voltage exceeds 643 V, and has a switch-off hysteresis up to 618 V. An external switch-on command can also be input via terminal 50 using an M24 signal (terminal 15) which has higher priority. When the controller power supply is available, the DC link voltage can be pulsed down to a value <643 V, under the assumption that the supply is disconnected and the pulsed resistor rating is sufficient.

3.6.2 Design



6SC6110-0GB00 pulsed resistor module

3.6.3 Mode of operation



Block diagram of the pulsed resistor module

3.6.4 Type designation

6 S C 6 1 1 0 – 0 G . 0 0

Basic module version

A = Monitoring module

B = 0.3/30 kW pulsed resistor module

Version

3.7 Options

3.7.1 Main spindle option board

3.7.1.1 System integration and design

With the modular axis design, the functional scope can be expanded to include main drive spindle functions. The main spindle board is inserted into the standard option slot provided for this purpose. This board has all of the necessary connection points and setting components for the various functions. Setting points which are required in operation can be adjusted from the front with the board inserted. Additional setting elements are located on the board, and can only be adjusted when the board is withdrawn.

The main spindle function option board can be inserted after the slot cover has been removed.[1]

The main spindle option board includes the following functions:

- Ramp-function generator for main spindle operation, which can be set via potentiometer and can be changed over 1:10 via terminal 102 (PLC-compatible, floating input). Setting range, 10 ms to 10 s.
- Changeover between main spindle and C-axis operation via terminal 61 (PLC-compatible, floating input).

  For main spindle operation, a quasi-constant power range can be set by reducing the current setpoint limit as a function of the speed.

  In the C-axis mode, the speed setpoint evaluation is reduced 1:10 via terminal 24/20.
- Actual value outputs
  - Speed actual value, terminal 75
  - Power display, terminal 162[2]
  - Current actual value, terminal 162[2]
- Limit value stages (relay outputs)
  - $|I_{act}| > I_x$
  - $|n_{act}| < n_{set}$
  - $|n_{set}| < n_x$
  - $n_{act} = n_{set}$

  The relay outputs can be defined as either NC, NO, or changeover contacts by mounting 0 Ω resistors on solder pins.

  The reference points can optionally connected to one another. The relay outputs have a 1A/30 V rating.

  The $n < n_{off}$ function is available as additional monitoring function. This results in pulse cancellation after a selected speed has been reached. A signal is not output at the terminals in this case.

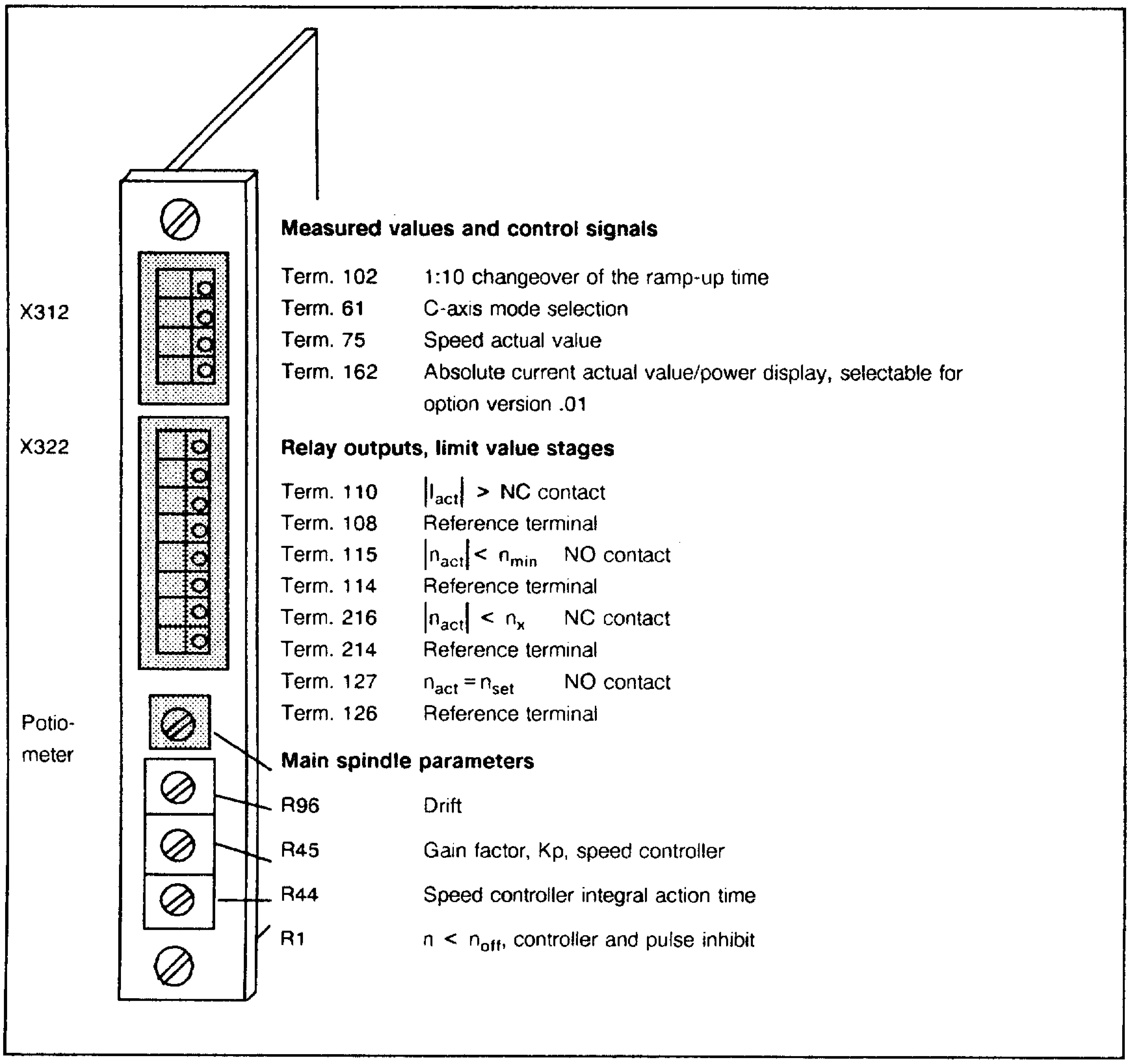
1) *Resistors R4 and R5, and if necessary, C4 should be removed from the feed module parameter board.*

2) *Depending on the equipping, terminal 162 is either a power or current actual value display (refer to the Installation Guide, SIMODRIVE 611, Order No. 6ZB5 420-0AT02-0AA0).*

- Setting points

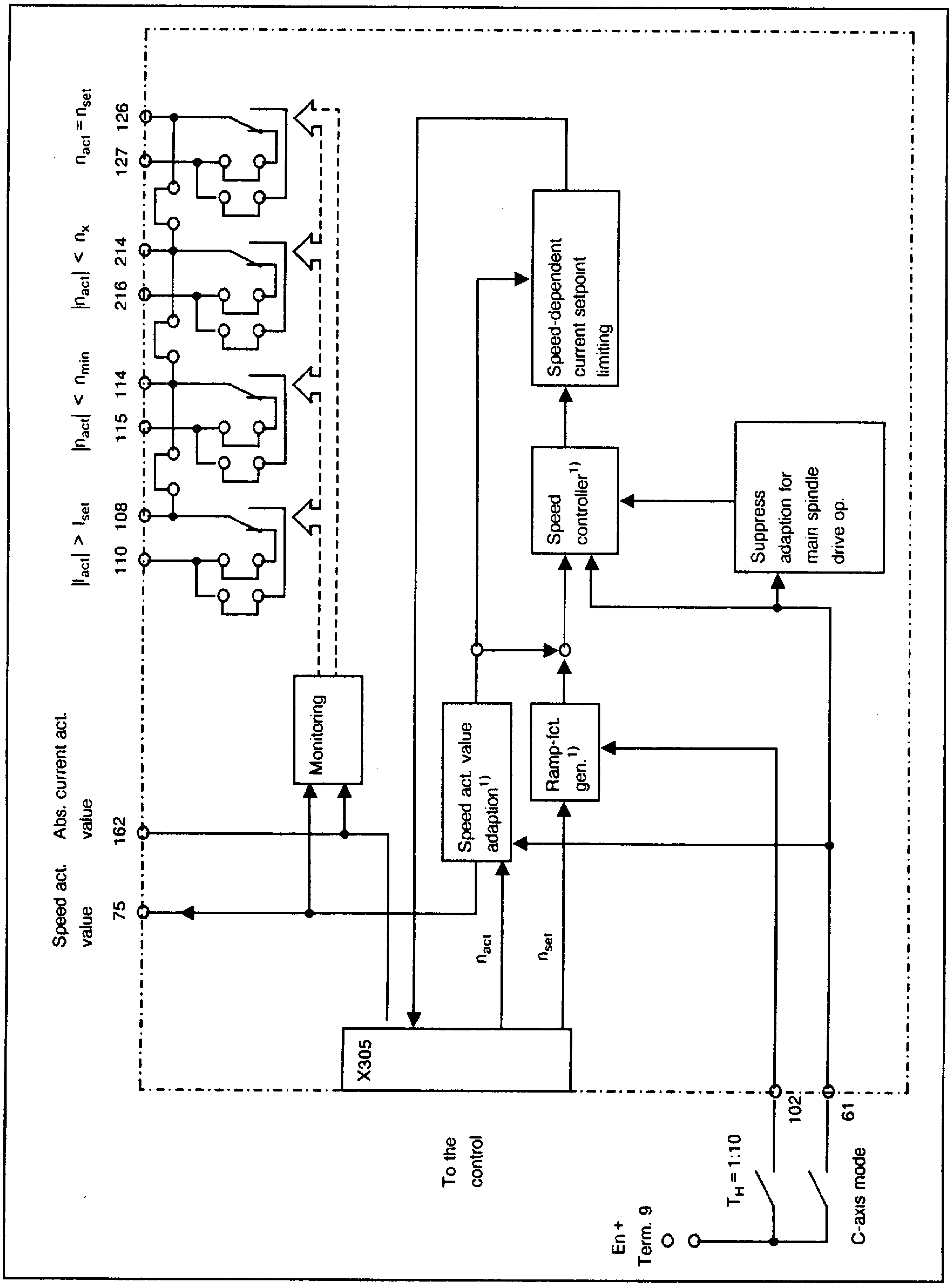
  The following potentiometer settings can be made at the front of the option board in operation:

  - Drift adjustment (multi-turn potentiometer) R96
  - Proportional gain of the speed controller R45
  - Integral action time of the speed controller R44
  - Shutdown time for $n < n_{off}$ for initiating controller and pulse inhibit R1



Option board, main spindle function

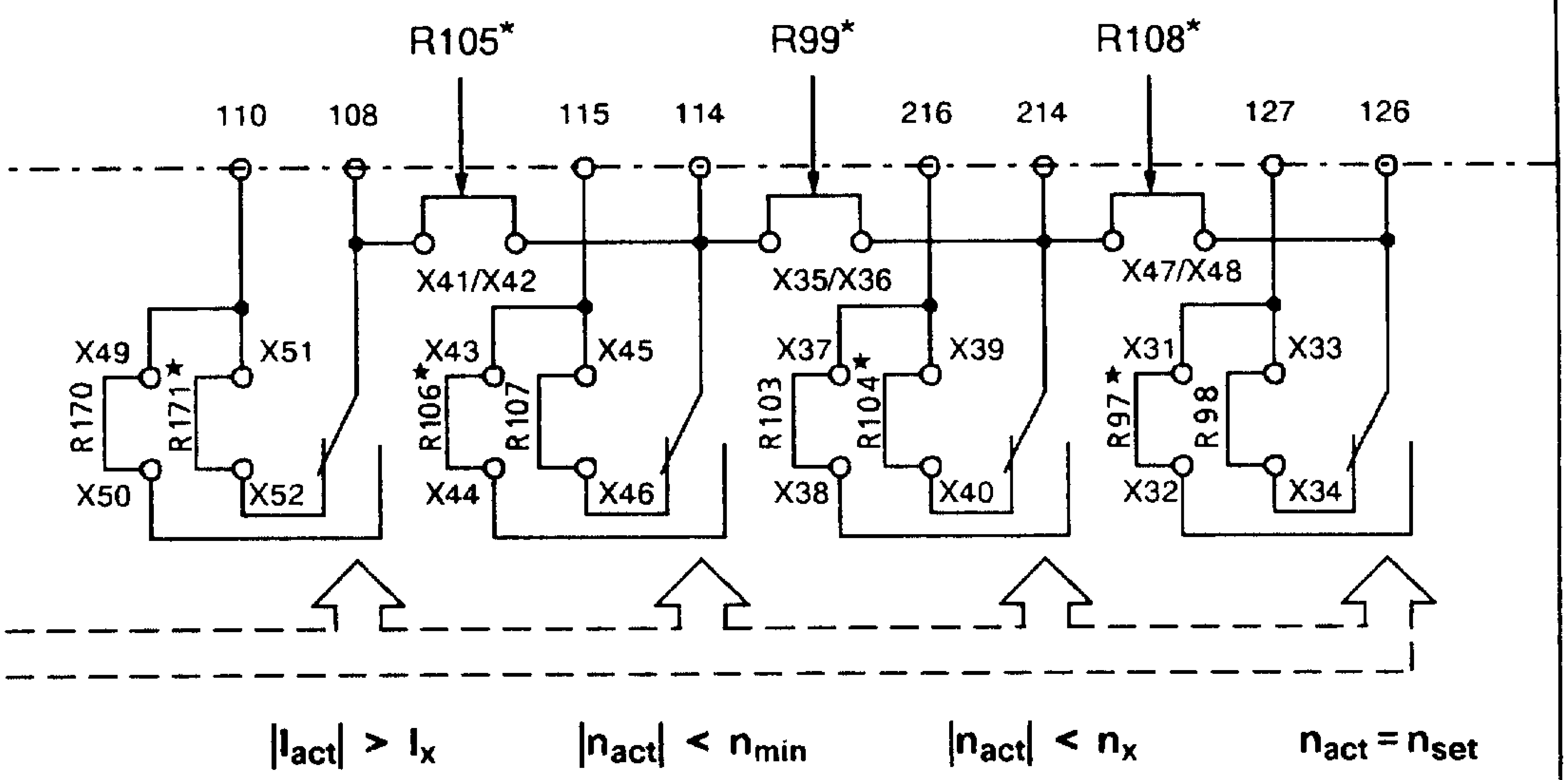
3.7.1.2 Mode of operation of the option board



Block diagram of the option board, main spindle function for SIMODRIVE 611 PWM converters

1) *Can be set on the option board*

3.7.1.3 Limit value stages (relay terminals)



The resistors, designated with R...* are 0 Ω as standard.

3.7.1.4 Type designation

6SC6110-0PA00

P = Option board

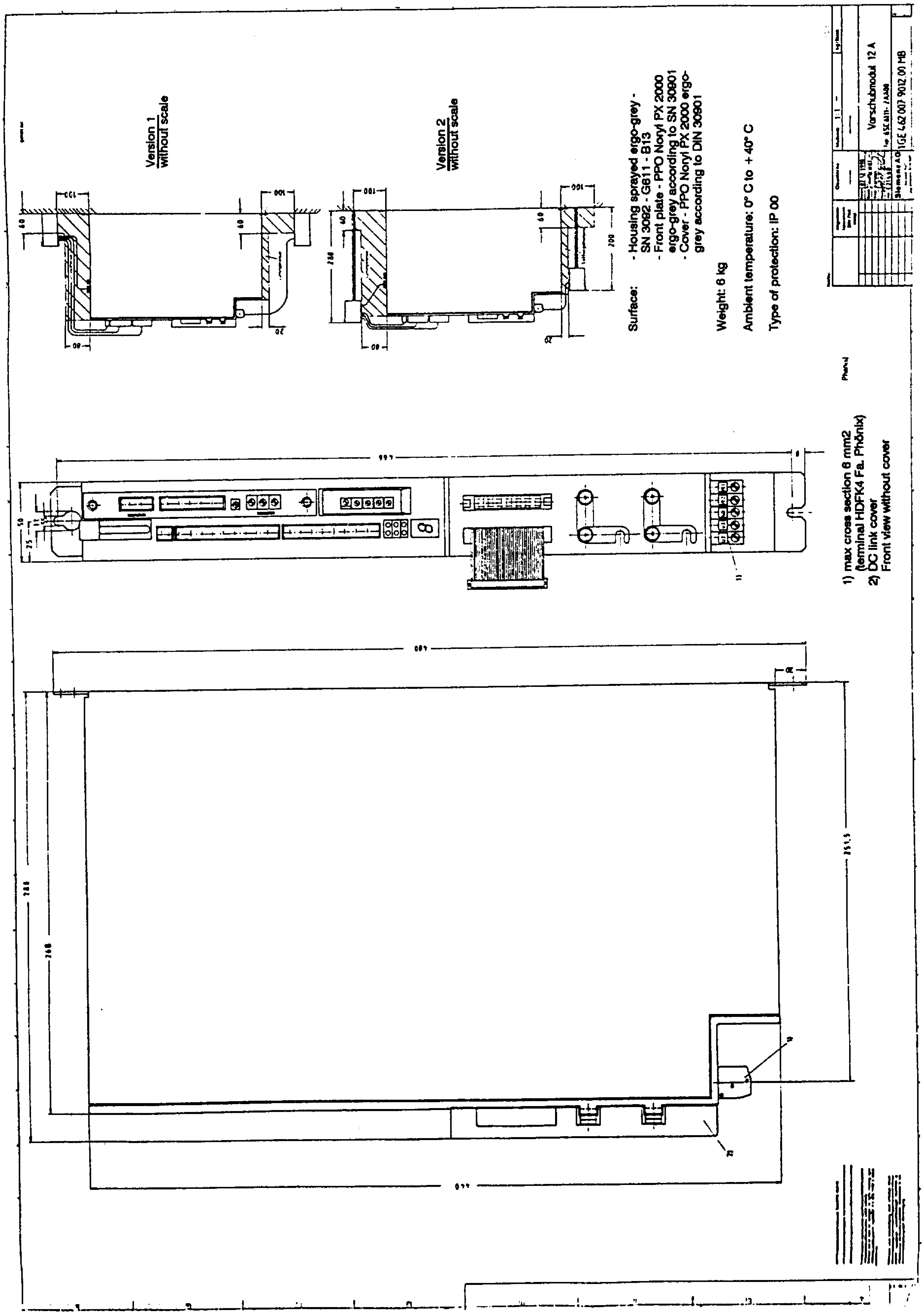
A = Main spindle expansion board A

0 = Standard design

1 = Version with power display

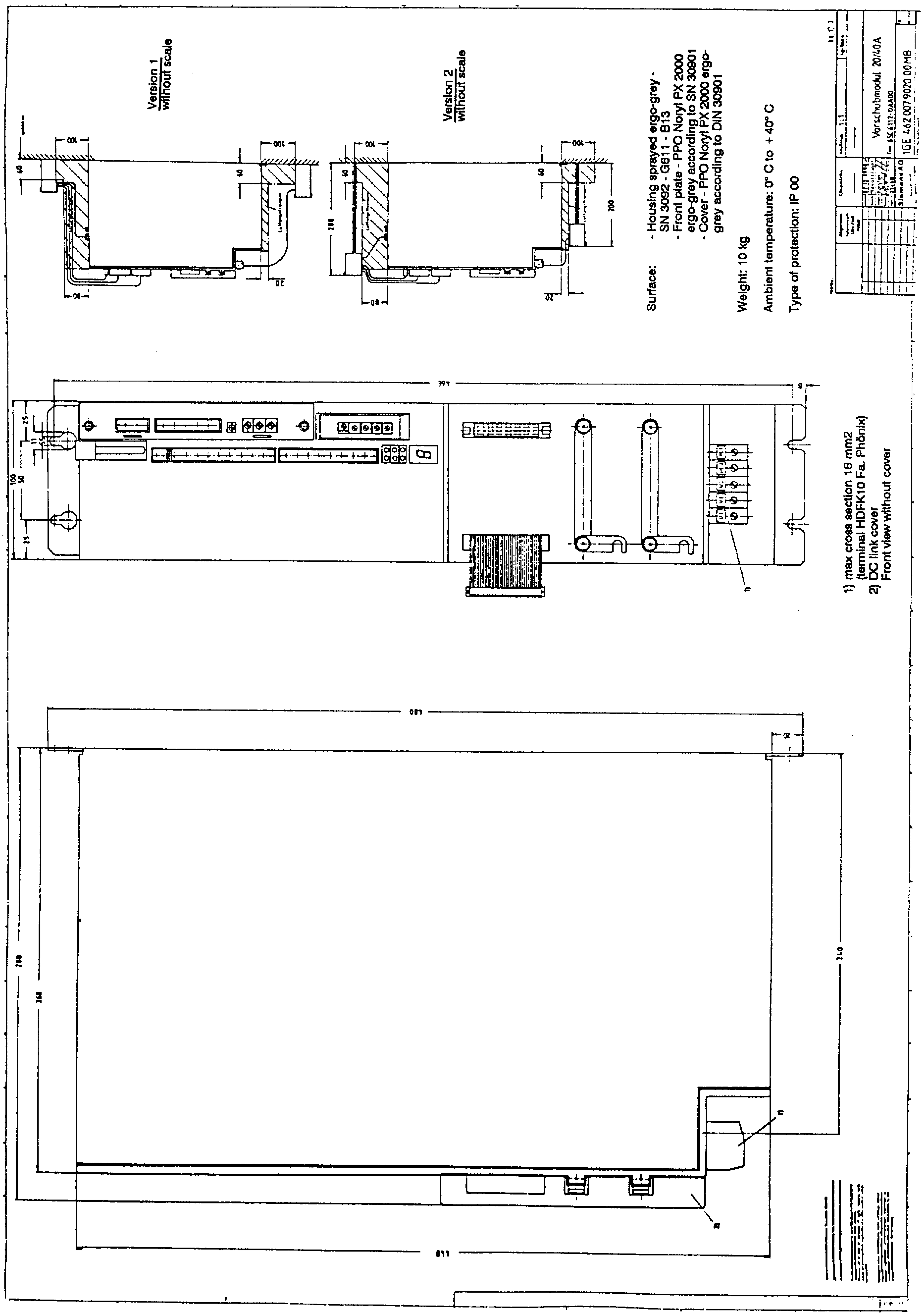
3.8 Dimension drawings for SIMODRIVE 611 transistor PWM converters

- Feed modules 3/6 A, 6/12 A, 12/24 A

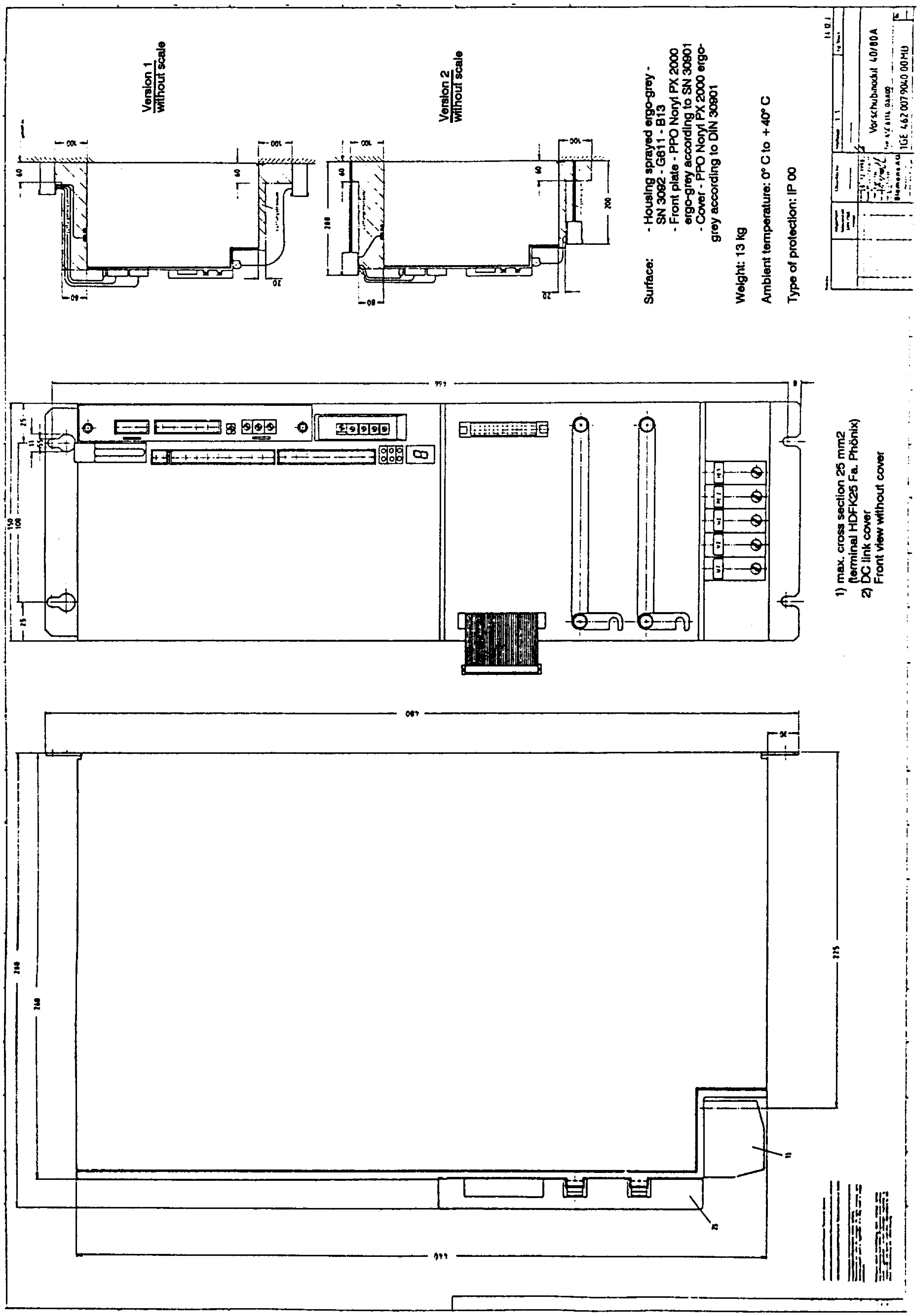


 6ZB5 420-0AS02
SIMODRIVE (PJ)

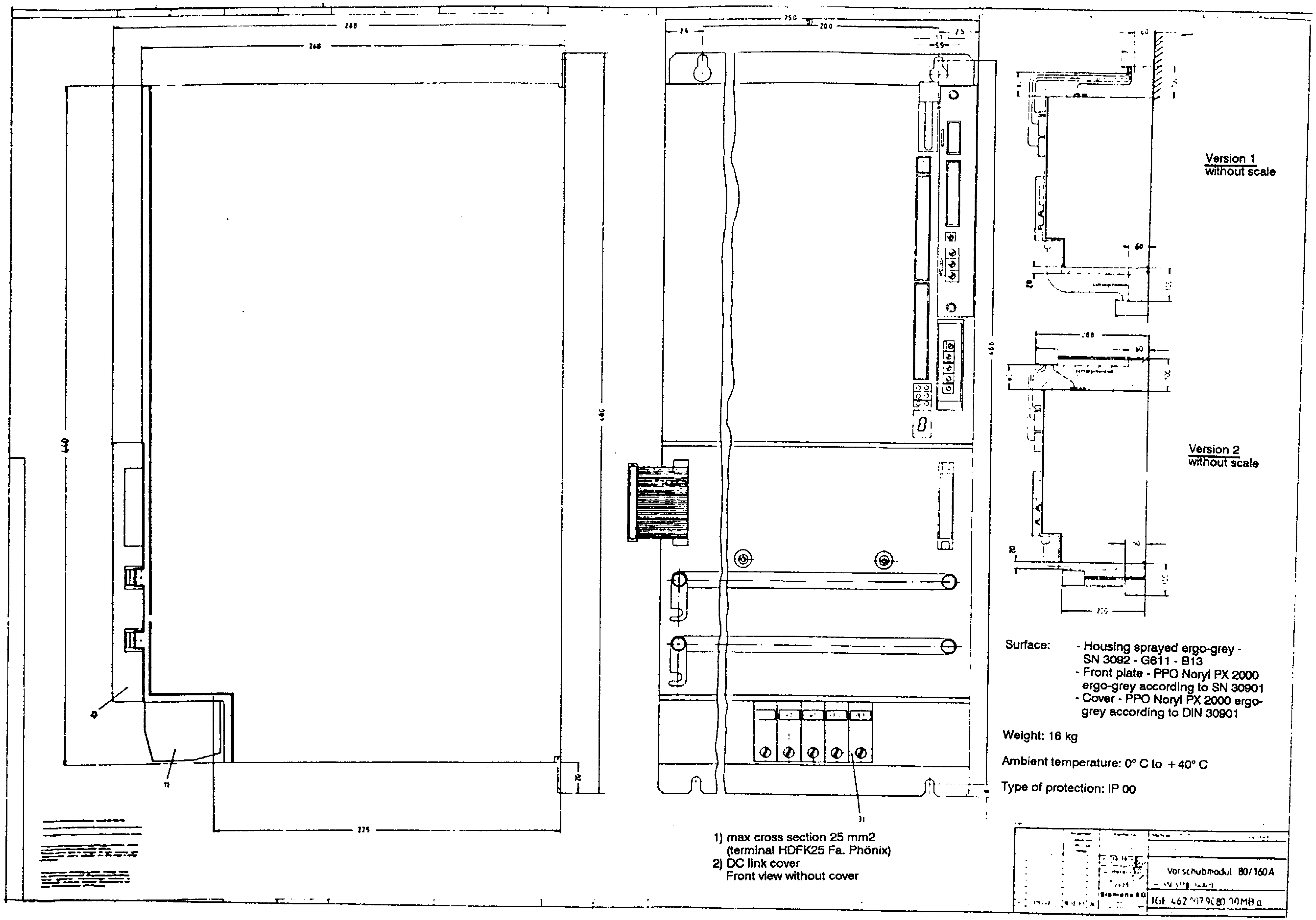
- Feed module 20/40 A



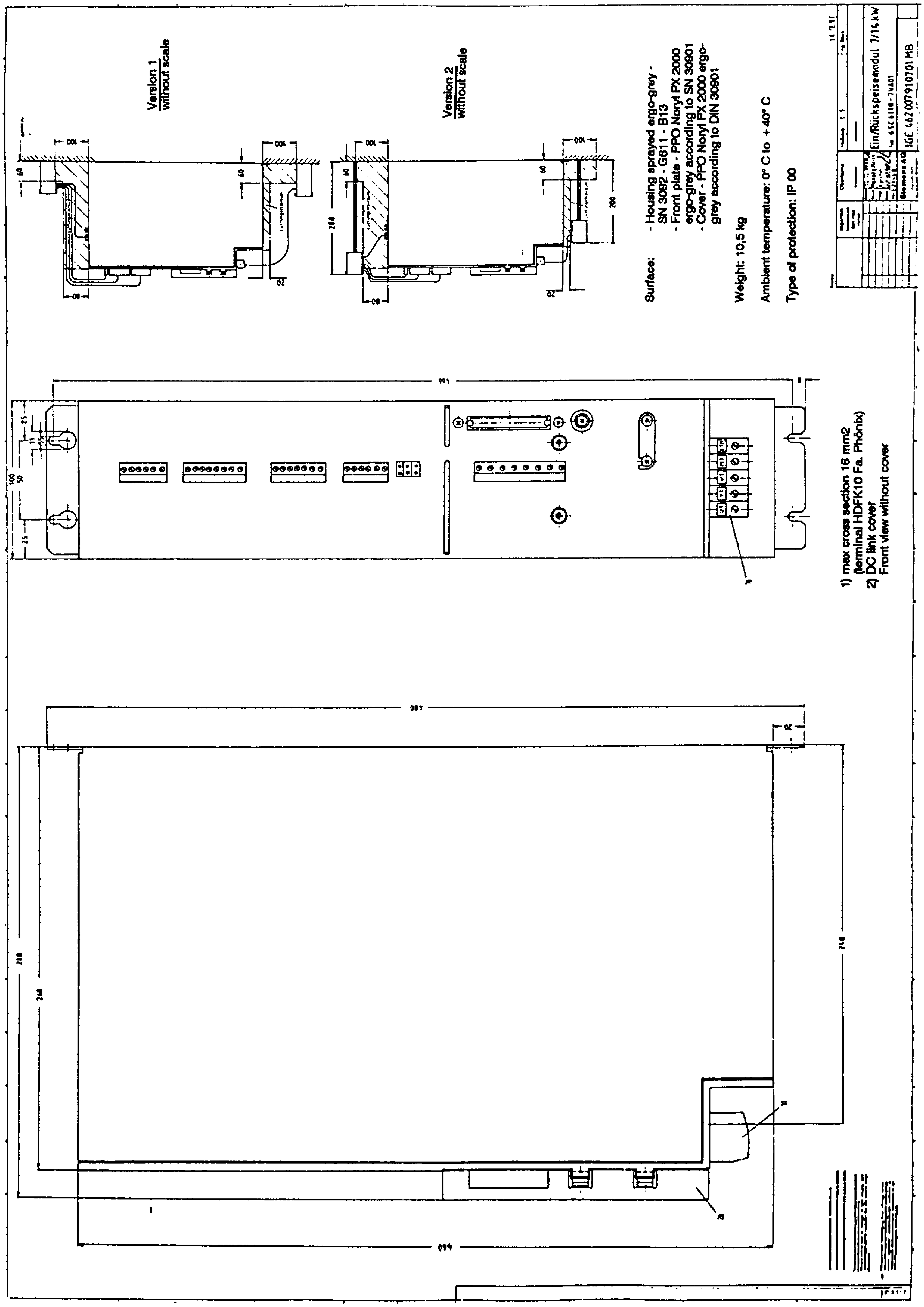
- Feed modules 40/80 A, 60/120 A



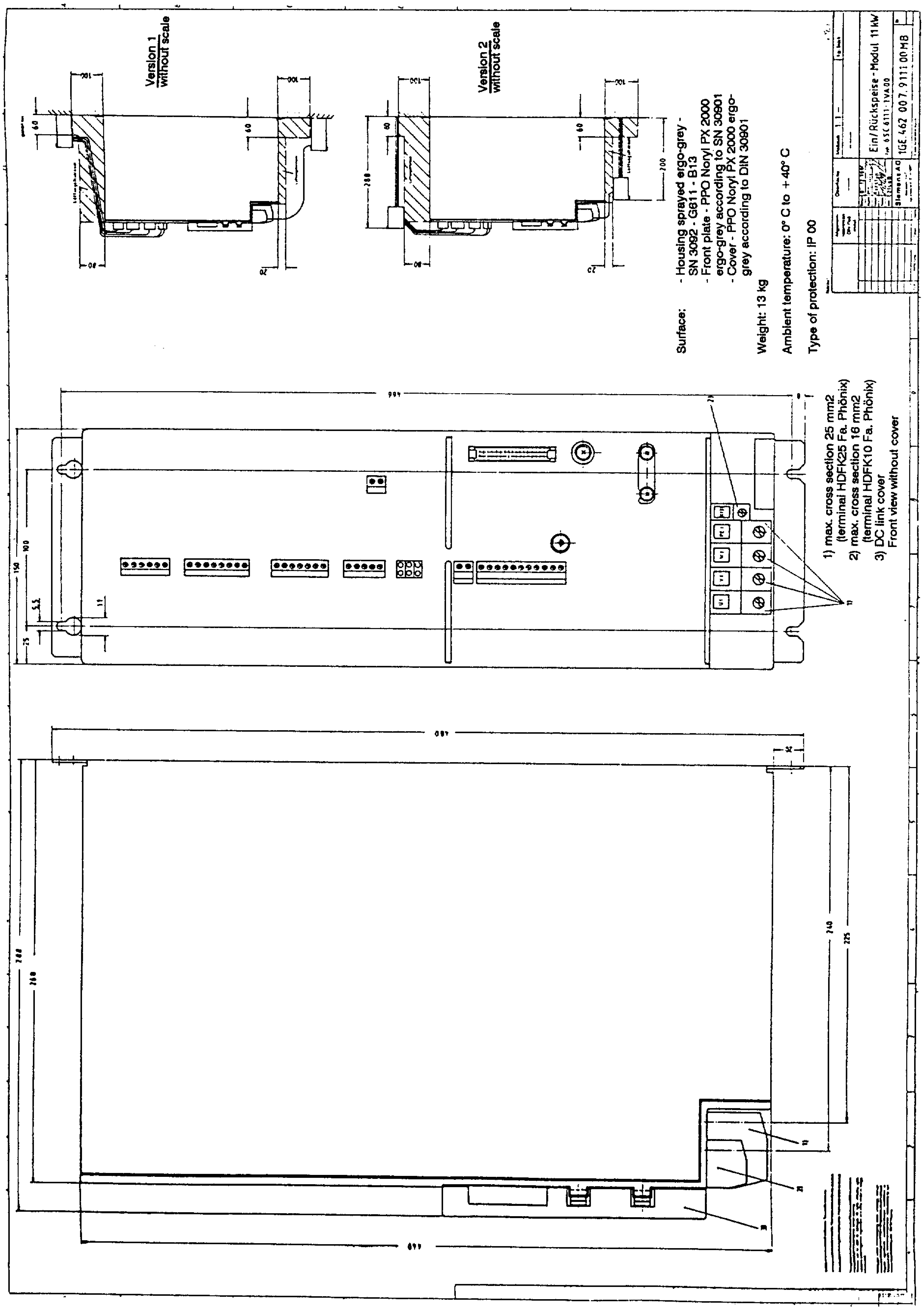
- Feed module 80/160 A



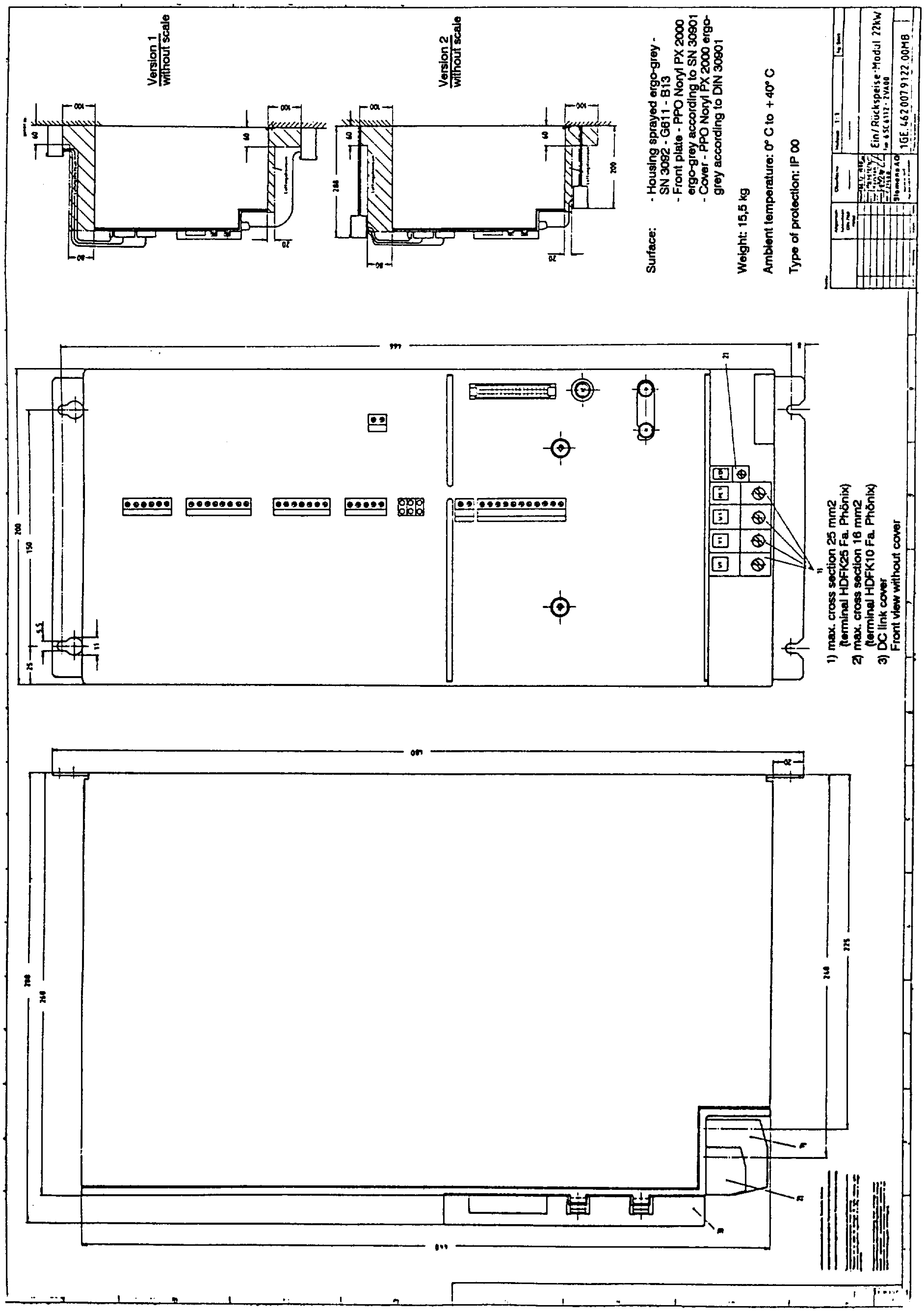
- Infeed/regenerative feedback module 7/14 kW



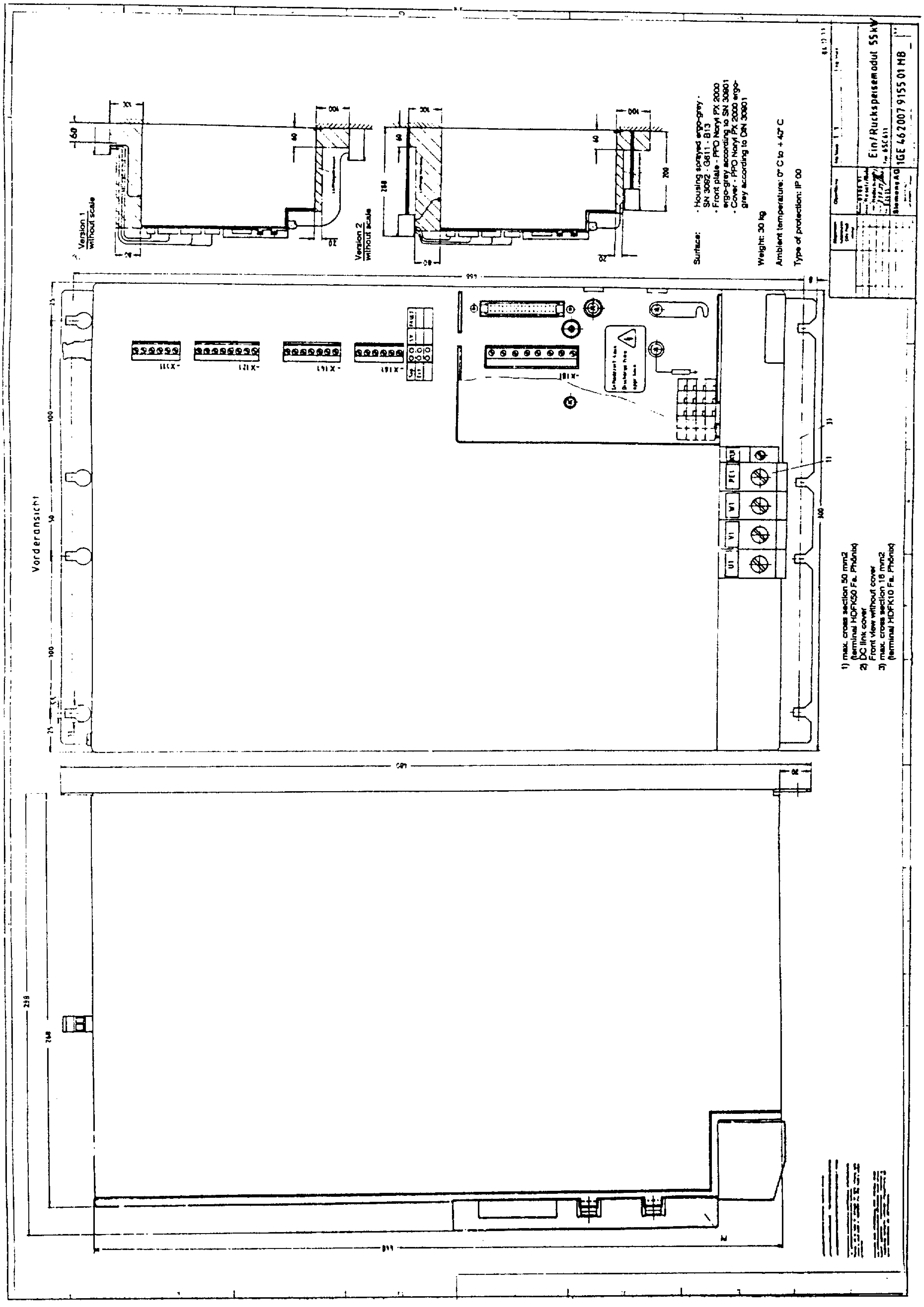
- Infeed/regenerative feedback module 11/22 kW



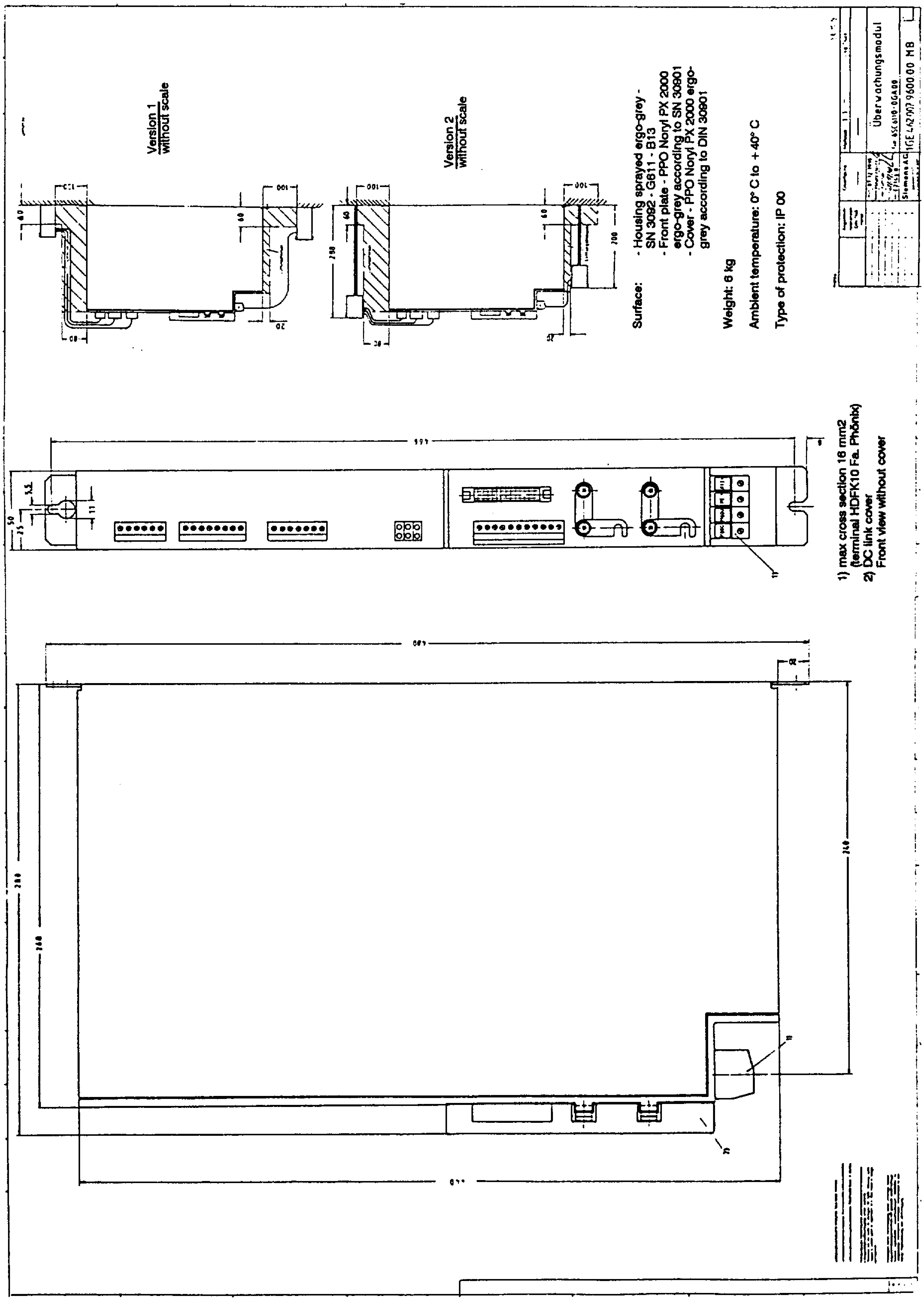
- Infeed/regenerative feedback module, 22/44 kW



- Infeed/regenerative feedback module, 55/88 kW

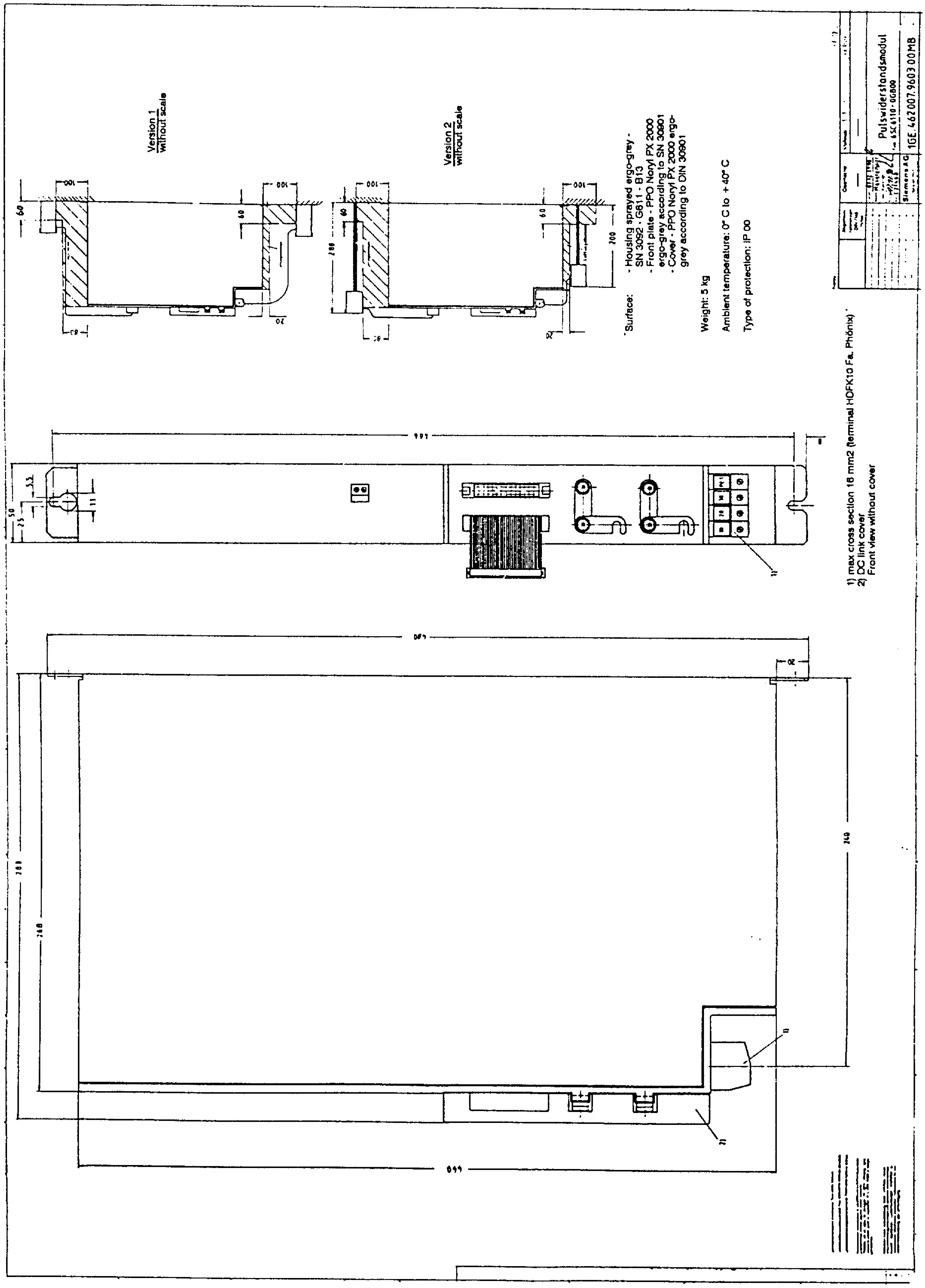


- Monitoring module

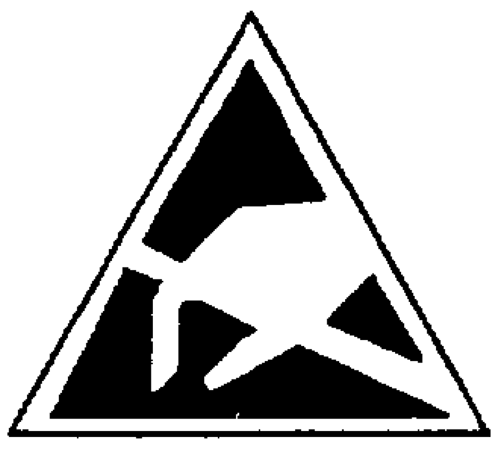


 6ZB5 420-0AS02
SIMODRIVE (PJ)

- Pulsed resistor module



3.9 Mounting instructions for SIMODRIVE 611 transistor PWM converters



CAUTION

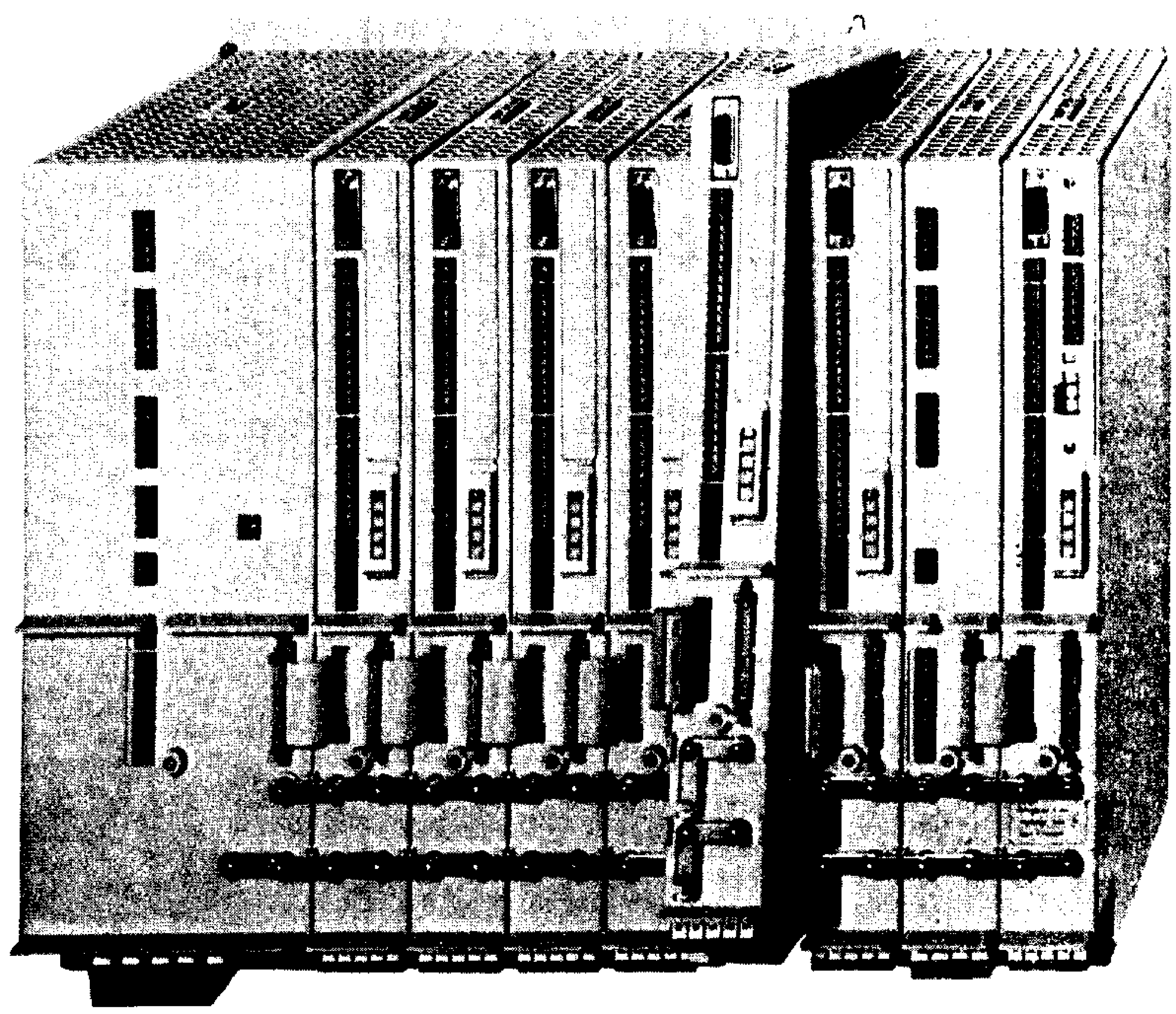
The boards contain components which can be destroyed by electrostatic discharge. The human body must be electrically discharged before electronics boards are touched. This can be simply done by touching a conductive object immediately beforehand (e.g. bare metal cubicle components, socket connector protective contact).
Information, refer to Section 3.9.3.

3.9.1 Installing the PWM converter

SIMODRIVE 611 transistor PWM converters are designed for cubicle installation. Please refer to the dimension drawings for mounting dimensions and location of the mounting points.

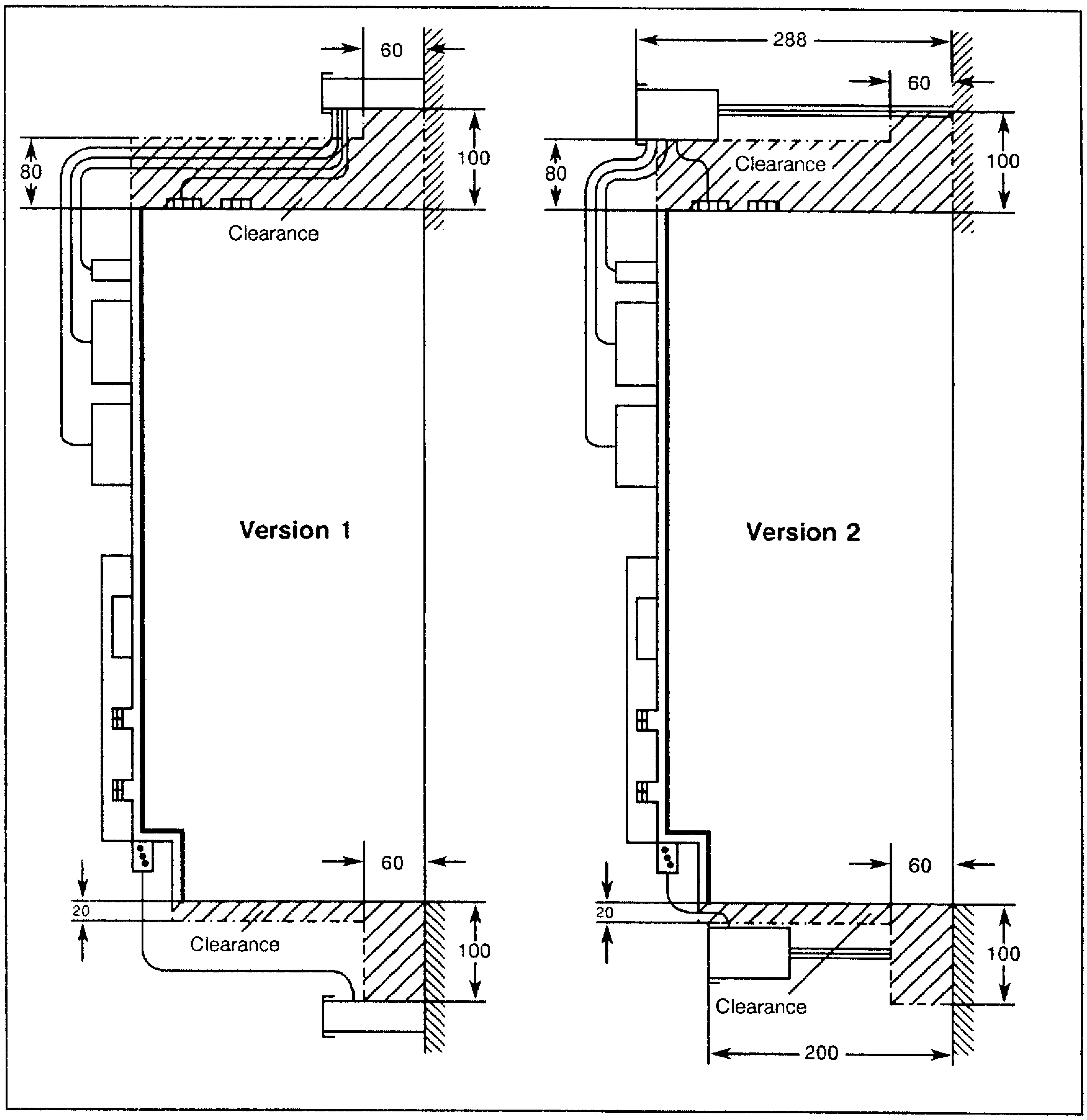
The module mounting points are always in a 50 mm grid.

A clearance of at least 100 mm must be maintained above and below the converters to ensure that air intake and discharge are not restricted. Mount the converters so that they are protected against conductive dust deposits and gases.

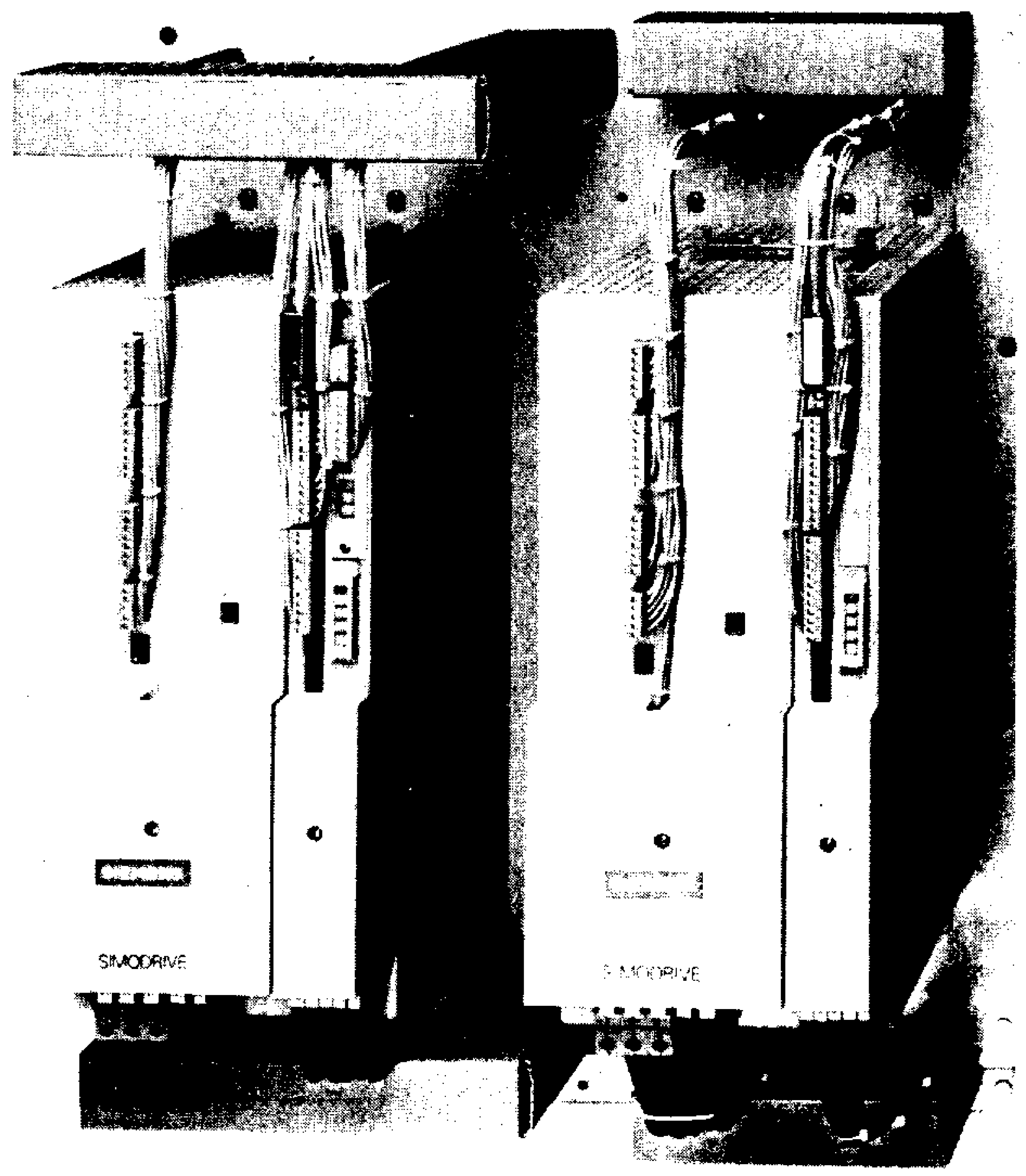


Example of a SIMODRIVE 611 feed drive with the DC link covers opened

If two or more units are mounted one above the other, the heated, discharged air must be directed away from the converter mounted directly above it using baffles or by providing sufficient clearance; or the unit must be de-rated as specified in Section 3.2.4.



Cable routing and air intake and discharge clearances when mounting modules



Recommended cable routing for SIMODRIVE 611

The overall design and front covers provide protection against coming into contact with live components according to DIN VDE 0106, Part 7.

3.9.2 Connecting-up the PWM converter

The PWM converters are connected to the supply through commutating reactors. The infeed/regenerative feedback unit includes, as standard, inrush current limiting. To connect-up the M600 DC link, the jumper bars can be closed on the infeed/regenerative feedback unit. It should always be ensured that the protective ground on the infeed/regenerative feedback module is connected to the central protective ground. Motors must also be individually grounded. The protective ground should be routed with the motor feeder cable. Connect-up the converters as recommended (refer to the diagram of the SIMODRIVE 611 grounding concept, Section 5.12).

The relevant regulations must always be observed when engineering and integrating the converter system with motor into the complete machine system and connecting to the supply. In addition to the general regulations, standards VDE 0160, VDE 0113/EN 60204, VDE 0100, VDE 0100 Part 300, VDE 0100 Part 410, DIN 2853, DIN 2854 apply.
e.l.c.b.s cannot be used.

WARNING

According to VDE 0160 Sections 5.5 and 6.5, it is not permissible to connect converters with B6 supply configurations to supplies where the only protective measure against "indirect contact" are e.l.c.b.'s.

If a converter with a B6 configuration is electrically connected with several other parallel circuits and operated through a common e.l.c.b., if a fault condition occurs, the e.l.c.b. might not respond, thus not providing any shock protection.

Another protective measure "protection against dangerous electric currents flowing through the body" according to VDE 0100 Part 410 should be provided.

EMC

SIMODRIVE 611 converter systems are designed according to VDE 0160/05.88; VDE 0558 in addition to other relevant regulations. Industrial supply networks and industrial areas are the basis. When the equipment is used in different environments (i.e. industrial and domestic), additional external measures must be provided to adapt to the required local EMC level. Information on this subject is provided in Section 5.13. It is the responsibility of the user to ensure that the supply conditions defined locally are maintained.

The recommendations, specified in Section 5.12 should be observed for cubicles and machines.

Standards and specifications

The following standards were taken into account during the design of the SIMODRIVE 611 converter system (excerpt of the most important):

DIN VDE 0100	Regulations for setting-up power equipment with voltages up to 1000 V
DIN VDE 0113/02.86; EN 60204	Electrical equipment on industrial machines
DIN VDE 0558	Regulations for semiconductor converters
DIN VDE 0106	Protection against dangerous currents flowing through the human body
DIN VDE 0109	Air and creepage distances
DIN VDE 0110	Insulation classes
DIN VDE 0160/05.88	Equipping power equipment with electronics
DIN 40050	IP degrees of protection
VBG 4	Implementation of accident protection regulations "electrical systems and equipment"

Power connection

The motor feeders can be directly connected at the axis modules. The terminals provided allow cable cross-sections to be connected for module currents according to DIN VDE 0113.

The SIMODRIIVE 611 PWM converters have the following protective functions:

- Short-circuit and ground-fault proof power section design
- Semiconductor fuses as short-circuit protection in each module with connection to the DC link
- Electronic I^2t monitoring as overload protection
- Motor temperature monitoring using PTC thermistors

If the motor inrush current (stall current) I_0 and the rated converter current I_{rated} are the same, and the motor feeder cross-section is matched to the I_{0RMS} of the motor, cable overload protection is provided by the PWM converter.

For SIMODRIVE 611 PWM converters, an axis-specific signal for the I^2t power section monitoring functions and motor PTC evaluations are available. Further, an I^2t alarm is provided as group signal for all axes (terminals 5.1 to 5.3).

Independent of the signals, each power section is individually protected by its I^2t monitoring, which reduces the current limit to the rated power section current.
The cable cross-section must therefore be dimensioned according to the power section used, motor, ambient conditions (temperature) and protective devices (refer to the following table).

Power section	I_{RMS}[1] [A]	Cross-section at +30 °C [mm²]	Cross-section at +40 °C [mm²]
3 A/6 A	2.46	1.5	1.5
6 A/12 A	4.92	1.5	1.5
12 A/24 A	9.9	1.5	1.5
20 A/40 A	16.3	2.5	4
40 A/80 A	32.7	10	10
60 A/120 A	49.2	16	16
80 A/160 A	65.6	35	35

Cable cross-sections required for the SIMODRIVE 611 PWM converters acc. to DIN VDE 0113 and VDA

1) *RMS value of the continuous current limited by the I^2t monitoring*

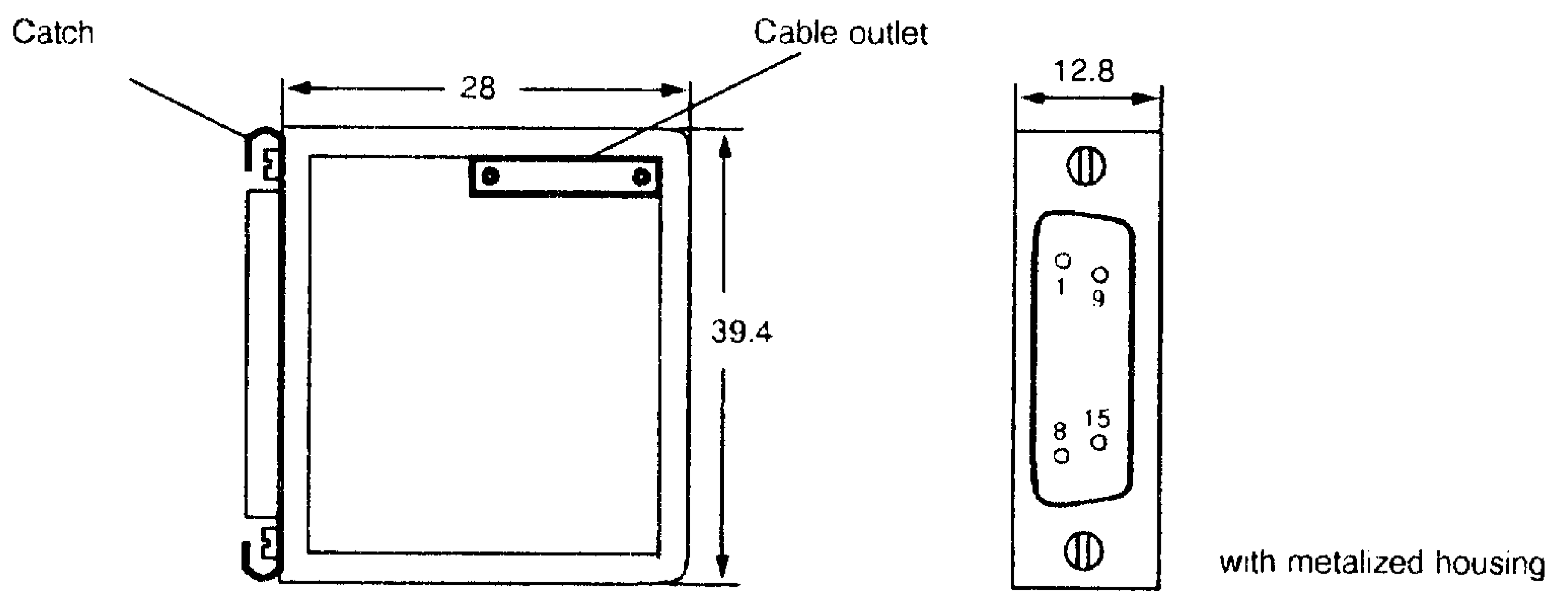
An additional protective device must be provided if a smaller cable cross-section is to be used. In this case, we recommend the use of a thermally delayed overload relay (without phase-failure monitoring), such as one of the 3UA series, listed in Catalog NS2. This is necessary to prevent premature tripping at zero speed (one motor phase failed for a longer period of time). The cable cross-section and the overload relay can then be rated, for example, for the rated motor current or possibly for a specific duty cycle.

A "cable thermally overloaded" signal is available when an overcurrent relay is used. This signal can either be evaluated by the PLC or alternatively logically interlocked in the conventional section of the drive open-loop control.

Encoder cables

Setpoint and actual value cables are screened and must be routed separately from load- and contactor control cables. Interference may occur with non-suppressed contactor coils and it is therefore advisable to provide these with RC elements. For multi-axis configuration, every setpoint and actual value cable must be twisted and screened individually so that mutual interference between axes cannot occur.

Converter connectors	
Order No.	15-pin socket connector X311 at the feed module, only crimped, for cable diameters 5.75 to 9 mm.
6FC9348-7AT	

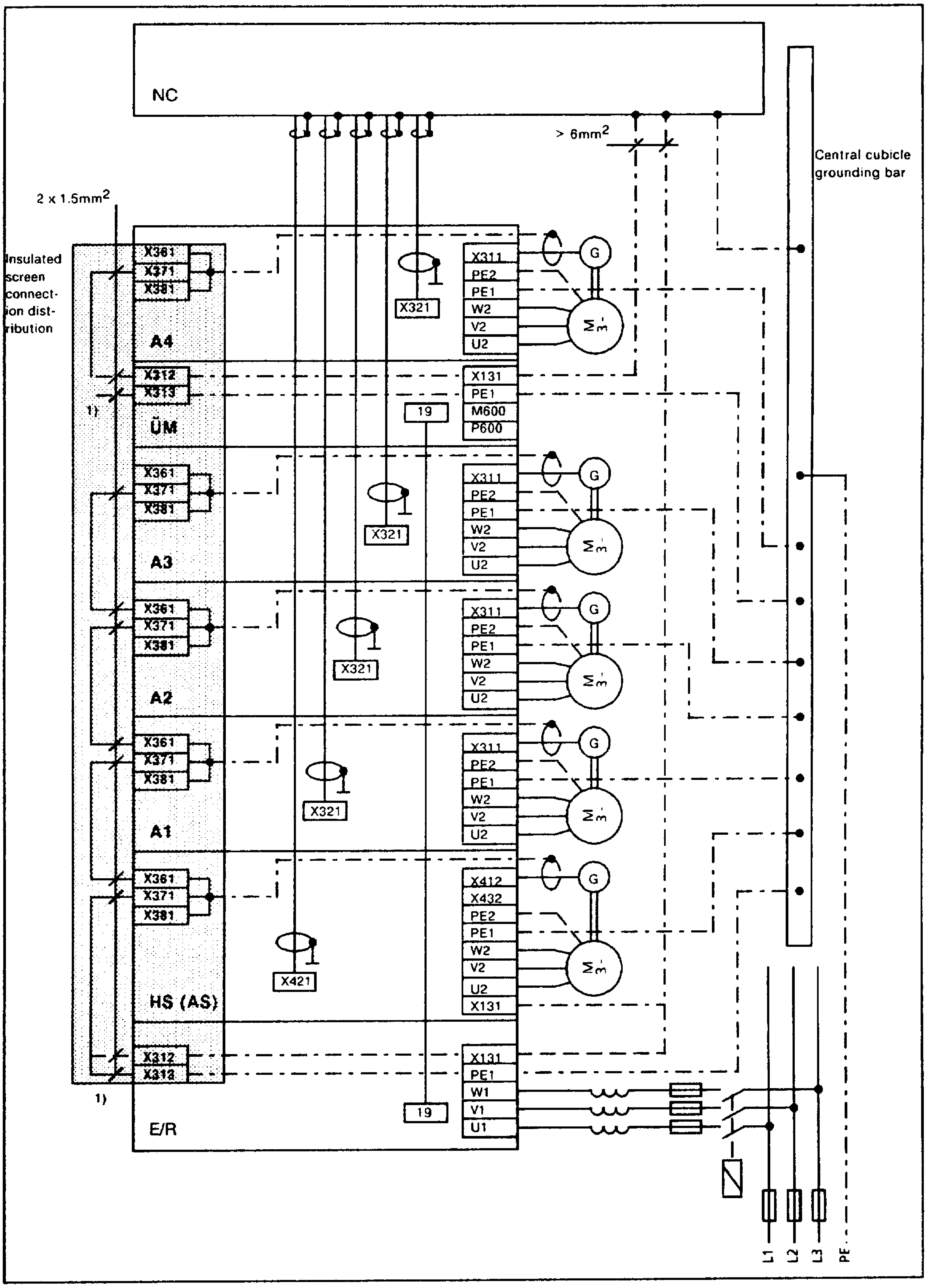


Connector with metalized housing for connecting to the SIMODRIVE 611 PWM converter

Note: The setpoint cable screen must be connected to ground on the NC side. It is not permissible that this screen is connected to ground at the converter.

Every setpoint cable must be separately screened and twisted.

The ground connection between the NC and PWM converter must be as short as possible: Minimum cable cross-section 6 mm². Connection X131 must be connected to the NC ground, and when used with NC, must be connected to the central grounding bar.



SIMODRIVE 611 grounding concept

1) *Should be connected to X313 or X312 depending on the particular system.*

All SIMODRIVE 611 modules have three separate floating voltage systems. The components operated at the DC link level, the electronics potential level and screen potential.

The transistors pulsed at the DC link act as a noise source for the other two voltage levels, the effect of which cannot be measured as far as the electronic functions are concerned. Careful design of the overall cubicle is in this case mandatory.

This involves consequentially separating power cabling and control cabling, i.e. setpoint and actual value cables. All cables involved with power distribution are pulsed at switching speeds of several kV/µs at the DC link, and can thus cause both inductively as well as capacitively coupled noise in adjacent cables. This is especially true for cables running in parallel over longer distances.

The ideal situation is to use the shortest possible twisted cables within the cubicle as well as mounting the line commutating reactor as close as possible to the converter, as the line-side power section already has a reduced noise threshold.

Screen connections should be carefully made. A faulty screen connection is a potential source of noise (screen connections should be made through the largest possible surface area with the lowest resistance).

A central location should be provided in the cubicle for the grounding point. This should be connected to the cubicle mounting panel through a large surface area and grounded according to the connection cross-section.

All modules mounted in the cubicle are connected with their PE1 connection to this central grounding point. This is also true for all other components which have to be grounded. This PE connection should be realized with a power cable cross-section according to the module rating.

The same is true for the PE2 ground connection to the motors. The motor base frame itself should be connected through the largest possible cross-section to the central grounding point. Components used for measuring functions should be connected to ground through the largest possible surface area.

If the above mentioned points are taken into account, the power cabling can be optimally configured. The module electronics potential is now connected. Terminal X131 on every infeed/regenerative feedback unit and monitoring module is used. The electronics ground is internally connected to this terminal and it is possible to connect this to ground using the largest possible cross-section (>6 mm^2). If an NC control is used, this is realized at its grounding bar, so that the analog speed setpoints are referred, as precisely as possible, to the equipment potential. This grounding bar is in turn connected to the grounding point in the cubicle using the highest possible cross-section, however separated from the "power grounds". If an NC control is not used, point X131 should be connected directly to this bar.

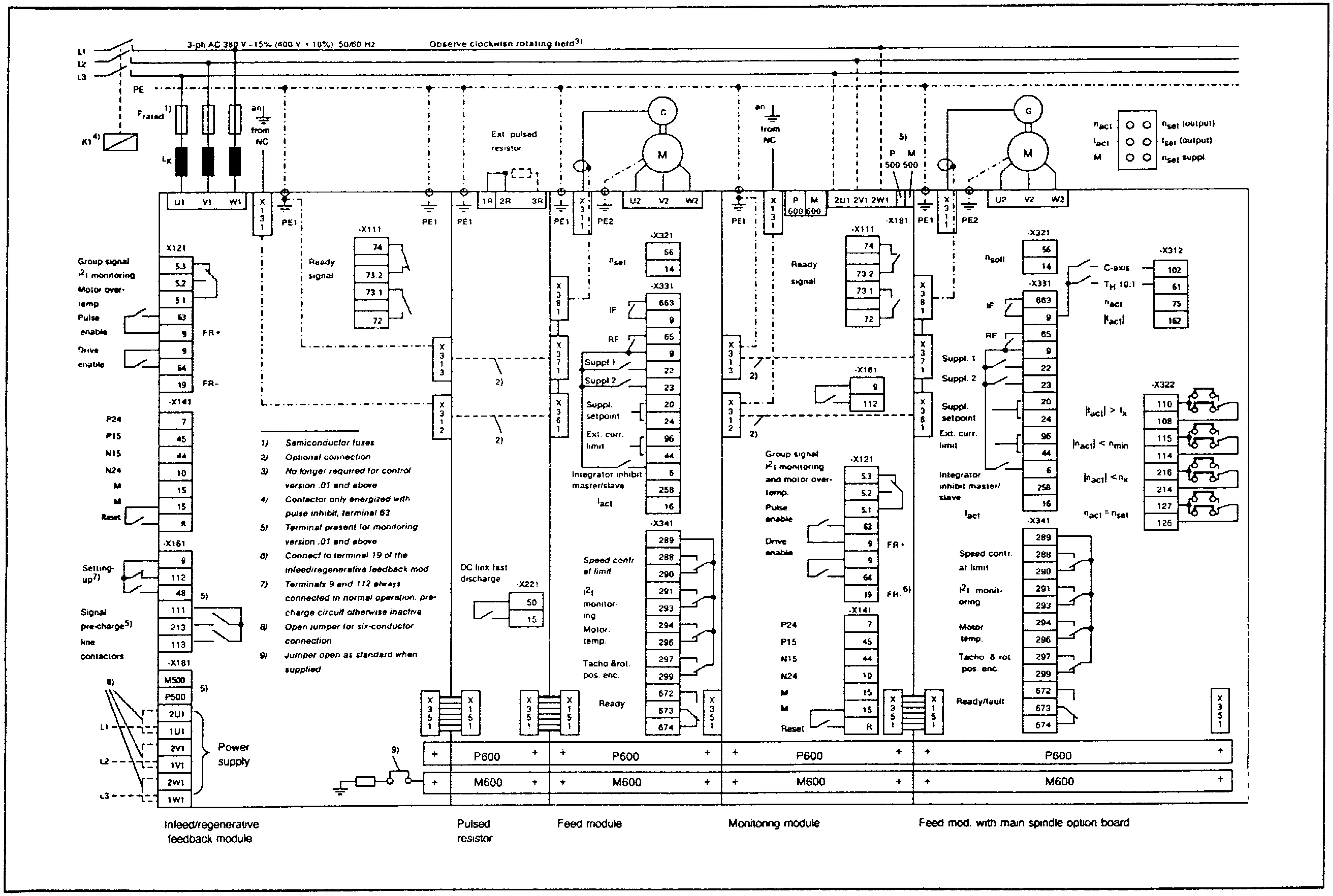
X131 should be connected separately for each system, as the individual electronics systems are floating with respect to one another when several monitoring modules are used.

If a main spindle or induction motor module is used, this must be mounted directly adjacent to the infeed/regenerative feedback unit, and terminal X131 of the main spindle (induction motor) module used instead of terminal X131 of the infeed/regenerative feedback module.

Finally, the individual cable screens must be connected. The speed actual value cables are provided with subminiature D plug connectors. If the cable screen is connected to the connector housing, then this is automatically connected to the module screen potential when the connector is inserted. A connection is now established to the screen connection distributor X361-X381 through the PC board. These isolated potentials are connected together with X361 and X371. This should be realized using two 1.5 mm^2 cables, which should be as short as possible. The next connector to the infeed/regenerative feedback unit or monitoring module must then be connected with its X313 or X312 connection. In this case, a decision can be made as to how the best smooth running characteristics are obtained; generally, this is realized by connecting to X312.

Other screens can be connected to the module using X381, a 4-pin plug connector. From experience, this is especially the case for the speed setpoint. This should always be fed to the module from the NC using a screened cable.

If the above mentioned points are observed, a disturbance-free system can generally be set-up. However, if sporadic faults still occur, then the first step is to search for loose electrical connections, especially in the ground loop, or for additional plug-in connections but also in the power circuit (DC link). Further, all screen connections should be checked for a high-frequency low-ohmic connection. In exceptional cases, a different screening concept can be tried (screen connections at X313; motor grounds to the central grounding point; X131 directly grounded; speed setpoint screen grounded at both ends; speed actual value screen not grounded or connected to the rear cubicle panel through a large surface area etc.).


3-ph.AC 380 V -15% (400 V + 10%) 50/60 Hz
Observe clockwise rotating field3)
L1
L2
L3
PE
K1 4)
F rated 1)
L K
an from NC
Ext. pulsed resistor
Group signal
i²t monitoring
Motor over-temp.
Pulse enable
Drive enable
Ready signal
P24
P15
N15
N24
M
Reset
Setting-up 7)
Signal pre-charge 5)
line contactors
Power supply
DC link fast discharge
1) Semiconductor fuses
2) Optional connection
3) No longer required for control version .01 and above
4) Contactor only energized with pulse inhibit, terminal 63
5) Terminal present for monitoring version .01 and above
6) Connect to terminal 19 of the infeed/regenerative feedback mod.
7) Terminals 9 and 112 always connected in normal operation, pre-charge circuit otherwise inactive
8) Open jumper for six-conductor connection
9) Jumper open as standard when supplied
n set
IF
RF
Suppl 1
Suppl 2
Suppl. setpoint
Ext. curr. limit
Integrator inhibit master/slave
I act
Speed contr. at limit
i²t monitoring
Motor temp.
Tacho & rot. pos. enc.
Ready
Ready/fault
C-axis
T H 10:1
n act
I act
n set (output)
I set (output)
n set suppl.
|I act| > I x
|n act| < n min
|n act| < n x
n act = n set
P600
M600
Infeed/regenerative feedback module
Pulsed resistor
Feed module
Monitoring module
Feed mod. with main spindle option board

3.9.3 Handling the modules and boards

ECB instructions

Generally, electronic boards should only be touched when absolutely necessary.

The human body must be electrically discharged before touching an electronic board. This can be simply done by touching a conductive, grounded object directly beforehand (e.g. bare metal cubicle components, socket outlet protective conductor contact).

Boards must not come into contact with highly-insulating material (e.g. plastic foils, insulated desktops, articles of clothing manufactured from man-made fibers).

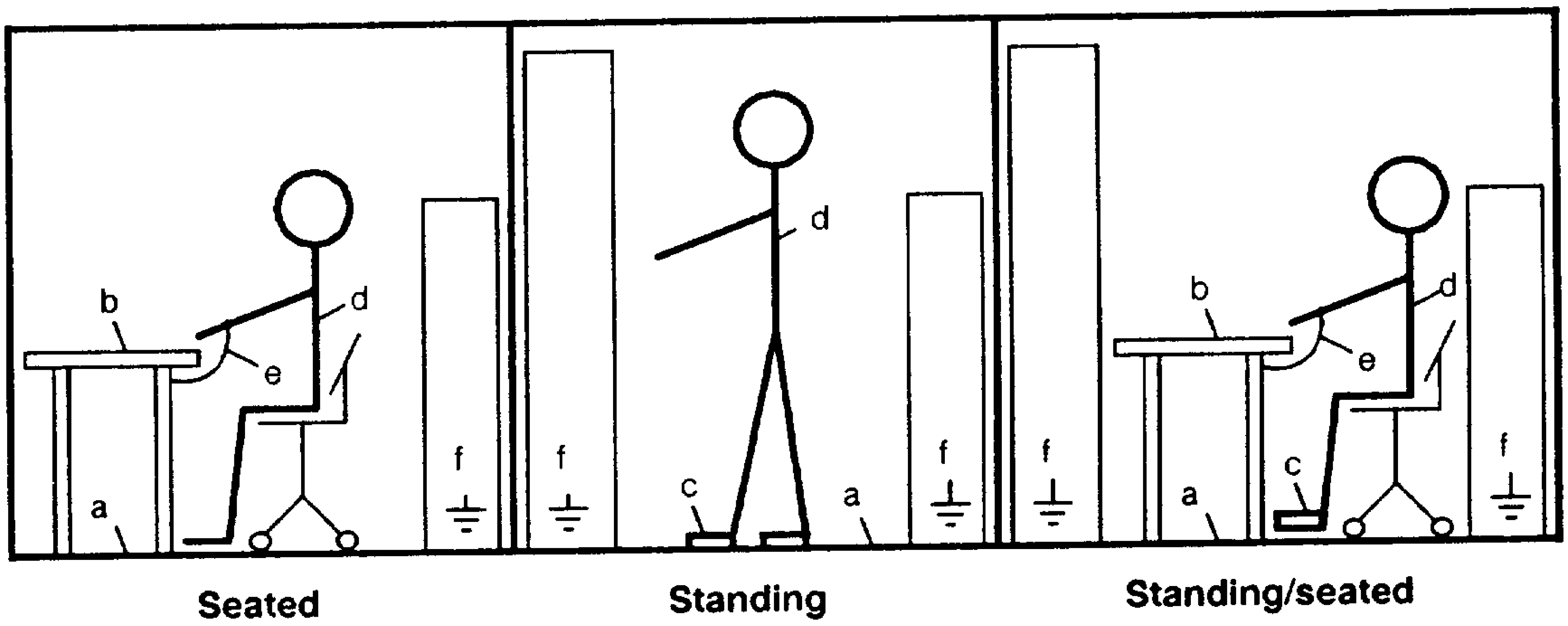
Boards must only be placed on conductive surfaces.

When soldering, the solding iron tip must be grounded.

Boards and components should only be stored and transported in conductive packaging (e.g. metalized plastic boxes, metal containers).

If the packing material is not conductive, the boards must be wrapped with a conductive packing material, e.g. conductive foam rubber or household aluminum foil.

The necessary ECB protective measures are clearly shown in the following diagram.



a = Conductive flooring
b = ECB table
c = ECB shoes

d = ECB overall
e = ECB chain
f = Cubicle ground connection

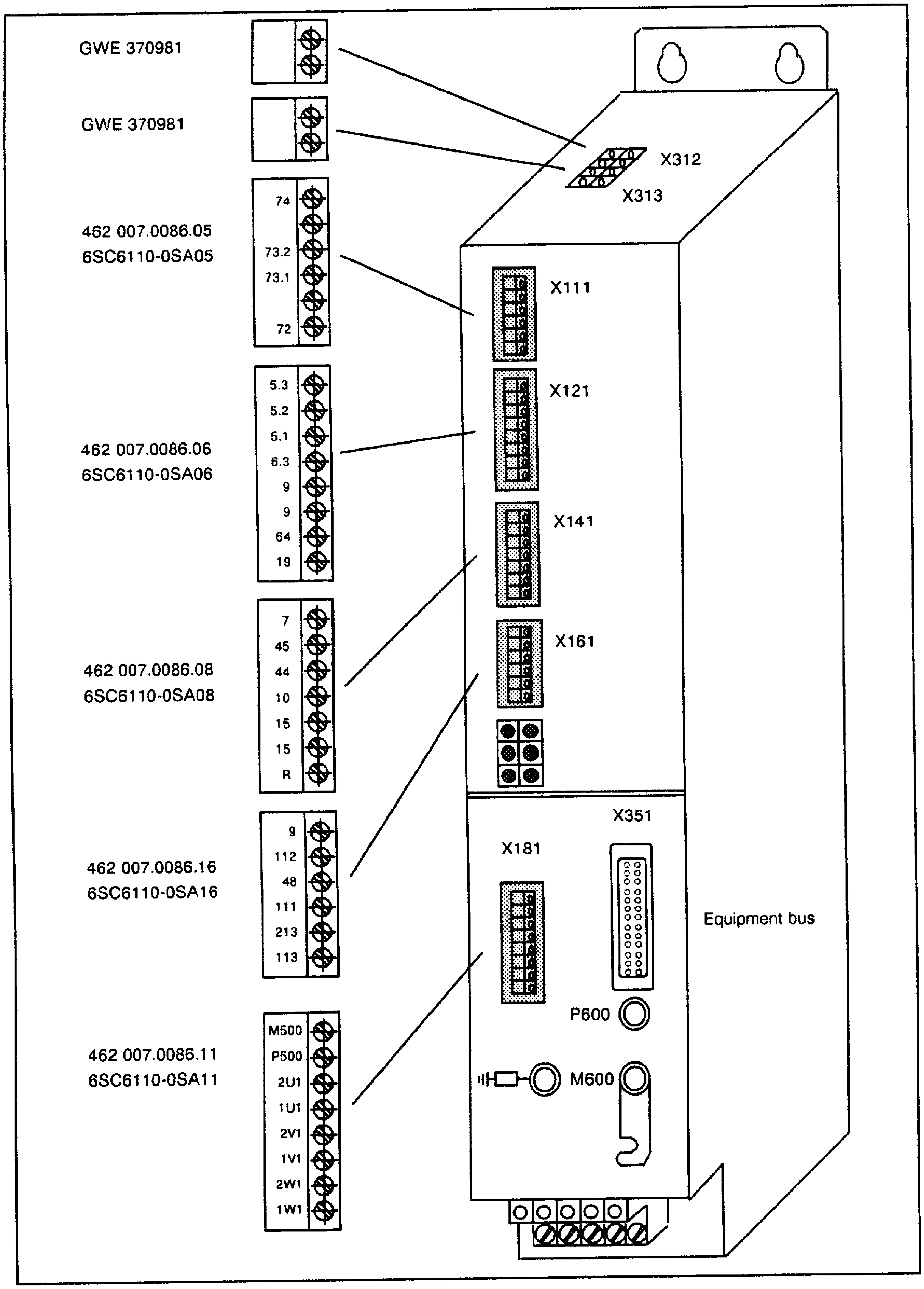
 6ZB5 420-0AS02
SIMODRIVE (PJ)

3.10 Terminals

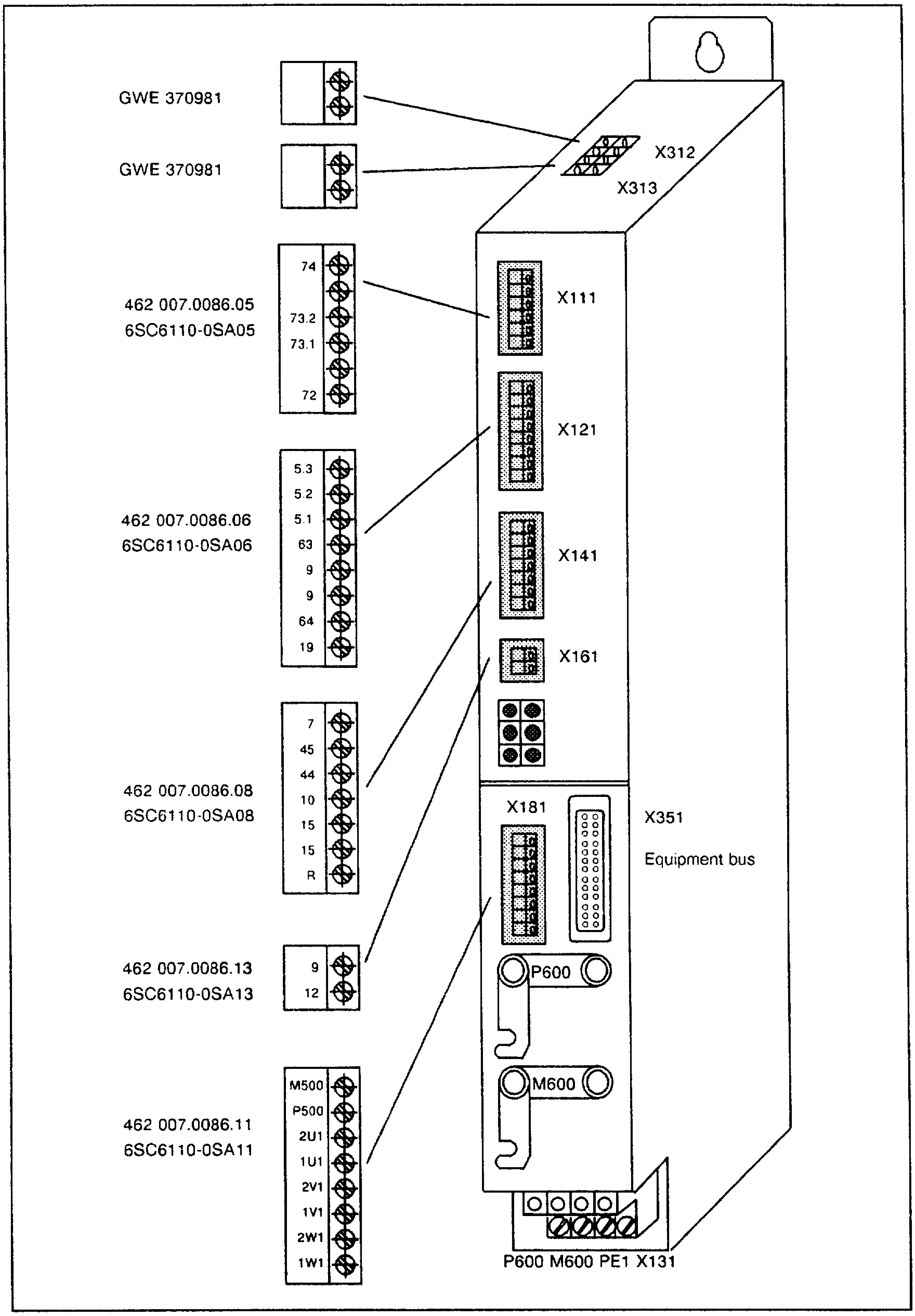
3.10.1 Infeed/regenerative feedback unit; monitoring module

Term. No.	Location	Function	Type 1)	Typical voltage	Max. cross-section
U1 V1 W1	I/R	Supply	I	3-ph. 380 V AC	25 mm²
PE1	I/R	Protective conductor	I	0 V	25 mm²
PE1	MM	Protective conductor	I	0 V	16 mm²
P600		DC link	I/O	+300 V	Busbar
M600		DC link	I/O	−300 V	Busbar
P600	MM	DC link	I	+300 V	16 mm²
M600	MM	DC link	I	−300 V	16 mm²
	X131	Electronics M	I/O	0 V	16 mm²
	X151/351	Equipment bus	I/O	Various	Ribon cable
M500	X181	DC link power supply	I	600 V	1.5 mm²[3)]
P500	X181	DC link power supply	I	600 V	1.5 mm²[3)]
1U1	X181	Output L1	O	380 V	1.5 mm²
2U1	X181	Input L1	I	380 V	1.5 mm²
1V1	X181	Output L2	O	380 V	1.5 mm²
2V1	X181	Input L2	I	380 V	1.5 mm²
1W1	X181	Output L3	O	380 V	1.5 mm²
2W1	X181	Input L3	I	380 V	1.5 mm²
7	X141	P24	O	+18...30 V/50 mA	1.5 mm²
45	X141	P15	O	+15 V/10 mA	1.5 mm2
44	X141	N15	O	−15 V/10 mA	1.5 mm²
10	X141	N24	O	−18...30 V/50 mA	1.5 mm²
15	X141	M	O	0 V	1.5 mm²
R	X141	Reset	I	Term.15/R_E = 10 kΩ	1.5 mm²
5.3 5.2 5.1	X121 X121 X121	Relay contact, group signal I²t motor temperature	NC NO I	+30 V/1.0 A	1.5 mm² 1.5 mm² 1.5 mm²
63	X121	Pulse enable[4)]	I	+12 V...30 V/R_E = 1.5 kΩ	1.5 mm²
9	X121	Enable voltage[4)]	O	+24 V	1.5 mm²
64	X121	Drive enable[4)]	I	+12 V...30 V/R_E = 1.5 kΩ	1.5 mm²
19	X121	Enable voltage (ref. pot.)[4)]	O	0 V	1.5 mm²
74 73.2 73.1 72	X111 X111 X111 X111	Relay contact Signal Ready	NC I I S	250 V AC/1 A 30 V DC/1 A	1.5 mm² 1.5 mm² 1.5 mm² 1.5 mm²
9	X161	Enable voltage[4)]	O	+24 V	1.5 mm²
112	X161	Setting-up oper./normal oper.[2)]	I	+12 V...30 V/R_E = 1.5 kΩ	1.5 mm²
48	X161	Contactor control[3)]	I	+12 V...30 V/R_E = 1.5 kΩ	1.5 mm²
111 213 113	X161 X161 X161	Auxiliary contact center point Pre-charging contactor Line contactor	I NO NO	+30 V/1 A	1.5 mm²[3)] 1.5 mm²[3)] 1.5 mm²
	X313	Screen connection PE	O	0 V	2×1.5 mm²
	X312	Screen connection X131	O	0 V	2×1.5 mm²

1) I ≙ Input O ≙ Output NC ≙ Normally closed contact NO ≙ Normally open contact (for signal NO = high/NC = low)
2) Terminals 112 and 9 must be jumpered in standard operation
3) Terminal available from infeed/regenerative feedback unit and monitoring module, version .01
4) Reference ground terminal 19 (not connected with the general reference ground terminal 15)



Connectors for the infeed/regenerative feedback unit 6SC611□-□VA01 (standard version)

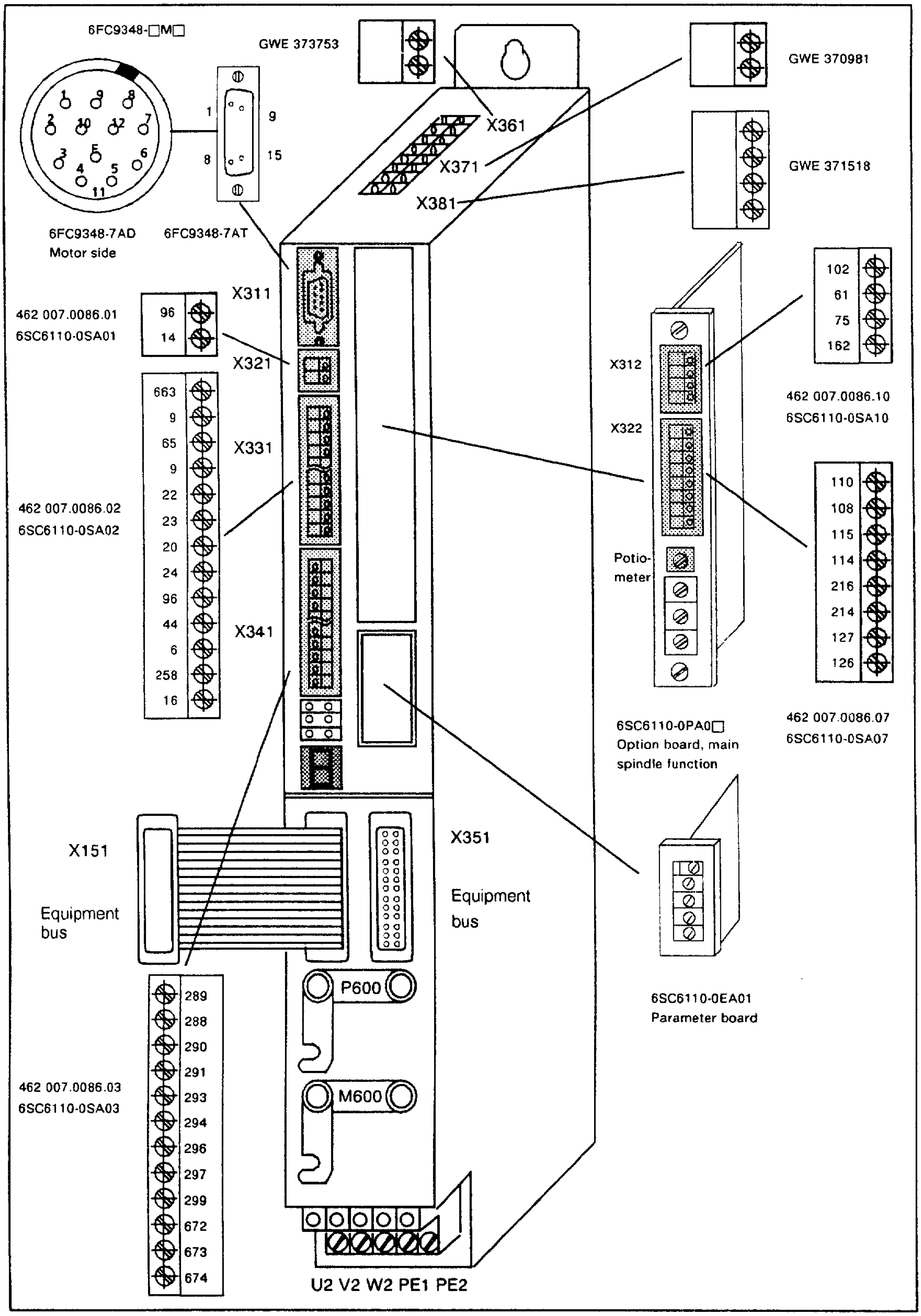


Connectors for the 6SC6110-0GA01 monitoring module

3.10.2 Feed module including main spindle drive option

Term. No.	Location	Function	Type 1)	Typical voltage	Max. cross-section
U2 V2 W2		Motor supply	O	3-ph. 600 V AC	6 mm² (3/6/12 A mod.) 16 mm² (20 A mod.) 25 mm² (40/60 A mod.) 35 mm² (80 A mod.)
PE1 PE2		Protective conductor	I	0 V	6 mm² (3/6/12 A mod.) 16 mm² (20 A mod.) 25 mm² (40/60 A mod.) 35 mm² (80 A mod.)
P600		DC link	I/O	+300 V	Busbar
M600		DC link	I/O	–300 V	Busbar
	X151/351	Equipment bus	I/O	Various	Ribbon cable
	X361-X38	Screen connection distrib.	I/O	0 V	1.5 mm²
56 14[3)	X321 X321	Speed setpoint 1 (Differential input)	I I	0 V... ± 10 V	1.5 mm² 1.5 mm²
663	X331	Pulse enable[4)	I	+ 13 V...33 V/R_E = 1.5 kΩ	1.5 mm²
9	X331	Enable voltage[4)	O	+ 24 V	1.5 mm²
65	X331	Controller enable[4)	I	+ 13 V...33 V/R_E = 1.5 kΩ	1.5 mm²
9	X331	Enable voltage[4)	O	+ 24 V	1.5 mm²
22	X331	Select suppl. setpoint 1[4)	I	+ 13 V...33 V/R_E = 1.5 kΩ	1.5 mm²
23	X331	Select suppl. setpoint 2[4)	I	+ 13 V...33 V/R_E = 1.5 kΩ	1.5 mm²
20[3) 24	X331 X331	Supplementary setpoint (differential input)	I I	0 V to ± 10 V	1.5 mm² 1.5 mm²
96	X331	External current limiting	I	0 V to ± 33 V	1.5 mm²
44	X331	Electronics voltage	O	–15 V/10 mA	1.5 mm²
6	X331	Integr. inhibit, speed contr.	I	+ 15 V...33 V/R_E = 2.3 kΩ	1.5 mm²
258	X331	Slave/master	I/O	0 V... ± 10 V	1.5 mm²
16	X331	I_{act}	O	0 V... ± 10 V	1.5 mm²
289	X341	Signals, center contact	I	30 V/1.0 A max	1.5 mm²
288 290	X341 X341	Speed controller at limit	NO NC	30 V/1.0 A max[6) 30 V/1.0 A max[6)	1.5 mm² 1.5 mm²
291 293	X341 X341	I^2t monitoring	NO NC	30 V/1.0 A max[6) 30 V/1.0 A max[6)	1.5 mm² 1.5 mm²
294 296	X341 X341	Motor overtemperature	NO NC	30 V/1.0 A max[6) 30 V/1.0 A max[6)	1.5 mm² 1.5 mm²
297 299	X341 X341	Tachogenerator and rotor position encoder monitoring	NO NC	30 V/1.0 A max[6) 30 V/1.0 A max[6)	1.5 mm² 1.5 mm²
672 673 674	X341 X341 X341	Ready/ fault	NO I NC	30 V/1.0 A max[6) 30 V/1.0 A max[6) 30 V/1.0 A max[6)	1.5 mm² 1.5 mm² 1.5 mm²
102	X312[5)	T_H = 10:1[4)	I	+ 13 V...33 V/R_E = 1.5 kΩ	1.5 mm²
61	X312[5)	C-axis[4)	I	+ 13 V...33 V/R_E = 1.5 kΩ	1.5 mm²
75	X312[5)	n_{act}	O	0 V... ± 10 V	1.5 mm²
162	X312[5)	$\|I_{act}\|/P_{act}$[7)	O	0 V... + 10 V	1.5 mm²
110 108	X322[5) X322[5)	$\|I_{act}\| > I_x$	NO/NC[2) I	30 V/1.0 A max 30 V/1.0 A max	1.5 mm² 1.5 mm²
115 114	X322[5) X322[5)	$\|n_{act}\| < n_{min}$	NO/NC[2) I	30 V/1.0 A max 30 V/1.0 A max	1.5 mm² 1.5 mm²
216 214	X322[5) X322[5)	$\|n_{act}\| < n_x$	NO/NC[2) I	30 V/1.0 A max 30 V/1.0 A max	1.5 mm² 1.5 mm²
127 126	X322[5) X322[5)	$n_{act} = n_{set}$	NO/NC[2) I	30 V/1.0 A max 30 V/1.0 A max	1.5 mm² 1.5 mm²

1) *I ≙ Input O ≙ Output NC ≙ NC contact NO ≙ NO contact (for signal, NO = high/NC = low))*
2) *Can be optionally switched-over using jumpers (refer to Section 3.7)*
3) *Differential input reference point*
4) *Reference ground, terminal 19 (not connected with the general reference ground, terminal 15)*
5) *On the main spindle option board*
6) *Voltage referred to PE potential*
7) *Valid for main spindle drive option .01*



Connectors for the 6SC611□-□AA00-Z feed module with main spindle drive option 6SC6110-0PA0□

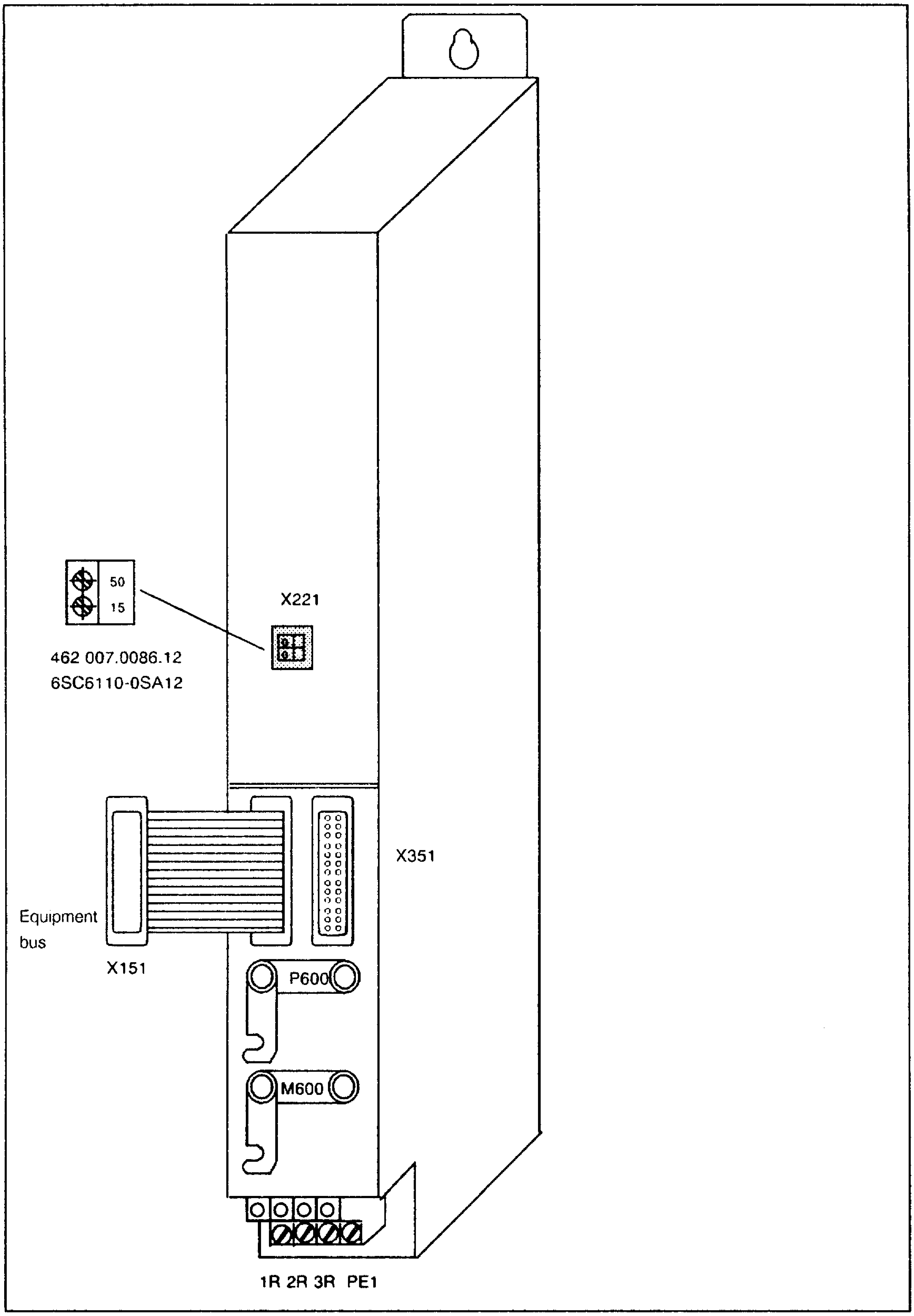
3.10.3 Pulsed resistor module

Terminal No.	Location	Function	Type 1)	Typical voltage	Max. cross-section
1R		Pulsed resistor output	O	+600 V	16 mm^2
2R		Pulsed resistor, internal	I	+600 V	16 mm^2
3R		Pulsed resistor, external	I	+600 V	16 mm^2
P600		DC link	I/O	+300 V	Busbar
M600		DC link	I/O	-300 V	Busbar
PE1		Protective conductor	I	0 V	16 mm^2
	X151/351	Equipment bus	I/O	Various	Ribbon cable
15	X221	M	O	0 V	1.5 mm^2
50	X221	DC link discharge	I	Term. 15	1.5 mm^2

If external 24 V power supplies are used with the modules (signals including the enable signals), then their ground potential should be connected to the enable voltage reference potential (terminal 19).

When using numerical controls with non-floating electronic outputs, terminal 19 must be connected to the NC reference potential (connect terminals 19 and 15).

1) *I ≙ Input O ≙Output*



Connectors for the 6SC6110-0GB00 pulsed resistor module

3.10.4 Terminal description, main- and supplementary setpoints

The individual setpoint inputs are assigned to the main and supplementary setpoints corresponding to the operating modes. The following combinations are possible:

Operating mode	Setpoint	Differential input 1, term. 56/14	Differential input 2, term. 24/20	Select internal setpoint 1, term. 22	Select internal setpoint 2, term. 23	Socket NZ	Master-slave term. 258
Speed controlled	Main setpoint	X					
	Suppl. setpoint		X	X	X	X	
Current controlled	Main setpoint		X				
	Suppl. setpoint			X			
Slave (current contr.)	Main setpoint						X
	Suppl. setpoint						

Explanation regarding the table:

X	Optimum, taking into account the setpoint input characteristics
(blank)	Possible
(shaded)	Not permissible, and to some extent, not possible

Characteristics of the setpoint inputs:

Operating mode	Setpoint input	Ref.terminal of the setpoint input for int./ext. voltages	Smoothing	Adaption for reference via the setpoint input	Setpoint available at test socket
Speed controlled	Differential input 1, term. 56/14	Term. 14 / term. 14	Parameter board: $\tau = C4 \cdot 10\ k\Omega$, e.g. C4 = 470 nF	X	Test socket R
	Differential input 2, term. 24/20	Term. 20 / term. 20	Control board, fixed: $\tau = 680\ \mu s$		
	Select, suppl. setpoint 1, term. 22	--[1] / term. 19	Smoothing not possible		
	Select, suppl. setpoint 2, term. 23	--[1] / term. 19	Smoothing not possible		
	Socket NZ	Term. 14[2] / term. 14	Parameter board: $\tau = C4 \cdot 10\ k\Omega$,	X	Test socket R
Current controlled	Differential input 2, term. 24/20	Term. 20 / term. 20	1st stage - control board: $\tau = 680\ \mu s$ (fixed) 2nd stage - parameter board: $\tau = C6 \cdot 1\ k\Omega$		Test socket T: Setpoint at term. 24/20 is intern. inverted, inverted setpoint available at socket T
	Select suppl. setpoint 1, term. 22	--[1] / term. 19	Parameter board: $\tau = C6 \cdot 1\ k\Omega$		Test socket T
	Select suppl. setpoint 2, term. 23	--[1] / term. 19	Parameter board: $\tau = C6 \cdot 1\ k\Omega$		Test socket T
Slave (current contr.)	Master-slave term. 258	--[1] / term.15	Smoothing with C6, whereby the number of slave axes is included: $\tau = (C6_{master} + C6_{slave1} + ...C6_{slaves}) \cdot 1\ k\Omega$		Test socket T

Characteristics of the setpoint inputs

1) *--/: When using internal voltages, the reference potentials are already connected together.*

2) *If terminal 14 is open-circuit or is connected to M, socket M or terminal 15 can be selected as reference terminal.*

- The absolute supplementary setpoint is defined as follows using R_x if it is not 10 V:

$$R_x = \frac{20\ \text{k}\Omega\ (10\ \text{V} - |n_{set}|)}{|n_{set}|}$$

$|n_{set}|$: Absolute speed setpoint value in V

R_x: Depending on supplementary setpoint 1 or 2 (selected using terminals 22 or 23) and the required direction of rotation, one of the resistors R16, R17, R19 or R21 should be selected (refer to the following table).

- If $R_x > 1\ \text{M}\Omega$, a voltage divider should be used.

  Depending on whether supplementary setpoint 1 or 2 is used 1kΩ should be mounted in one of the resistor locations R18 or R22 , either 1 or 2 (refer to the subsequent table). Resistor R_x can then be determined using the following equation

$$R_x = \frac{0.95\ \text{k}\Omega\ (10\ \text{V} - |n_{set}|)}{|n_{set}|}$$

  Motor direction of rotation when viewing the motor shaft:

  - Positive setpoint at terminals 56/14, terminals 24/20, terminal 258, socket NZ
  - DIL switch S2.1: ON (OFF): all directions of rotations reversed

Operating mode	Motor direction of rotation					
	Differential input 1, term. 56/14	Differential input 2, term. 24/20	Suppl. setpoint 1, term. 22	Suppl. setpoint 2, term. 23	Socket NZ	Master-slave term. 258
Speed controlled	↺	↻	R16 (R18) ↻ R17 (R18) ↺	R19 (R22) ↻ R21 (R22) ↺	↺	
Current controlled		↻	R16 ↻ R17 ↺	R19 ↻ R21 ↺		↻

4 Commutating reactors

4.1 Application

For converters connected to single-phase and three-phase supplies, reactances are always required on the supply side of the converter to limit supply voltage dips due to commutation. Converters which are directly connected to the supply must be connected through commutating reactors.

The minimum value of the voltage drop of the commutating reactor should be approximately 4%, so that for a ratio of the installed load to the short-circuit rating of the supply at the connection location, of 1:100, the commutating dips do not exceed 20% of the peak value of the basic fundamental (DIN VDE 0160, 5.3.1.3).

Please note, that the commutating reactor data is valid for a 50 Hz supply frequency. The rated AC current of the reactor must be reduced to 90% of the specified value when operated at 60 Hz.

Further, the reactor is an energy storage device for the step-up controller in the infeed/regenerative feedback unit. The reactor has higher harmonic losses due to the higher clock frequencies. These additional losses have been taken into account in the design.

Every infeed/regenerative feedback module requires its own commutating reactor as specified.

4.2 Design

- General

  The commutating reactors correspond to protection class I according to DIN VDE 0550/0532. There are no open live components which can be touched.

- Insulation system

  The commutating reactors described in the following have insulation class H. They are only thermally utilized to insulation class F which provides a higher thermal reserve in operation. A high short-time overload capability is achieved as a result of the special core and winding design. This is especially advantageous for use with SIMODRIVE 611.

- Terminals

  The commutating reactors are equipped with the proven SIGUT terminals. The cable cross sections which can be connected allow DIN VDE 0113, Table B II to be used for series machines, routed in cable ducts, at +40°C ambient temperature.

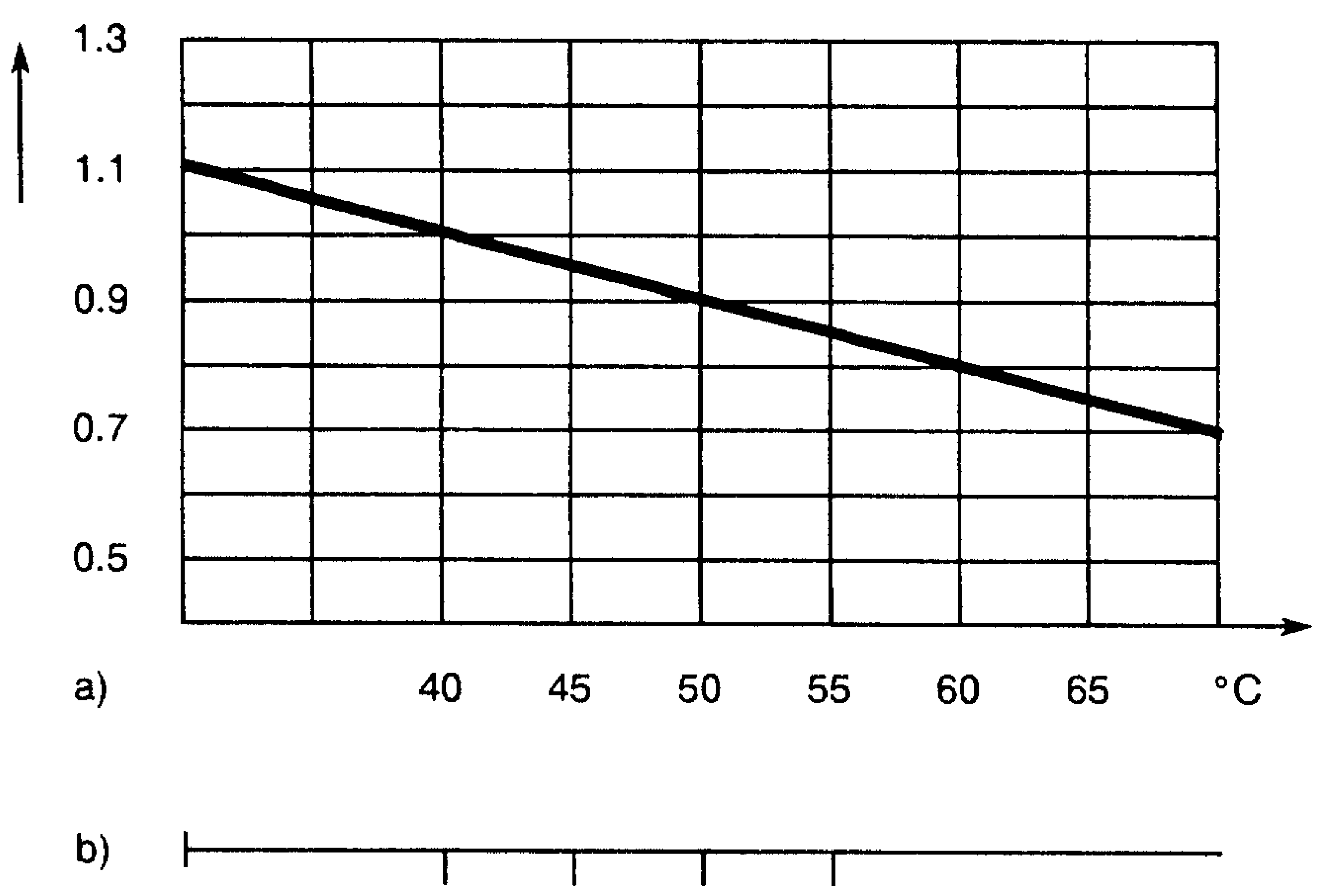
4.3. Technical data

The technical data is based on specific conditions under which the commutating reactors can be loaded:

- Continuous operation S1
- Frequency 50 Hz/60 Hz
- Installation altitude up to 1000 m above sea level
- Degree of protection IP 00
- Ambient temperature +40 °C

A reduction factor C must be applied for different ambient temperatures and installation altitudes. The permissible current capacity of the commutating reactor is then given by:

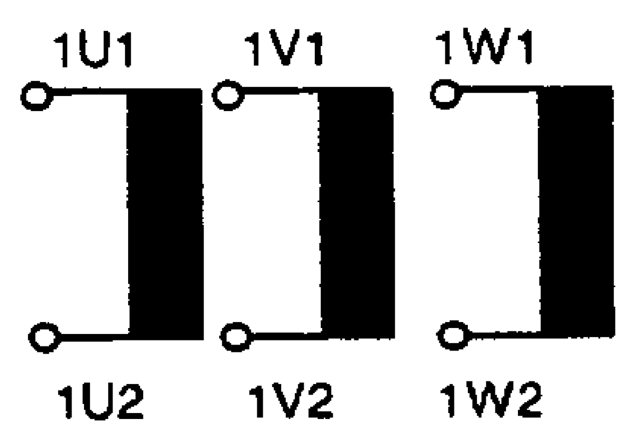
I_{LN} reduced = c · I_{LN}



Reduction factor as a function of

a) Ambient temperature above +40 °C
b) Installation altitudes above 1000 m

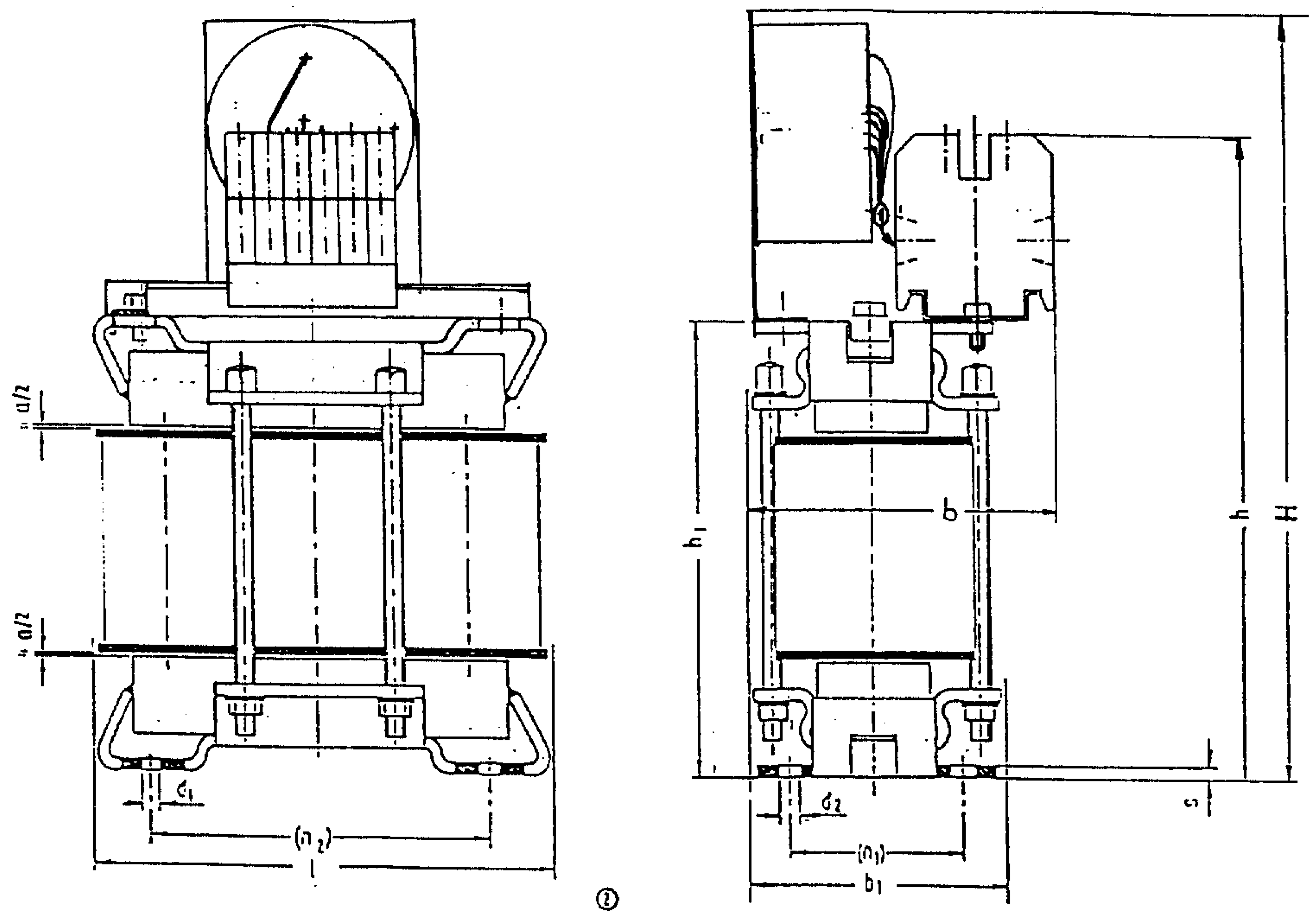
Reduction factor c

Commutating reactor type	4EP3803-2DS	4EP4003-8DS	T60405-A4930-X091	4EP4100-0DS	4EU3081-2EA00
Supply voltage	3-ph. 380V AC (400 V) 50/60 Hz				
$I_{rated\ eff}$	13.5 A	21 A	22 A	42 A	105 A
Voltage drop ΔU at $I_{rated\ EMS}$, per reactor phase	7.4 V	7.6 V	13 V	7.9 V	9.1
Reactor losses	80 W	110 W	110 W	170 W	370 W
Phase inductance L_S	1.75 mH	1.15 mH	1.1 mH	0.6 mH	0.27 mH
Weight	~ 8.5 kg	~ 13 kg	~ 8.8 kg	~ 16 kg	~ 44 kg
Terminals	8WA 1304	8WA 1304	8WA 1304	8WA 1305	8WA 1206
Cable cross-section (finely stranded)	16 mm²	16 mm²	16 mm²	35 mm²	70 mm²
Circuit diagram					

The commutating reactors are suitable for indoor installation with external climatic conditions according to DIN 50 010.

Ambient temperatures at rated power when de-rated lowest value for all types	 +40 °C +80 °C -25 °C
Relative air humidity at +40 °C, occassionally up to annual average up to Moisture condensation occassionally permissible	 100 % 80 %
Degree of protection	DIN 40050-IP 00

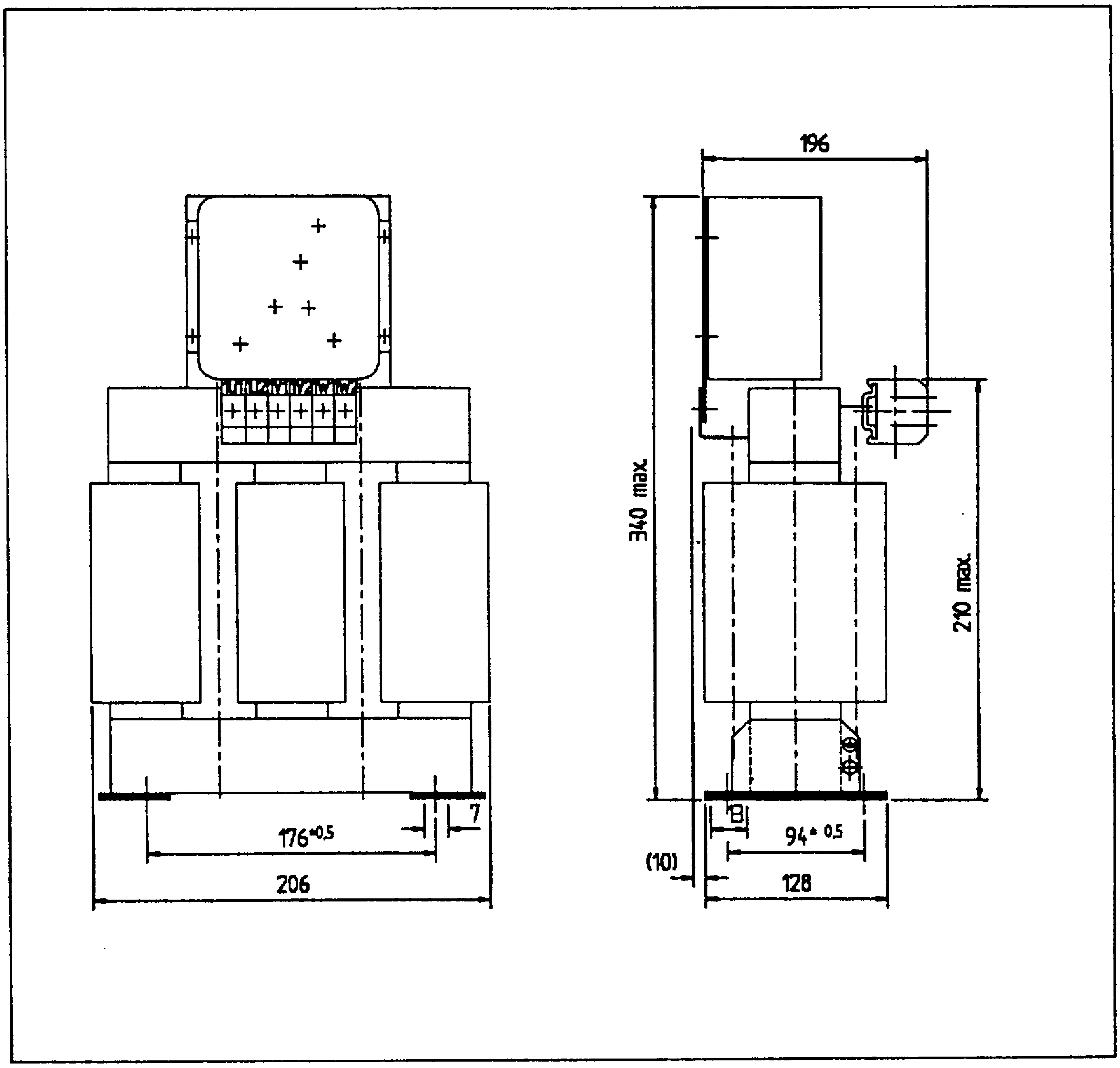
4.4 Dimension drawings of the commutating reactors



Dimension drawing of commutating reactors 4EP38, 4EP40

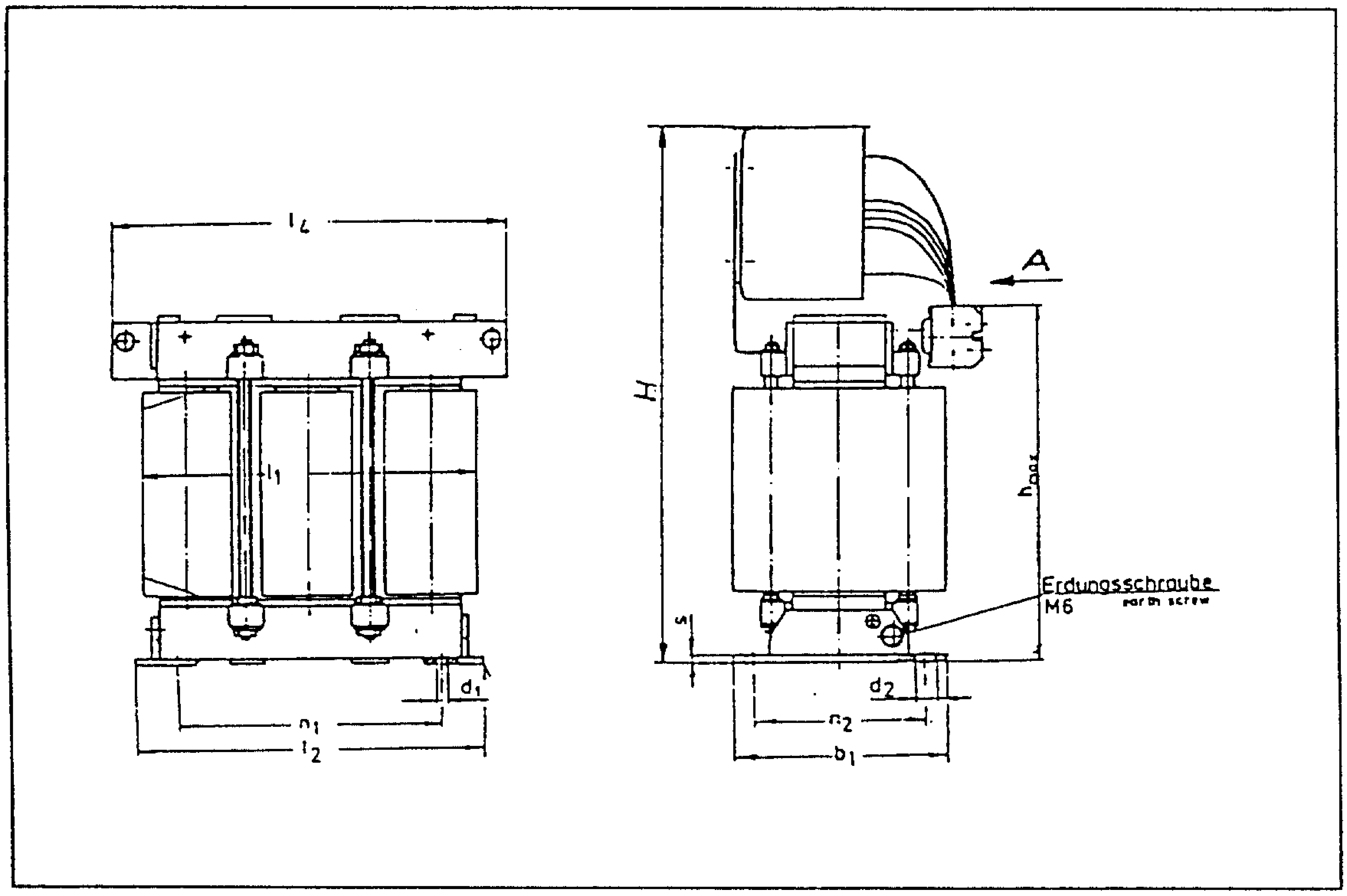
Commutating reactor		Main dimensions														
Type	Core section	l max.	h max.	b max.	H max.	h_1 max.	a max.	b_1 max.	s	d_1	d_2	d_3	n_1	n_2	Weight kg	Terminal type
4EP38	3UJ 75/400	153	170	133	240	150	5	90	2.5	6.0	8.0	M5	64	113	6.5	8WA 1304
4EP40	3UJ 90/500	182	195	146	260	175	5	102	3.0	7.0	10.0	M6	76	136	11.0	8WA 1304

Dimensions in mm



Dimension drawing of 4EP4100 - 0DS commutating reactors

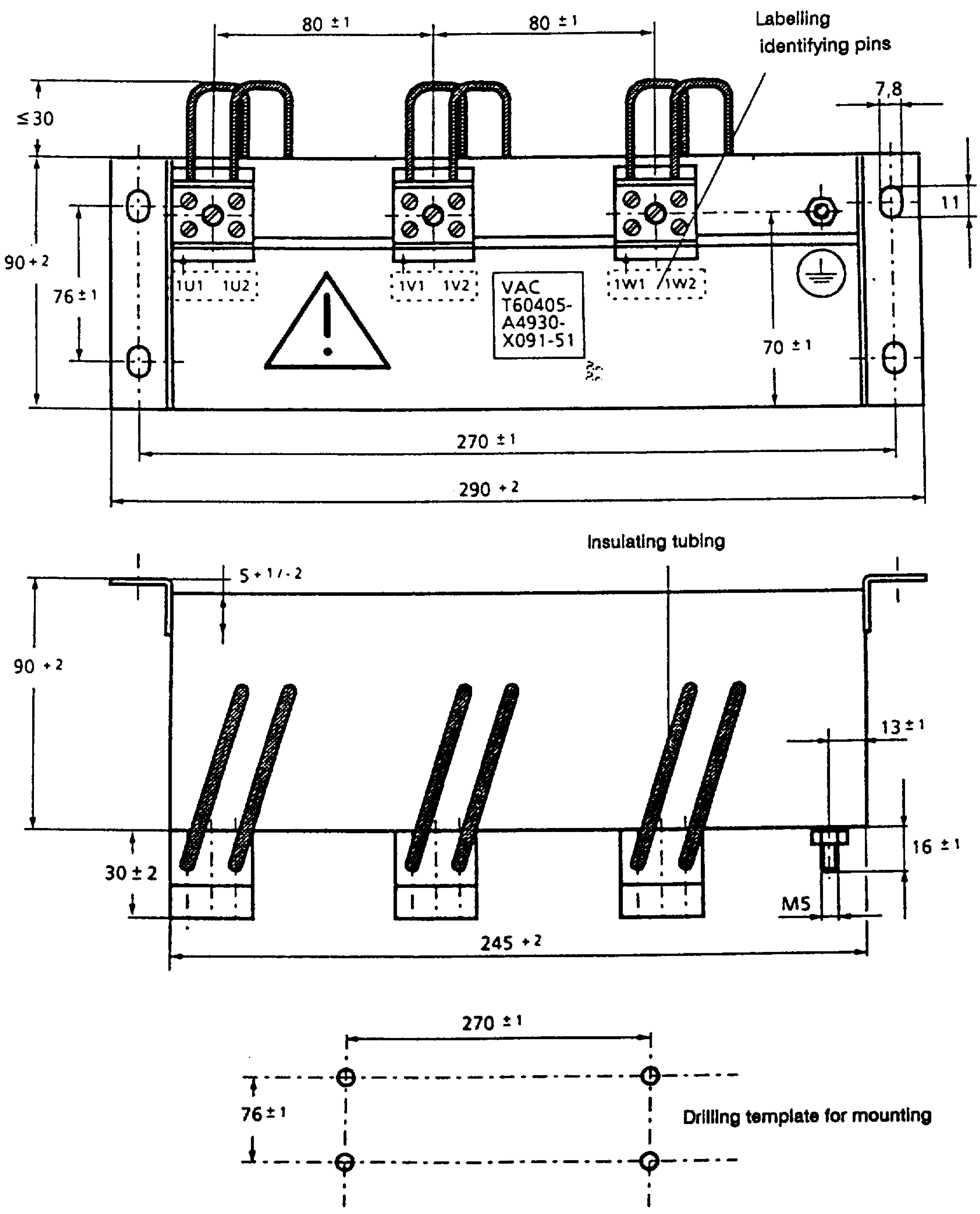
Dimensions in mm



Dimension drawing of commutating reactors EU

Commutating reactor		Main dimensions															Terminal type
Type	Core section	b_1 -0.5	h max.	L_4 ±1	H	d_1	d_2	d_3	l_1 max.	l_2 ±1	a	b_2 ±1	n_1 ±0.5	n_2 ±0.5	s	Weight kg	
4EU30	3UJ 150/75	155	280	310	420	10	18	M8	285	264	10	74	224	118	6	45	8WA 1206

Dimensions in mm



Terminal connection data

		mm²	AWG	[A]	U~[V]
Connection data	Finely stranded	10	8	61	500
Connection data	Solid	16	6	87	500

Dimension drawing of commutating reactors T60405-A4930-X091

5 Recommended circuit configurations

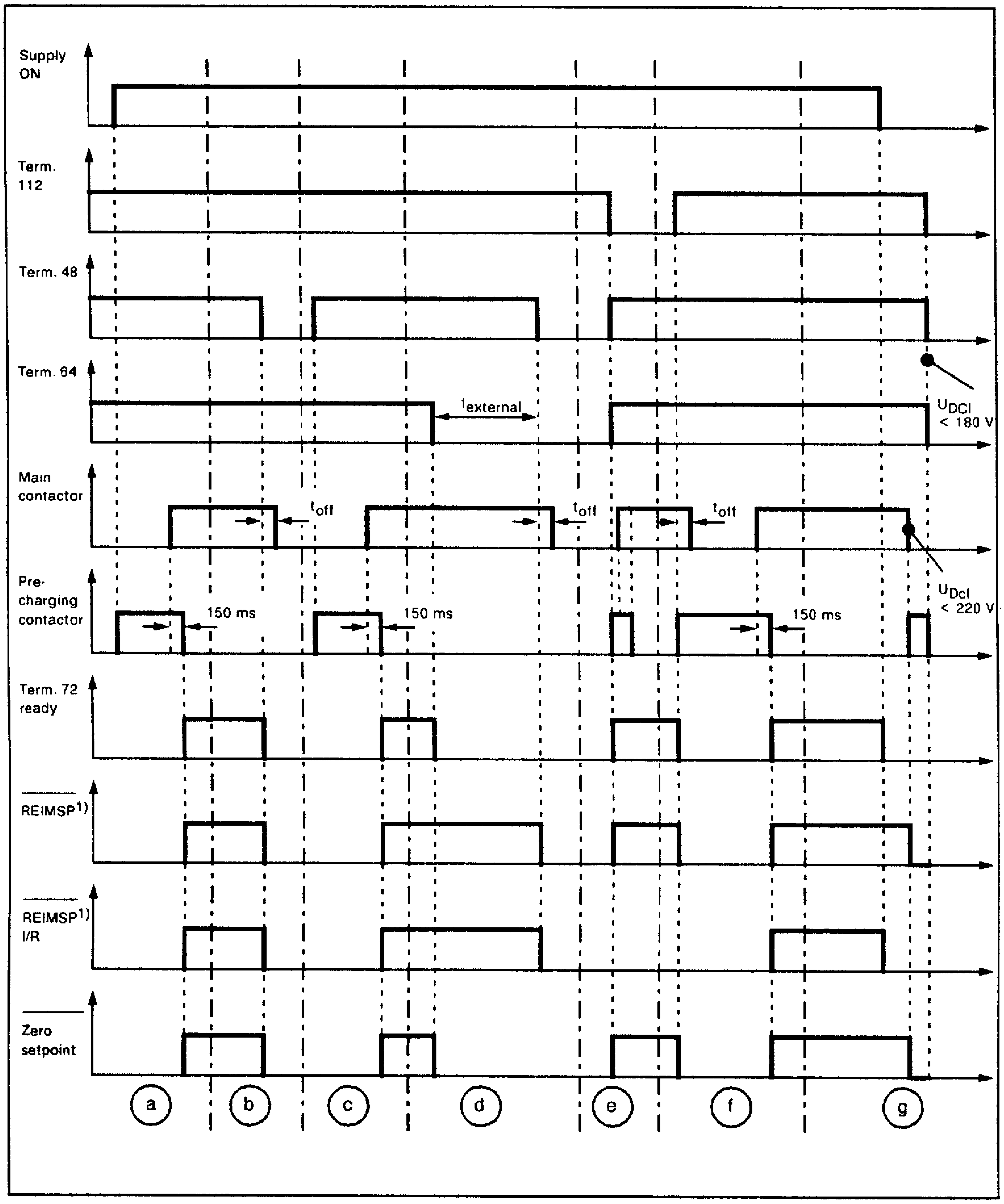
All of the recommended circuit configurations described here refer to the infeed/regenerative feedback unit with integrated control board N1, version .01 (can be connected up without observing the phase sequence), and monitoring board G1, version .01 (terminal 48, power supply buffering at supply failure).

The above boards are accommodated in all infeed/regenerative feedback modules, Order No. 6SC611□-□VA01. The contactor circuits represent pure functional sequences. Other functions are not shown (e.g. emergency stop).

Each individual application must be carefully considered from the safety aspect taking into account VDE 0113/EN 60204 and VDE 0160. The appropriately modified circuit should then be selected for a particular application and if required supplemented by additional external circuit components.

5.1 Internal enable interlocking for various modes

For enable signals which are continuously input externally (jumpers), these signals are internally inhibited, as shown in the following diagram, until the specific converter conditions for enable are fulfilled. Safe converter operation is thus essentially guaranteed even for erroneous external control operations.



Internal enable sequence

1) *REIMSP = Controller and pulse inhibit*

a Switching-on the unit with enable signals available:

When the supply voltage is switched-on via the main switch, the DC link is first pre-charged through pre-charging contactor K12 (valid for 3-conductor connection, terminal 48 jumpered). The axes (REIMSP) and the infeed/regenerative feedback (REIMSP-E/R) are inhibited during this drive-specific charging time, and zero setpoint (S0) is entered for all axes. A ready signal is not output.

After the charging sequence has been completed, main contactor K1 is energized, and after a delay (150 ms) the pre-charging contactor is opened and the setpoints and controller internally enabled. The ready signal indicates that the equipment is centrally ready for operation.

b Switching-off the equipment with terminal 48:

When terminal 48 is de-energized, all axes are inhibited (pulse cancellation), and the ready signal at the infeed/regenerative feedback module is withdrawn. All axes which are not at standstill, coast down.

The main contactor is de-energized, and the contacts open after the drop-out delay time has expired. The DC link discharges with its discharge time constant (approx. 1 min.). The electronics power supply remains operational.

c Switching-on the equipment with terminal 48:

When terminal 48 is energized (the enable voltage, terminal 9 connected), charging first starts through K12 as described under a). The completed charging sequence and the centrally enabled axes are signaled using the ready signal.

d Emergency stop:

When emergency stop is initiated, all connected axes must be brought to a standstill as quickly as possible and disconnected from the supply voltage. This is first realized by de-energizing the central drive enable signal (terminal 64). The ready signal drops-out instantaneously, and zero setpoint (S0) is internally entered, independent of any setpoints which are externally connected. All axes travel along their selected current limit to zero speed, and the pulses are cancelled after a monitoring time which is selected for each specific axis.
Terminal 48 can be de-energized (t__extern) after the longest monitoring time in the drive group has expired, and the pulses for all axes inhibited. The DC link is now disconnected from the supply and if short-circuit contactors are provided, they can shutdown axes which are still rotating due to an error condition, independent of the electronics.

If the DC link is to be quickly discharged through a contactor, before this contactor is switched-in, a delay is incorporated to take into account the drop-out time of the internal main contactor (approx. 100 ms and checkback signal contact, terminal 113).
The sequence is reversed when switching-on the unit; it must be ensured that the short-circuit contactor is first opened before terminal 48 or terminal 663 is energized!!!

e Switching-on the equipment in the setting-up mode:

To operate the equipment with reduced velocity, when terminal 112 is de-energized, internal main contactor K11 is switched-in independent of the charge condition of the DC link circuit or supply voltage magnitude. In this case, the supply monitoring and DC link monitoring are suppressed, and the DC link current controller remains inhibited. All axes receive an adjustable reduced current setpoint to reduce the maximum possible torque.

If the equipment is switched-on in this operating status, it should always be ensured, that when terminal 48 is energized, pre-charging contactor K12 is first switched-in, and then, after a timer has expired, main contactor K11. This means that the charging current is reduced, even with erroneous operator interventions, however, it cannot be prevented that the DC link is charged.

f Transition from setting-up- to standard operation:

To select standard operation from reduced velocity operation, only terminal 112 has to be energized. This instantaneously cancels all axis pulses and the ready signal is withdrawn. The main contactor opens after the drop-out delay, and the pre-charging contactor is closed to re-charge the DC link.

The monitoring functions are switched-in again after this charging sequence. This means, that up to this instant, the normal supply voltage must be available at terminals U1, V1, W1, as otherwise a supply fault will be identified and signaled and the infeed/regenerative feedback unit inhibited.

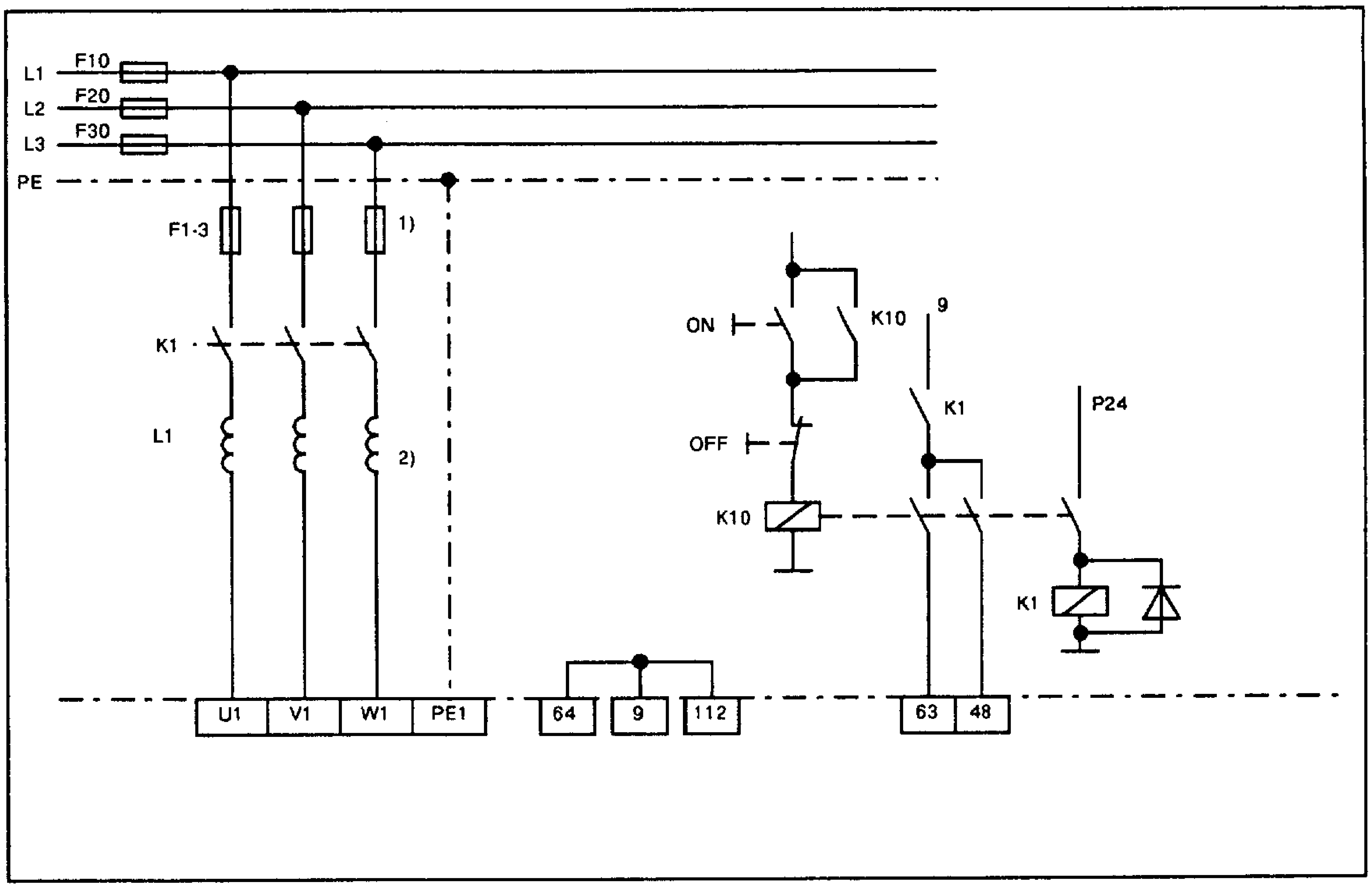
g Equipment operation during power failure:

The infeed/regenerative feedback module has a supply voltage monitoring function which, when it responds, immediately cancels the pulses for the DC link control. The fault is annunciated using the LED in the front panel.

When a pulsed resistor module is used, and the monitoring board is connected to the DC link (terminal P500, M500), the electronics power supply can be kept operational, even after a supply fault, in order to use the energy stored in the DC link to move the axes into a safe range. If the DC link voltage drops below a minimum value of 180 V, all enable signals are inhibited, and the electronics power supply shuts down. The equipment goes into a non-defined status.

The internal main contactor remains energized up to a DC link voltage of 220 V, and the DC link is discharged. The DC link pre-charging is not active, and thus, when the supply suddenly returns, the supply fuses could rupture due to the uncontrollably high DC link charging current.

5.2 Three-conductor supply connection



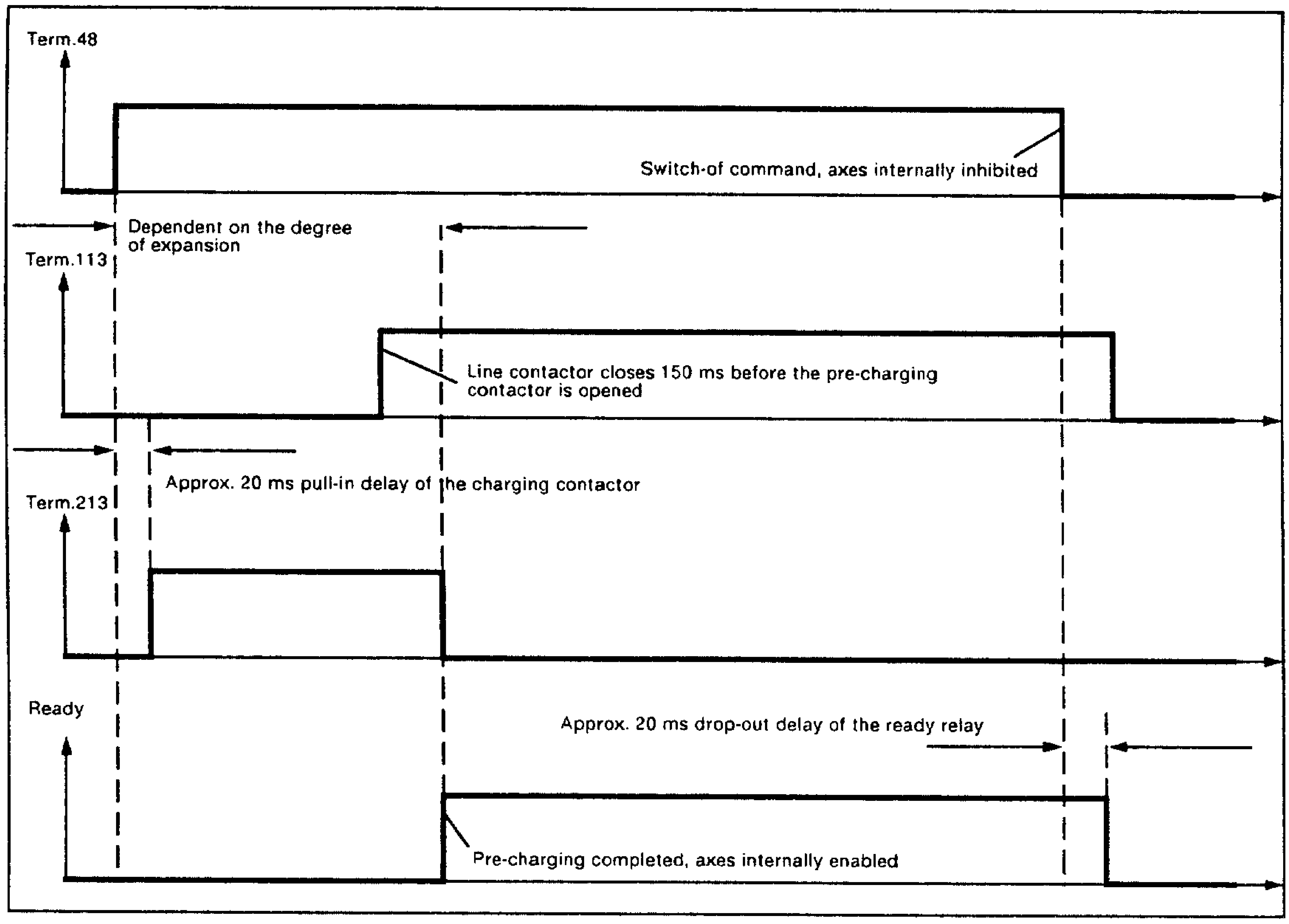
Three-conductor supply connection

For standard operation from the supply, the following points should be observed for the recommended circuit configuration above:

- When disconnecting from the supply, the pulses must be cancelled using terminal 63 on the infeed/regenerative feedback unit. At switch-on, DC link pre-charging is internally monitored, and the pulses are only enabled once the equipment is ready. At switch-off, the pulses are immediately inhibited via K10, and a drop-out delay is realized using the free-wheeling diode at K1.
- Contactor K1 is not absolutely necessary as the DC link is already isolated from the supply by the internal contactors[3]. In this case, the switch-on and switch-off sequence is only initiated via terminal 48, and the correct sequence of the enable signals is specified internally. Thus, terminal 63 can be jumpered.
  If the use of terminal 48 is also to be eliminated, then this can be connected to terminal 9, and the equipment start-up can be initiated when the main switch is actuated, when the electronic power supply voltages are established. Terminal 63 should be first de-energized when switching-off the equipment.

1) Use the specified semiconductor fuse type
2) Use the specified commutating reactor
3) This isolation does not represent safe electrical isolation

 6ZB5 420-0AS02
SIMODRIVE (PJ)



Switch-on and -off timing with terminals 63 and 64 jumpered

When the equipment is operated directly from the supply, the electronics power supply remains operational as long as the supply voltage is connected. When the DC link is connected to the supply this is signaled via terminals 111/113/213, when one of the two internal contactors are closed. This signal does not indicate that the DC link is in a no-voltage condition, as the discharge time constant of approx. 1 min. is effective at shutdown.

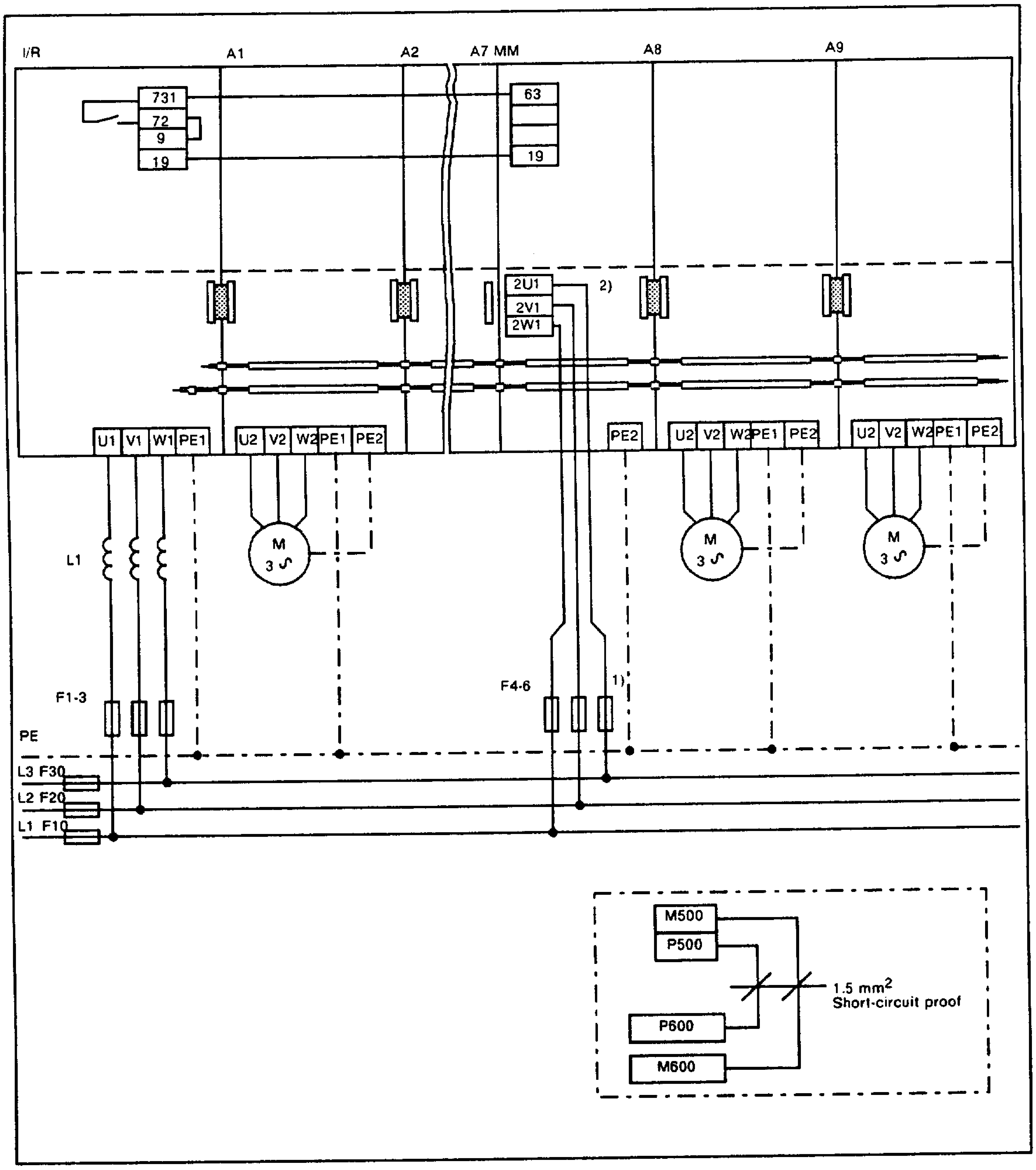
Charging is automatically initiated after supply ON and when the power supply voltages have established themselves by connecting terminal 48 to terminal 9. If the equipment is operated directly at the main switch, it can be run-up without any additional operator interventions. Also in this case, it should be ensured that the main switch is only opened when the pulses are first inhibited using terminal 63 on the converter.

5.3 Axis expansion using the monitoring module

The electronics power supply included in the infeed/regenerative feedback module can supply up to seven axes via the equipment bus, depending on the particular version. A monitoring module can be used to increase the number of axes.

The complete system now includes two separate electronic systems. Enable-and fault signals only influence the axes connected to a common equipment bus (the equipment bus is interrupted between the last axis and the monitoring module). In this case, it should be ensured that the axes, connected to the monitoring module can only be enabled, when the infeed/regenerative feedback unit signals the DC link is controlled via the ready signal.

Fault signals which are present, which affect the infeed/regenerative feedback unit, must act instantaneously on all of the axes connected at the monitoring module. To realize this, the infeed/regenerative feedback unit ready signal must be included in the monitoring module pulse enable (terminal 63).

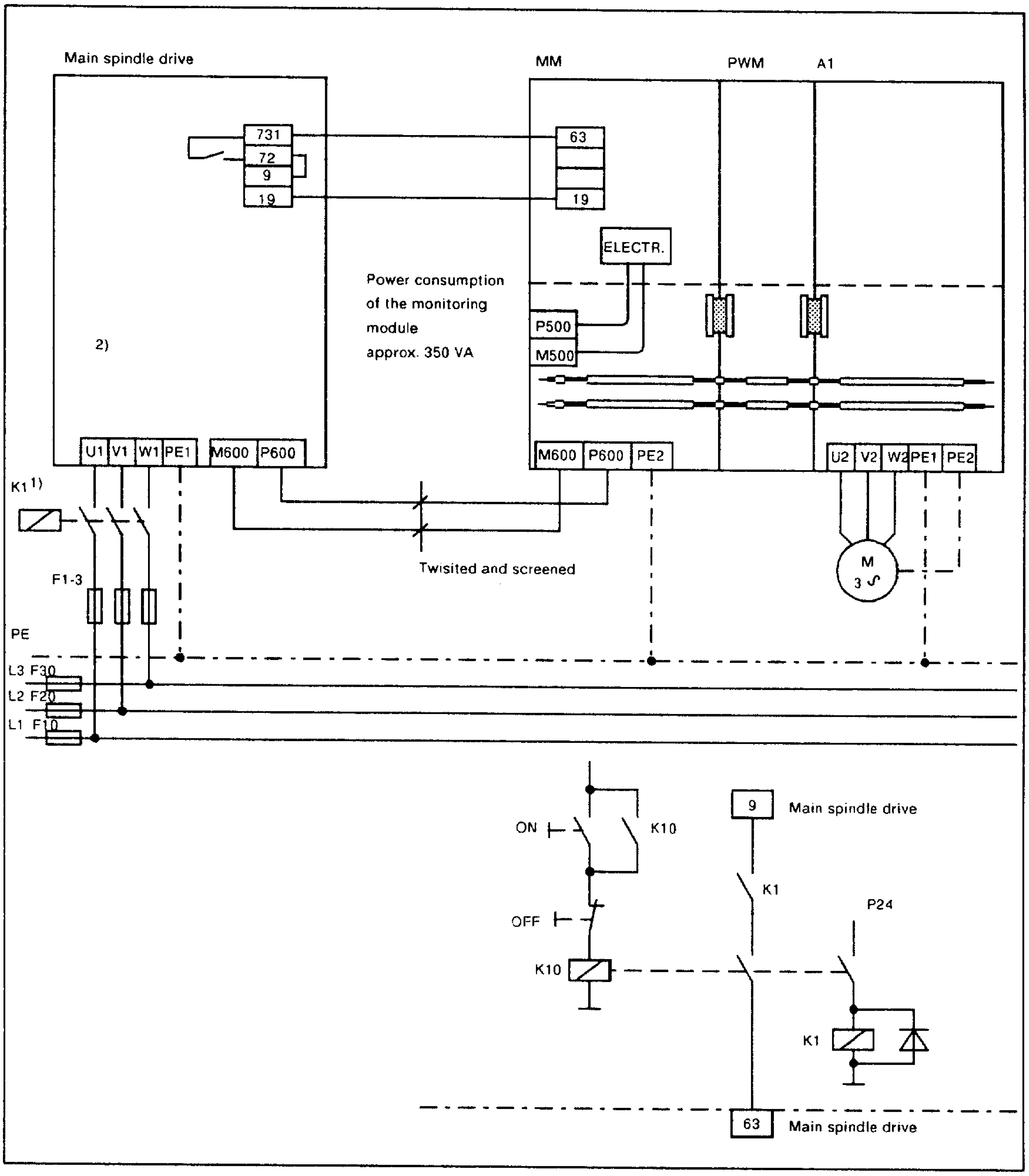


Axis expansion using the monitoring module

1) *Power consumption of the monitoring module is approx. 350 VA*

2) *Connection version, monitoring module*

5.4 Combination with SIMODRIVE 650/660



Coupling SIMODRIVE 650/660 and 611

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1) *K1 must remain energized for ≥ 40 ms when the supply fails.*
2) *In parameter P-53, bits 0 and 7 must be set to 1.*

The SIMODRIVE 611 converter can be simply coupled with a SIMODRIVE 650/660 using a monitoring- and pulsed resistor module if the selected main spindle drive motor requires more than 60 A continuous current. The DC links of both units are connected (cable cross-section according to the average feed drive rating).

When the converters are switched-on, the DC link of the SIMODRIVE 611 modules are pre-charged from the main spindle converter. The ready relay signals when charging has been completed, and the feed drive axes are enabled via terminal 63.

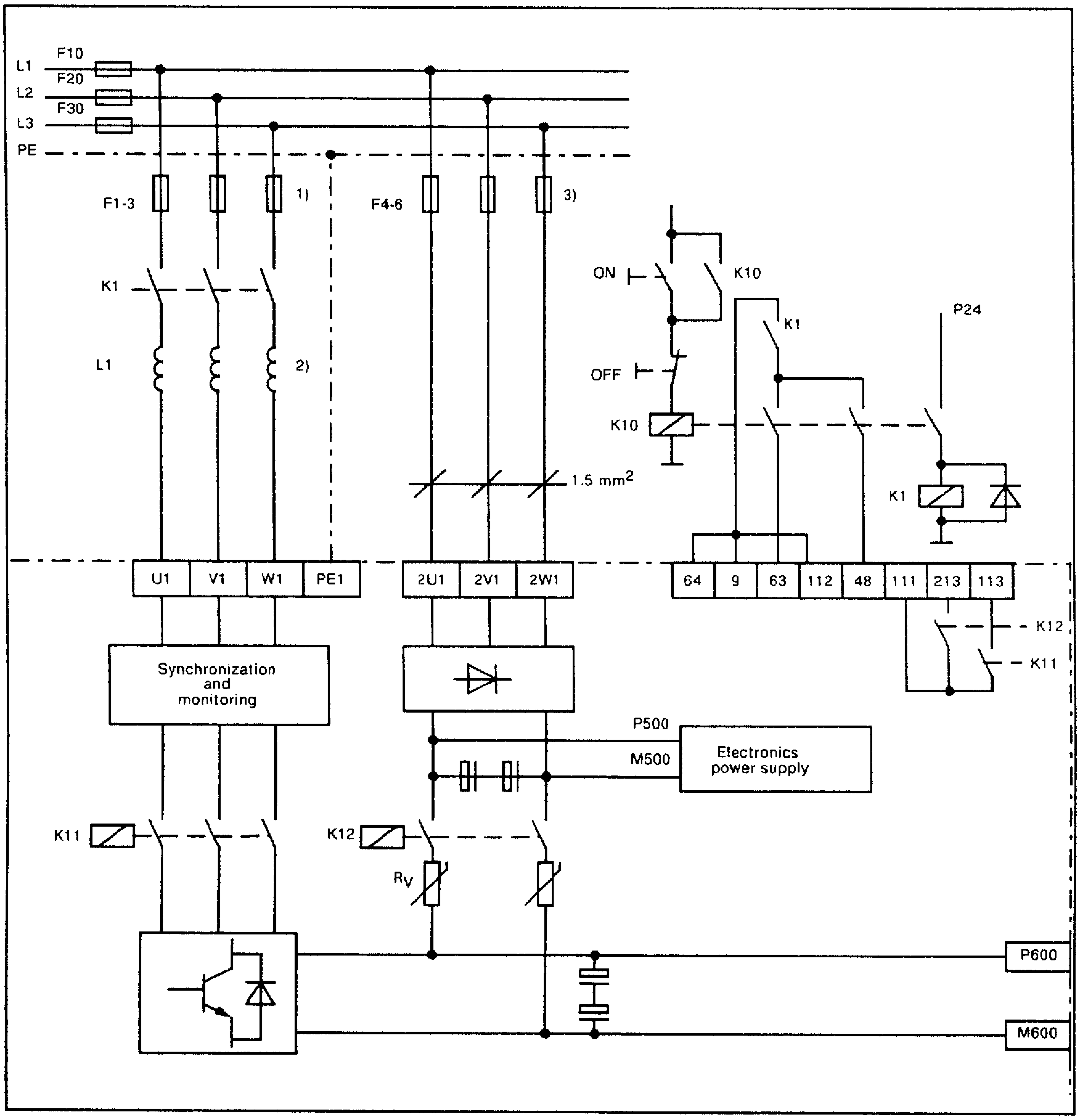
At shutdown, the SIMODRIVE 650/660 pulses are first cancelled and then the line contactor opened. The line contactor is also not necessary here, and the combination can be operated directly at the main switch, if it is ensured, that the main spindle converter pulses are inhibited before shutdown.

The power supply for the feed axes is operated directly from the DC link and is automatically switched-in when the switch-on threshold is exceeded.

The pulsed resistor module is necessary due to the limited dynamic performance of the thyristor bridge in the SIMODRIVE 650/660. However, it might not be required for low feed drive ratings and depending on the particular installation.

5.5 Six-conductor connection

To keep fault messages, even when the power is externally disconnected from the unit, with the six-conductor configuration, it is possible to continue to supply the electronics power supply after the voltage at main terminals U1, V1, W1 has been disconnected.
In this case, several internal switching sequences should be observed. The DC link pre-charging is taken from the same terminals as the electronics power supply. If terminal 48 is energized with voltage available at U1, V1, W1 and 2U1, 2V1, 2W1, relay K12 pulls-in, and the DC link is pre-charged through R_V. The charging time constant is a function of the degree of expansion and lies, for each module, between 2.5 and 100 ms (refer to the table in Section 5.6).



Six-conductor connection

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1) *Use the specified semiconductor type*
2) *Use the specified commutating reactor*
3) *Continuous current at V = 3-ph. 400 V AC approx. 600 mA, pulse current for charging, approx. 18 A (F ≥ 6.3 At).*

The DC link voltage and the current through PTC thermistor R_V are monitored during pre-charging (initiated via terminal 48). If the DC link voltage exceeds 270 V, and the charging current through the PTC thermistor has simultaneously decayed, the pre-charging sequence is considered to be completed, and the internal timers t1 and t2 started. Main contactor K11 is switched-on after t1 = 350 ms has expired. Pre-charging contactor K12 is opened after t2 = 500 ms has expired, and the drive is internally enabled.

The three-phase synchronization and supply voltage monitoring are taken from the main terminals U1, V1, W1. The supply voltage monitoring function is activated when main contactor K11 has pulled-in, pre-charging contactor K12 has dropped-out, and setting-up operation has not been selected. When a supply fault occurs, the infeed/regenerative feedback module unit pulses are cancelled, which in turn withdraws the central ready signal. The fault signal is self-latching, and can be cancelled by a reset pulse, by selecting setting-up operation, and by switching the unit off and on again (the supply fault does **not** affect connected axes, and is suppressed, if terminal 48 de-energized).

If terminal 48 is erroneously energized, without K1 being energized, the DC link is pre-charged through 2U1, 2V1, 2W1. The supply fault signal is issued after pre-charging, and the DC link discharges itself with the discharge time constant until the DC link voltage has dropped below 220 V, and a new charging sequence is initiated.

Main contactor k11 is energized during this discharge time. If main contactor K1 is now switched-in, this results in an unlimited high charging current and the line fuses rupture. Terminal 48 is thus interlocked with an auxiliary contact of K10, so that the unit is always switched-on through the pre-charging circuit.

5.6 Operation during supply failure

As the supply voltage monitoring only affects the infeed/regenerative feedback unit, when the supply voltage fails, the feed axes can be traversed until the DC link voltage drops below 220 V, which is that value which is required to maintain pulse enable.

To realize this, a pulsed resistor module must be used to transform the energy during braking (DC link controller is inhibited). If the axes must be moved to a safe position in this status, it should be taken into account that energy can be taken from the DC link during braking. Depending on the particular installation it might be necessary to increase the converter DC link capacitance by connecting-in external capacitors so that the required axis positions can be reached, before pulse cancellation is initiated when the DC link voltage reaches 220 V.

A differentiation must be made between two operating cases regarding the voltage difference which can be used. If the supply fails, when the DC link power is under 2 P_{rated}, the DC link voltage is at the controlled value of 600 V.

If the supply fails when an overload condition exists > 2 P_{rated}, the DC link voltage at the instant the supply fails, only corresponds to the rectified supply voltage, the minimum of which is $300\ V \cdot 1.35 \approx 400\ V$.

If a phase fails in the first case (fuse blows), the voltage difference which can be used is $V_{useful} = 600\ V - 200\ V \approx 380\ V$.

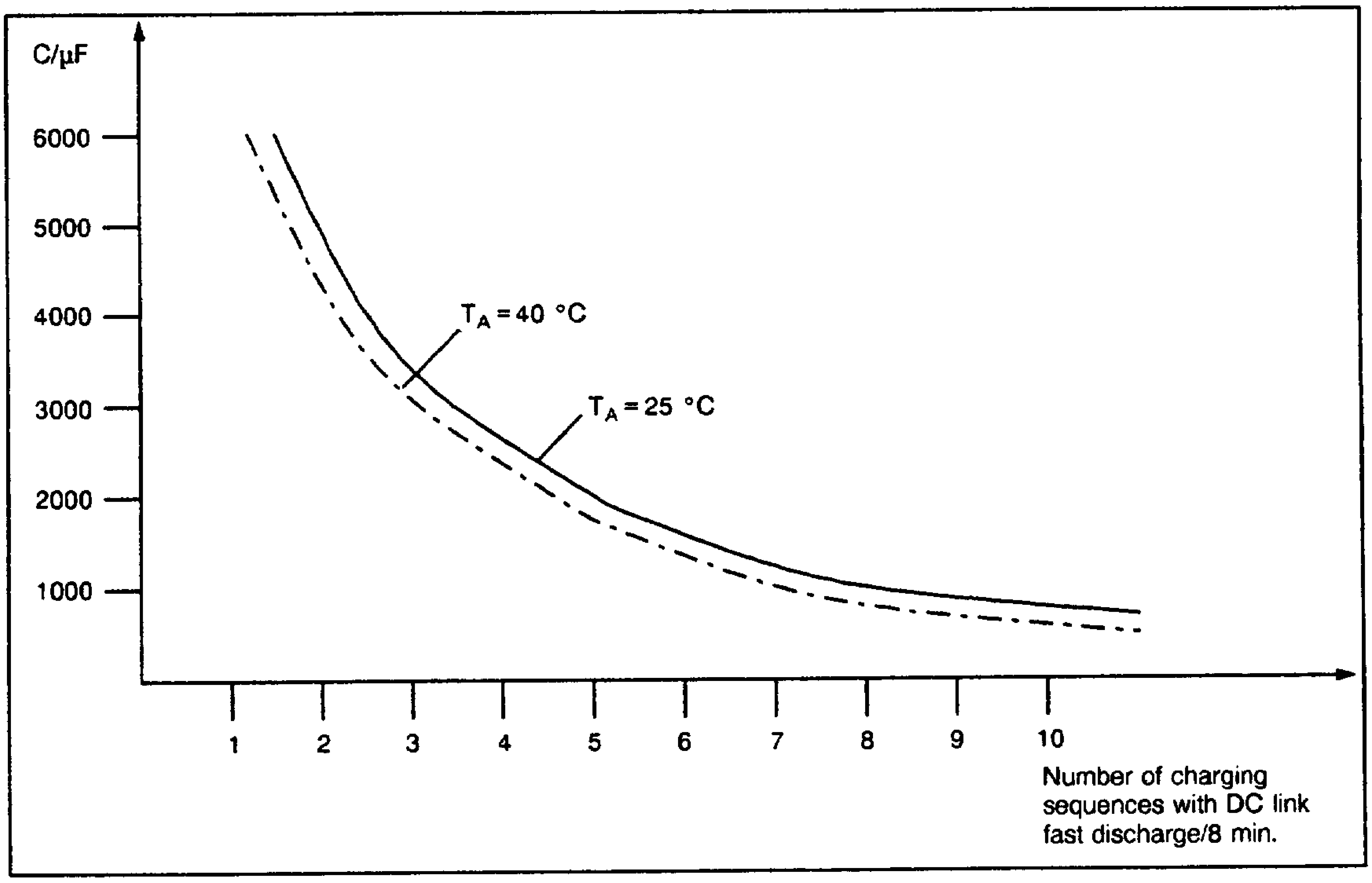
However, if all three supply phases fail, the DC link controller first attempts to increase the supply current as the DC link power used remains constant.

This sequence is continued, until the controller reaches the range above 200% current, the energy is supplied through pure diode current, and thus, in the second case, the useful voltage difference is only $V_{useful} = 400\ V - 200\ V \approx 180\ V$.

If the DC link capacitance has to be increased, then the pre-charging for this increased capacity must be externally realized, as the internal DC link pre-charging is designed for the internal DC link capacitance only.

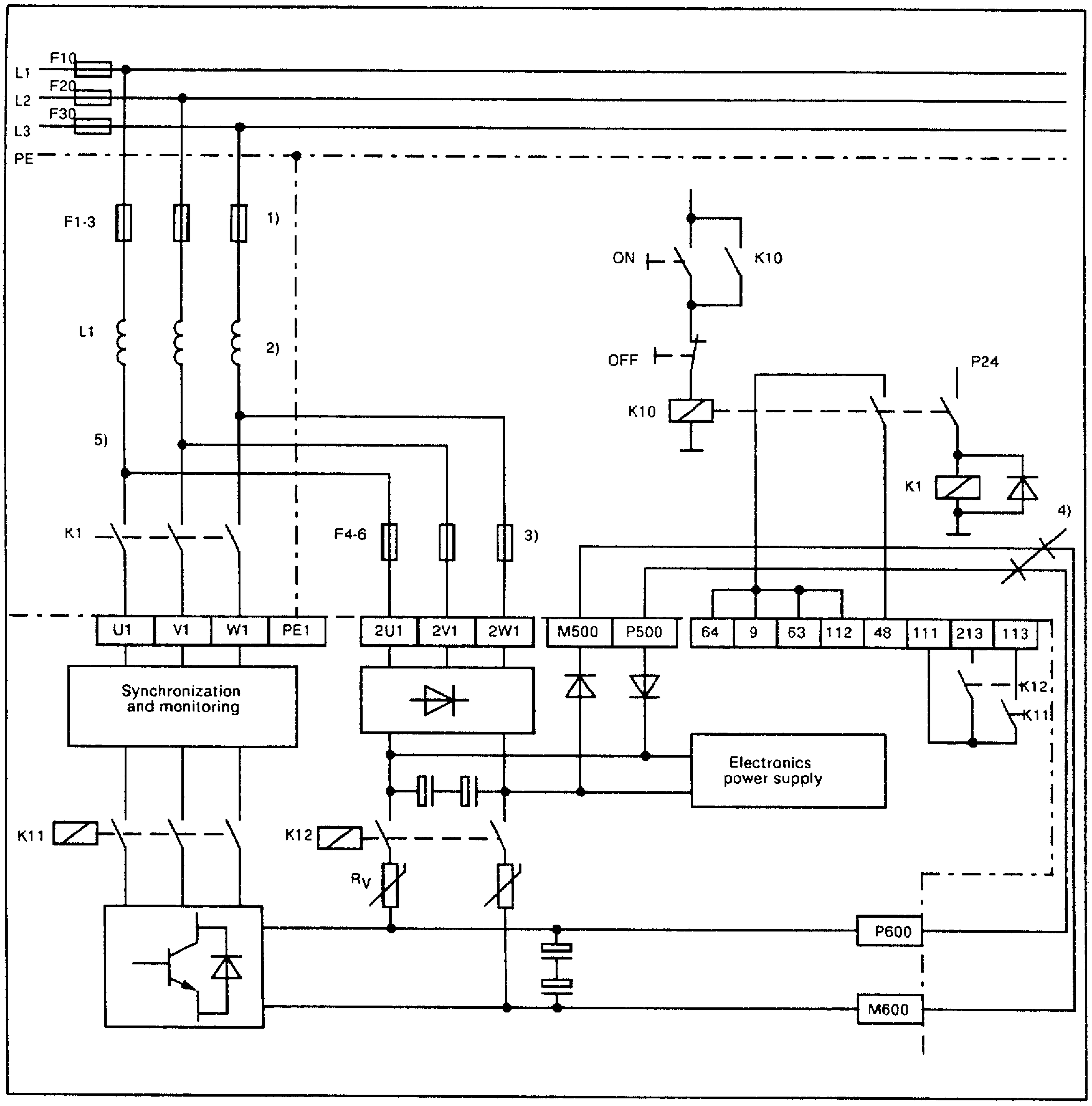
Module	$C_{DC\ link}$	Charging constant
Feed drive 3/6 A	45 µF	1.5 ms
Feed drive 6/12 A, 12/24 A	70 µF	2.1 ms
Feed drive 20/40 A	200 µF	6 ms
Feed drive 40/80 A, 60/120 A	350 µF	10 ms
Feed drive 80/160 A	1.6 mF	48 ms
I/R 7/14 kW	400 µF	12 ms
I/R 11/22 kW, 22/44 kW	800 µF	24 ms
I/R 55/88 kW	2.1 mF	63 ms
IM 5/7 A	200 µF	6 ms
IM 15/20 A	250 µF	7.5 ms
MS/IM 24/32 A	400 µF	12 ms
MS/IM 30/40 A	700 µF	21 ms
MS/IM 45/60 A	1.0 mF	30 ms
MS/IM 60/80 A	1.6 mF	48 ms

The DC link pre-charging in the infeed/regenerative feedback unit is realized using PTC thermistors and permits charging cycles according to the following diagram. The PTC thermistors will be damaged if the permissible switch-on/switch-off cycle is exceeded. If a higher cycle number is demanded, it should be checked as to whether armature short-circuit braking can be used in the motor circuit. DC link pre-charging is not necessary when the DC link is disconnected.



Switch-on/switch-off cycles

The above cycles are only valid if the DC link is quickly discharged after switch-off.
If this is not provided, then the charging sequences increase, as only the voltage difference in the DC link must be charged, which is obtained from the discharge time constant (approx. 1 min.), or, if it is connected to the DC link, the power drain from the power supply (approx. 350 VA).



Maintaining the power supply during supply failures

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1) *Use the specified semiconductor fuse type*
2) *Use the specified commutating reactor*
3) *Continuous current at V = 3-ph. 400 V AC approx. 600 mA, pulse current for pre-charging approx. 25 A*
4) *2 x 1.5 mm² connection, under the DC link cover*
5) *The connecting point must be between the reactor and infeed/regenerative feedback module.*

5.7 Reduced velocity with DC link fast discharge

The equipment can be operated in the setting-up mode by de-energizing terminal 112 for the "reduced velocity" safety function.

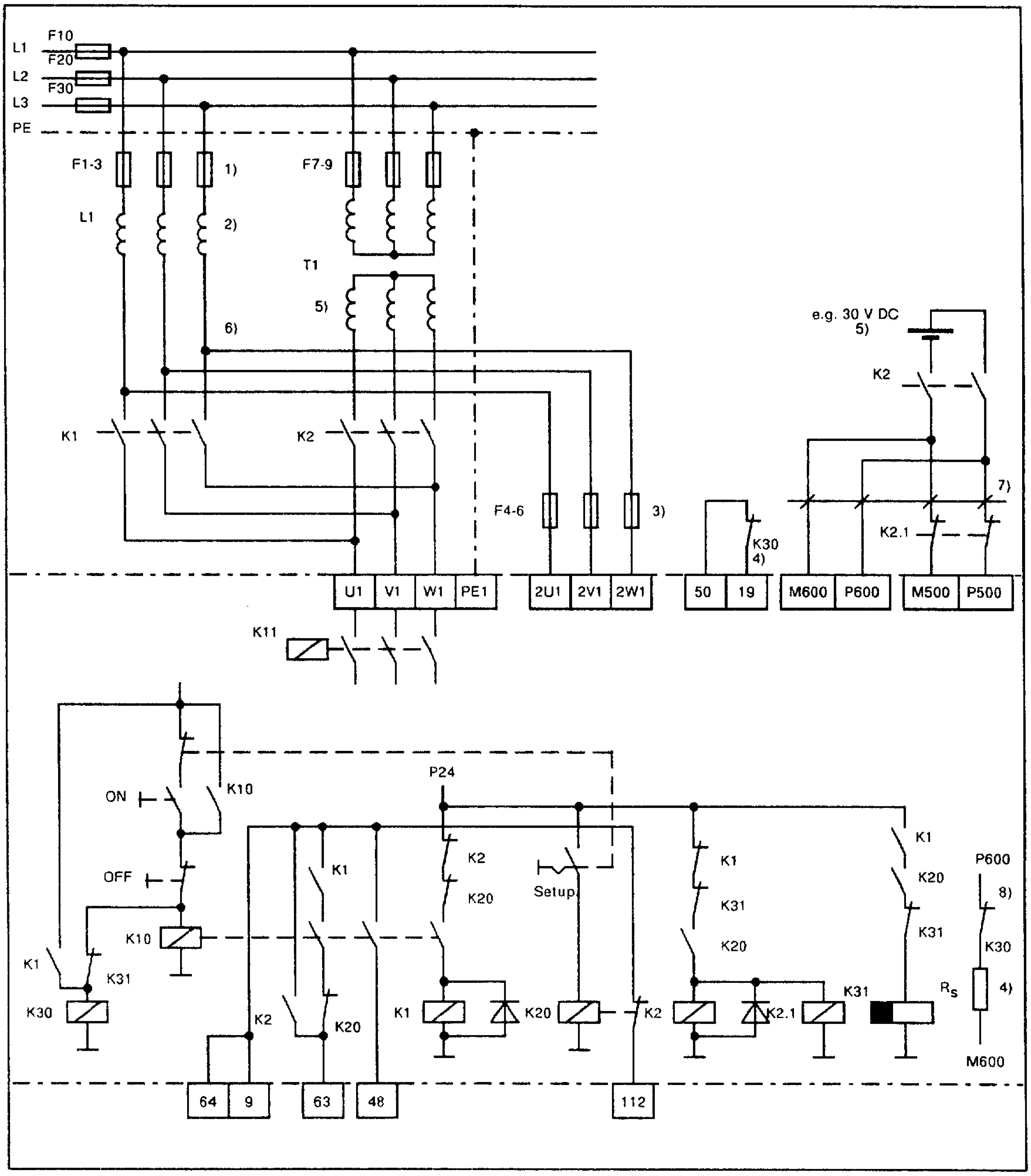
The DC link controller is inhibited in this function, the internal main contactor K11 switched-in, the speed controller monitoring functions disabled, and the maximum current setpoint reduced internally, which can be selected between 6% and 100%.

In the setting-up mode, main contactor K11 is permanently energized. As the integrated DC link pre-charging is not active, the high supply voltage can only be connected externally, if terminal 112 is energized, and there has been sufficient delay until the internal main contactor has dropped-out (approx. 100 ms).
If the setting-up mode is selected when the equipment is in the normal mode, the DC link only slowly discharges with its discharge time constant (approx. 1 min.). The DC link can be discharged quickly using a pulsed resistor module to accelerate the transition into the reduced voltage mode.

After K1 has dropped-out, a delay should be inserted, corresponding to the contactor used, before the pulsed resistor is switched-in via terminal 50.

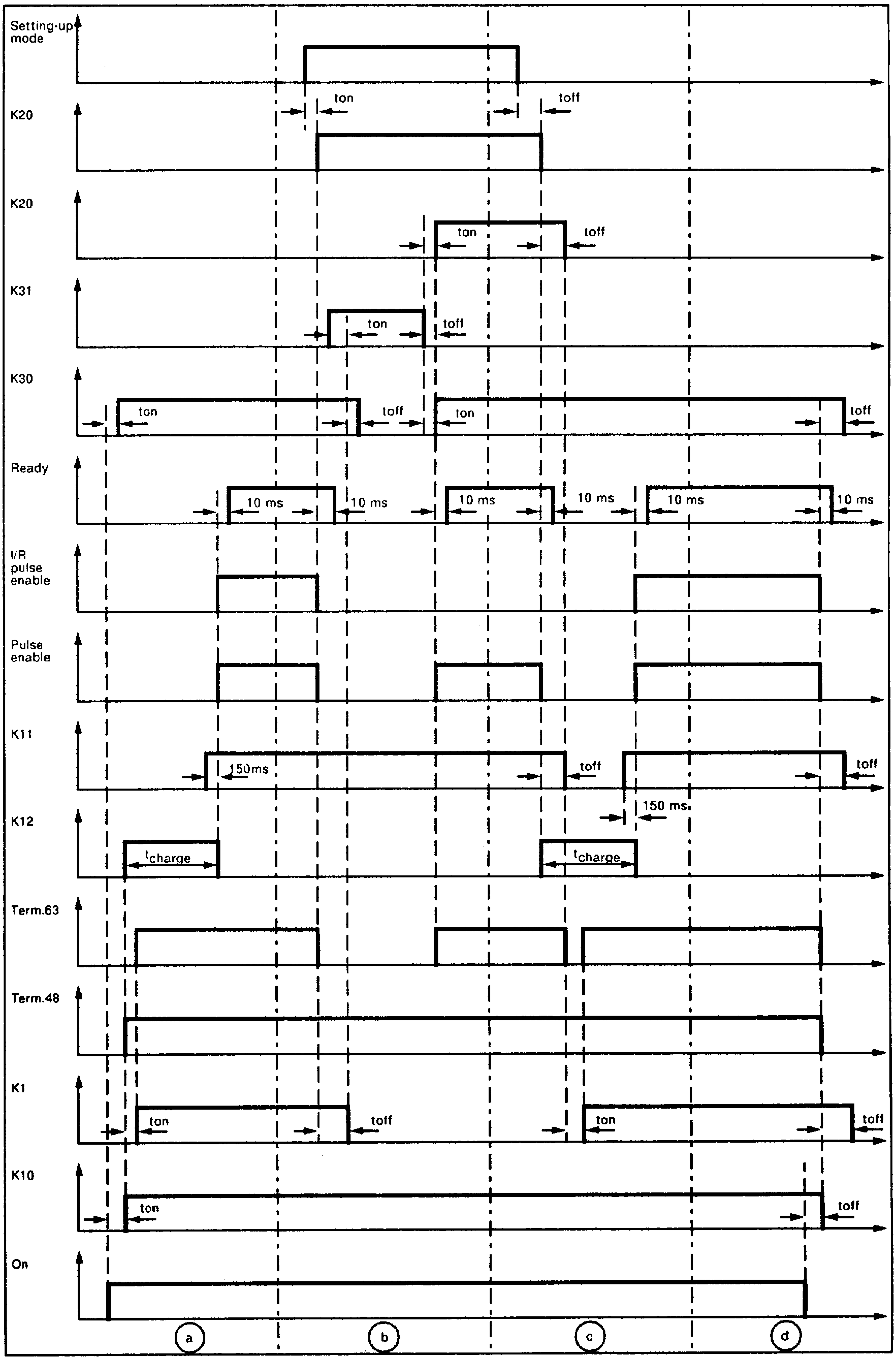
It should be noted, that when the equipment is switched-on via terminal 48, even when the setting-up mode is simultaneously selected, the pre-charging contactor k12 is always switched-in first, and then the main contactor after timer stage t1 has expired. Thus, even with erroneous operator control, a charging current surge can be reduced, however, it cannot be prevented that the DC link is still charged when the equipment is first switched-on.

If the operation during supply failure function (buffered operation) and setting-up mode are alternatively required on the same machine, the connection between P600/P500 and M600/M500 should be opened using the NC contacts of DC contactor K2.1 (V = 600 V DC) to electrically isolate the DC link from the supply, when the setting-up mode is selected. This contactor must be switched together with the contactor K2 for reduced supply voltage.



Setting-up mode with external voltage changeover

1) *Use the specified semiconductor fuse type*
2) *Use the specified commutating reactor*
3) *Continuous current at =3-ph. 400 V AC, approx. 600 mA, pulse current for pre-charging, approx. 25 A*
4) *DC link discharge, either through an external resistor or pulsed resistor module*
5) *Alternative application*
6) *Connecting point must lie between the reactor and infeed/regenerative feedback module.*
7) *Cables short and twisted*
8) *Picked-off at the DC link of the last module; cables, short and twisted*


Setting-up mode
K20
K20
K31
K30
Ready
I/R pulse enable
Pulse enable
K11
K12
Term.63
Term.48
K1
K10
On
ton
toff
10 ms
150ms
150 ms
tcharge
a
b
c
d

Timing

a Switch-on:

When the ON button is depressed, relay K10 pulls-in and latches, as long as the selector switch is not set to setting-up operation. This interlock prevents the high supply voltage from being connected to the converter with the pre-charging circuit inactive.

Relay/contactor K30 pulls-in and removes the DC link short-circuit through the external resistor or pulsed resistor module.

K10 energizes contactor K1 which is interlocked against K2, which, after its switch-in delay, enables terminal 48 and the still internally interlocked terminal 63.

The signal edge at terminal 48 starts the pre-charging sequence via the internal charging contactor K12. The charging time is dependent on the degree of expansion and an external signal is provided after this has been completed when the internal main contactor K11 is closed, the internal pulse enable, and the ready signal.

b Changeover into the setting-up mode:

Relay K20 pulls-in when the selector switch is changed-over and allows terminal 112 to be energized. Internally, pulse inhibit is output, with delay, to the infeed/regenerative feedback module. As the main contactor should be switched-out and the DC link quickly discharged, the axis pulses are also inhibited, externally via terminal 63.

K20 triggers a timer via K31 which initiates the DC link discharge and allows K31 to drop-out as soon as it is signalled that the supply is disconnected using an auxiliary contact of K1. The timer stage must be long enough, so that the DC link can still be discharged after the drop-out time of K1. The timer stage is inhibited via the auxiliary contact of K12, until setting-up operation is again selected.

If the DC link is discharged using a pulsed resistor module, a second module might be necessary for large expansion stages (200 ms duty cycle every 10 seconds)

K1 is de-energized via K20, and enables K2, after its drop-out delay time, via an auxiliary contact, which however still remains de-energized due to the NC contact from K31 until the DC link short-circuit has been removed. An AC voltage, which has been transformed down, or low DC voltage can be optionally switched to the DC link via K2. Both versions are illustrated in the "timing" diagram. The pulses are externally re-enabled at terminal 63 after the pull-in delay of K2, using an auxiliary contact, and the DC link is disconnected from the supply through the NC contacts at M500/P500. The ready signal indicates that the equipment is ready for operation with the lower DC link voltage.

c Changeover into the standard operating mode:

K20 drops-out when the setting-up mode is cancelled, which again connects terminal 112 to terminal 9. This edge internally triggers a new charging sequence. All pulses are internally cancelled, the internal main contactor K11 is opened, and the DC link is pre-charged again via K12.

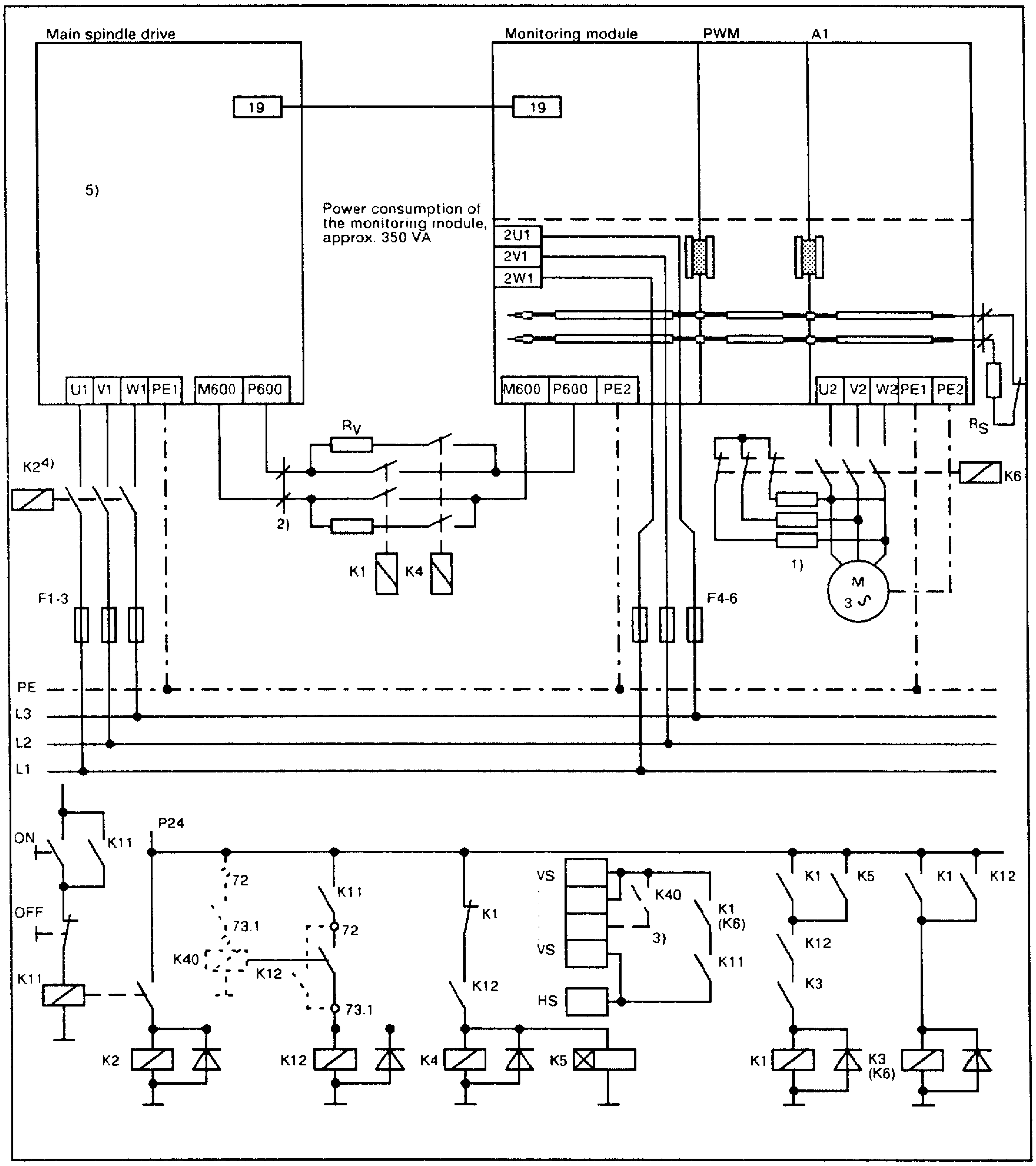
During charging, the standard supply voltage must be re-connected again. To realize this, K2 opens, delayed, and enables the main contactor. This pulls-in, and provides the external pulse enable via terminal 63. Charging is realized as for the standard switch-on, and is signaled as being completed via the ready relay.

d Switch-off:

K10 drops-out when the OFF switch is actuated. Pulse cancellation is immediiately issued via terminal 63, and main contactor K1 drops out. The main contactor drops-out when terminal 48 is de-energized and the ready signal is withdrawn.

When K1 drops-out, it de-energizes K30 via its auxiliary contact, and the DC link is quickly discharged. Thus, the converter power section is isolated from the supply with the electronics power supply still available and DC link discharged.

5.8 Combination with SIMODRIVE 650/660 and DC link isolation



Coupling SIMODRIVE 650/660 with 611

1) *Braking resistor/motor assignment, refer to the technical description.*
2) *Short-circuit proof cable or referred to the DC link fusing at the 650/660 (twisted and screened).*
6SC6508/6SC6608 125 A
6SC6512/6SC6612 250 A
6SC6520/6SC6620 315 A
3) *Without K14, terminals 64 and 9 can be jumpered.*
4) *When the supply fails K2 must still remain energized for ≥ 40 ms .*
5) *Bits 0 and 7 must be set to 1 in parameter P-53*

If the SIMODRIVE 650/660 converter is connected to the supply using a contactor according to the diagram "Coupling SIMODRIVE 650/660 with 611", the main contactor latches-in when the ON button is depressed. The line-side gating unit charges up the DC link by internally shifting the thyristor bridge firing angle from $\alpha = 150$ ° to $\alpha = 0$ °. This charging sequence requires approx. 3 seconds, and is completed when the ready relay pulls-in (terminals 72 to 74) (parameter setting according to the Instruction Manual SIMODRIVE 650/660).
The charged DC link signal initiates the charging of the feed drive DC link. If the feed drive section is never to be operationally disconnected from the main spindle DC link, then they can be directly connected with one another and the circuit section described in the following is not required (also refer to Section 5.4).

Contactor K4 is first closed, and the feed drive DC link is charged via R_V. When dimensioning the resistor, the peak power for charging as well as the continuous power, obtained from the switch-on/switch-off frequency, must be taken into account ($R_V = 5$ to 50 Ω: $\hat{P} = 7.2$ to 72 kW; $P = 10$ to 500 W).

The charging time is obtained from the magnitude of R_V and the number of axes. A timer K5 should be set, corresponding to this time, which, after this time has expired, switches-in the DC link contactor K1. This contactor is always switched under a no-current condition, so that it can be dimensioned according to the current carrying capability of the contacts as well as the 600 V DC blocking capability.

When this charging sequence has been completed, the drive pulses are enabled via terminals 63 for the main spindle and feed drives, and the DC link is controlled to 600 V DC[1].

When the unit is switched-off using the OFF button, the inverse sequence is maintained and the pulses are first inhibited via K11, and K1 and K2 opened.

The feed drive DC link can be optionally quickly discharged when the unit is switched-off, in order to, for example, brake the feed motors via R_S. In this case, short-circuit contactor K3 is switched-in via the auxiliary contacts of K12 and K1 as soon as the feed drive is disconnected from the main spindle unit.

The DC link is discharged and the motor braked through R_S, as soon as the DC link voltage falls below the EMF. R_S must be dimensioned so that the energy stored in all of the connected motors can be accepted.

With this circuit configuration, it should be noted that the motor braking current must flow through the power transistor free-wheeling diodes in the power section, and also through the DC link fusing of the power section. Thus, the discharge time must be selected long enough, so that the maximum current of the smallest axis does not exceed its limiting current. For example, a drive system with 3/6A and 60/120 A must be dimensioned, so that R_S causes a maximum of 6A to flow in the DC link of the lowest-rated axis. R_S is approximately obtained by dividing the EMF of the lowest-rated axis with the peak current of this axis.

Short-circuit contactor K6 can be used to provide a fail-safe circuit configuration. When this is realized, the feed drive section can be operated directly from the main spindle DC link, and can be braked at EMERGENCY OFF, independent of the converter status.

At switch-off, pulse cancellation is first initiated and the motor is isolated from the converter through K6, and short-circuit braked, At switch-on, the sequence is first vice versa, the short-circuit contactor is opened, and the motor re-connected to the converter before the pulses are enabled.

This version eliminates K1, K3, K4 and K5 as well as R_V, but must be separately realized for every feed drive axis.

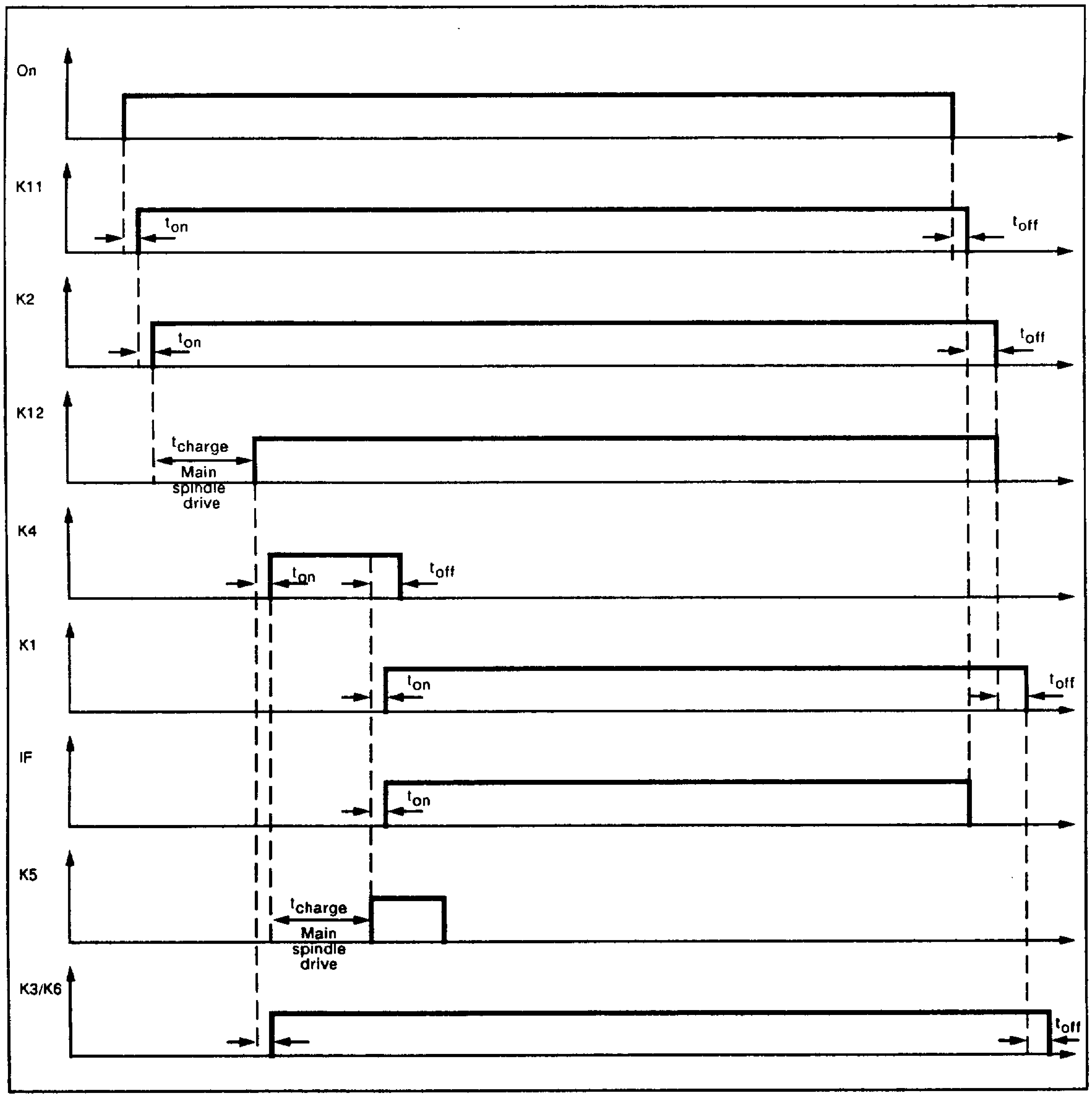
---

1) *from software release 14*

If operation during power failure is to be provided for the feed axes, jumpers should be inserted on the monitoring module, between M600 and M500 and P600 and P500. When the supply fails, the power supply is fed through this path, until the DC link voltage falls below 180 V. The drives can still be operated, whereby the braking energy is converted into heat in the pulsed resistor module, and the accelerating energy must be provided from the DC link.
This requires relay K40, which should be energized from the ready contact, terminals 72, 73.1 of the main spindle. In the arm to K12, this contact is now replaced by an auxiliary contact of K40.

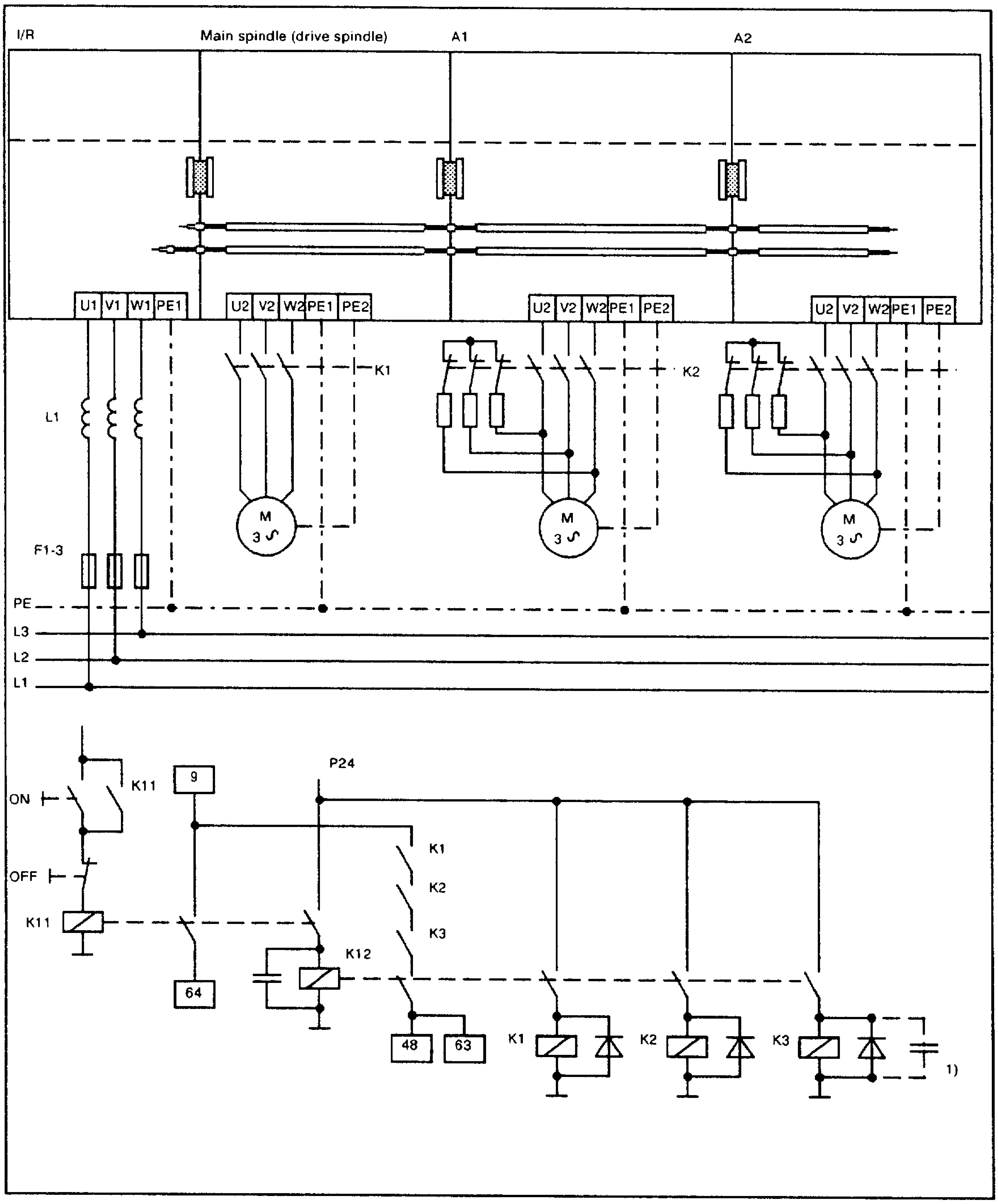
At switch-on, the end of the pre-charging sequence is signaled by the ready signal and the feed section is switched-in via K40. However, when the main spindle develops a fault condition (e.g. supply failure), pulse cancellation is not immediately realized for the feed drive axes and they can be braked via terminal 64. To realize this, as indicated in the diagram "coupling between SIMODRIVE 650/660 and 611" these are switched through a contact of K40 and the auxiliary contact of K40 is bridged by a contact from K12 in the arm of K12 so that K40 is latched-in (K40 drops-out when a main spindle fault signal occurs). Other circuits can be used to move the axes into safe positions as long as the DC link energy is sufficient and the P24 potential is sufficiently buffered so that the contactors do not drop-out and in turn initiate pulse cancellation at terminal 63.

The line contactor in front of the SIMODRIVE 650/660 drive can also be connected as contactor between the converter and main spindle motor, with the same switch-on timing. When the system is switched-off using the OFF button, the unit is still connected to the supply and the motors are electrically isolated. Fault signals at the converter are kept.



Enable signal timing

5.9 Emergency stop with the motor disconnected from the converter and armature short-circuit braking of the feed motors



Emergency stop with armature short-circuit braking

1) *Optionally with capacitor instead of diodes*

In order to brake all machine tool axes as quickly as possible in an emergency stop situation, an attempt should be made to electrically brake all axes at their maximum torque by de-energizing terminal 64.

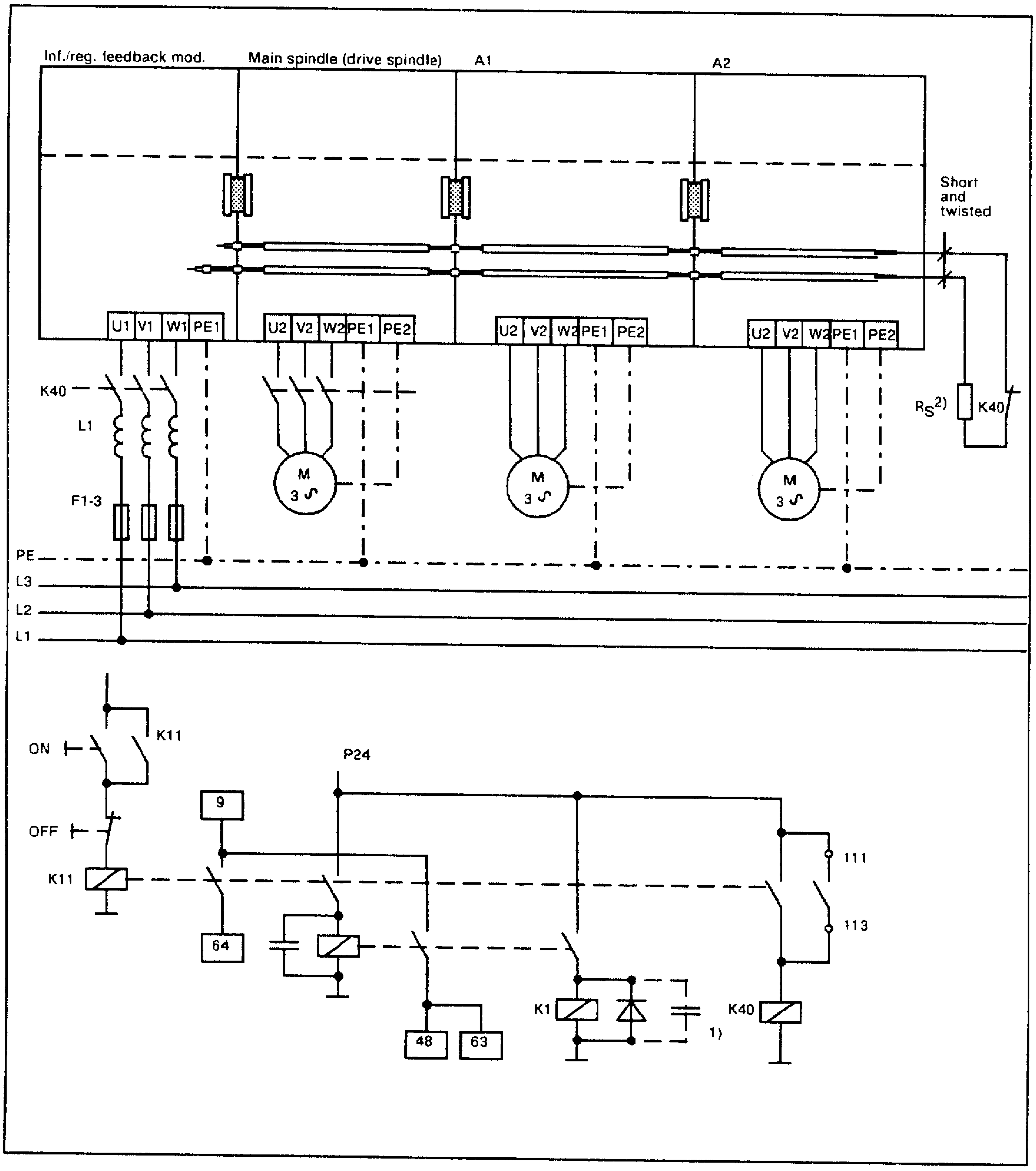
Although it involves the fastest possible braking method, it is not sufficient from the safety perspective, and must be backed-up by fail-safe circuits.

With the circuit illustrated in the diagram, at switch-on, the motors are connected to the converters through K1 to K3, and the armature short-circuit removed. DC link pre-charging is initiated via terminal 48, and after it has been completed, the converter is ready for operation.

When the emergency stop button is depressed, terminal 64 is first de-energized via K11, whereby the drives are braked down to n = 0. This sequence requires a defined time for each axis, which is obtained from the maximum torque, maximum speed and total moment of inertia. After the longest occuring time on the machine has expired, K12 should drop-out, the pulses at all axes are inhibited, and simultaneously K1 to K3 switched-out. A short drop-out delay is realized through their free-wheeling diodes or capacitors in order to ensure reliable pulse cancellation at the axes before the contactors are switched. Independent of the converter function, all feed motors are braked by short-circuiting the phases, which means that even when the converter is defective, all motors are reliably braked to standstill.

This armature short-circuit braking cannot be realized for induction motors, as the magnetization current is externally supplied. In this case, maximum safety is ensured by disconnecting the motor from the voltage supply. If it still runs when K1 is switched-out as a result of a faulty module, then it coasts down to zero speed, or must be mechanically braked.

5.10 Emergency stop with motor braking via fast DC link discharge



Emergency stop with DC link fast discharge

1) *Optionally with capacitor instead of diodes*
2) *Dimensioning, refer to Section 5.8*

The circuit, described under point 5.9, ensures that all feed axes are reliably (fail-safe) braked down to standstill, even if the converter is defective, however, this involves a high cost for motor and short-circuit contactors. To reduce this cost, the feed axes can be braked using a central DC link fast discharge. When the system is switched-off, an attempt is first made to electrically brake by de-energizing terminal 64, as described under point 5.9. After the time, set at K12, has expired (longest braking time), the converter is shutdown via terminal 48, and motor contactor K1 (of the induction motor), is opened.

After the internal main contactor has opened, the DC link short-circuit contactor drops-out via the checkback signal contacts, terminals 111, 112, and the DC link is discharged through R_S and disconnected from the supply. This contactor pulls-in when the on button is depressed through the contact from K11, before the pre-charging sequence is internally initiated.

If an axis is still moving at the instant of the DC link short-circuit, due to a defective converter, then this is braked until the DC link voltage falls below the EMF. The braking current is rectified through the free-wheeling diodes in the power section, and flows through the DC link fuse into discharge resistor R_S.

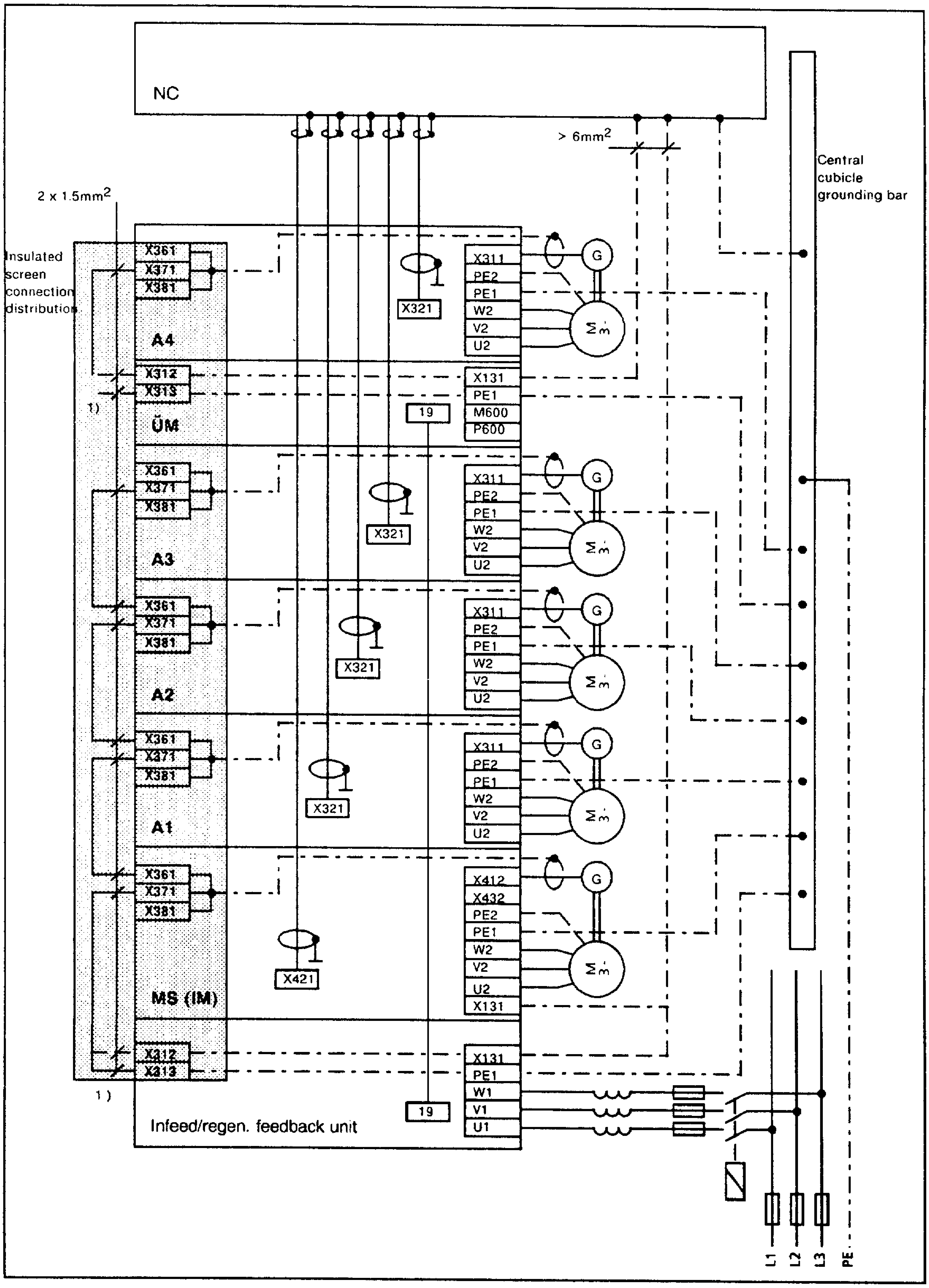
The difference between the EMF and the DC link voltage defines the magnitude of the braking current. When selecting R_S, it must be guaranteed that the DC link is only discharged so quickly, that this current does not exceed the maximum permissible current for the smallest axis (refer to Section 5.8). Further, R_S must be dimensioned so that it can convert the peak power occuring when the DC link is first short-circuited as well as the continuous power obtained from the total energy of the moved masses.

In comparison to the circuit in Section 5.8, the disadvantage is that all of the braking currents must flow through the semiconductors (free-wheeling diodes) as well as through the DC link fuses. If these elements are defective, the appropriate axes are no longer braked, but just coast down.

5.11 Limit values of the internal monitoring functions

692 V	Fault signal $V_{DC\ link}$> > and pulse cancellation
643 V	Pulsed resistor on
618 V	Pulsed resistor off
270 V	$V_{DC\ link}$ o. k. (yellow LED lit)
220 V	$V_{DC\ link}$ too low (yellow LED off)
215 V	Power supply on
188 V	Power supply off

5.12 Grounding concept



SIMODRIVE 611 grounding concept

1) *Should be connected to X313 or X312 depending on the particular system.*

All SIMODRIVE 611 modules have three electrically isolated voltage systems. The components operated at the DC link potential, the electronics potential and the screen potential.

The clocked transistors at the DC link represent a fault source for the other two voltage levels, the effects of which on the electronic functions, cannot be measured under ideal conditions. It is absolutely essential that the complete cubicle is carefully designed and layed-out from this perspective.

This includes the consequential separation of the power cabling and the control, setpoint and actual value cables. All cables involved in the power distribution are clocked with several kv/µs switching speed at the DC link and can result in noise in adjacent cables as a result of inductive as well as capacitive coupling. This is especially true for cables routed in parallel over longer distances.

The ideal situation is to keep the cables as short as possible, and twisted within the cubicle, and to have the line commutating reactor mounted as close as possible to the converter as the line-side power section already has a reduced noise level.

Special care should be taken in making the screen connections. An unreliable screen connection (the screen connection should have the largest surface area with a very low ohmic component) is a potential noise source.

A grounding point should be provided at a central position in the cubicle. This should be connected to the mounting panel of the cubicle using the largest possible surface area, and should be grounded corresponding to the connection cross-section.

All modules in the cubicle are connected to this central grounding point with their PE1 connection. The same is true for all other components to be grounded. This PE connection should use the correct cable cross-section corresponding to the power cabling, depending on the module size.

The same is true for the ground connection from the PE2 terminal to the motors. The machine foundation should also be connected to the central grounding point with the largest possible cross-section. Components involved in the measuring functions should be connected to ground with the largest possible surface area.

Optimum design is ensured on the power side when the above points are observed. The electronics potential of the modules should then connected. Terminal X131 is accessible at each infeed/regenerative feedback module and monitoring module for this purpose. Internally, the electronics ground is connected to this terminal and it is possible to ground this with the largest possible cross-section (>6 mm^2). If an NC control is used, this is realized at its grounding bar, in order to refer the analog speed setpoints as precisely as possible to the equipment potential. This bar is in turn connected, through a high cross-section conductor, to the central grounding point in the cubicle, however, it should be separated from the "power grounds". If an NC control is not used, terminal X131 should be directly connected to this bar.

X131 should be separately connected for each system, because when several monitoring modules are used, the individual electronics systems are electrically isolated from one another.

When using a main spindle or induction motor module, this should be located directly next to the infeed/regenerative feedback module and connected to terminal X131 of the main spindle (induction motor) module instead of terminal X131 of the infeed/regenerative feedback module.

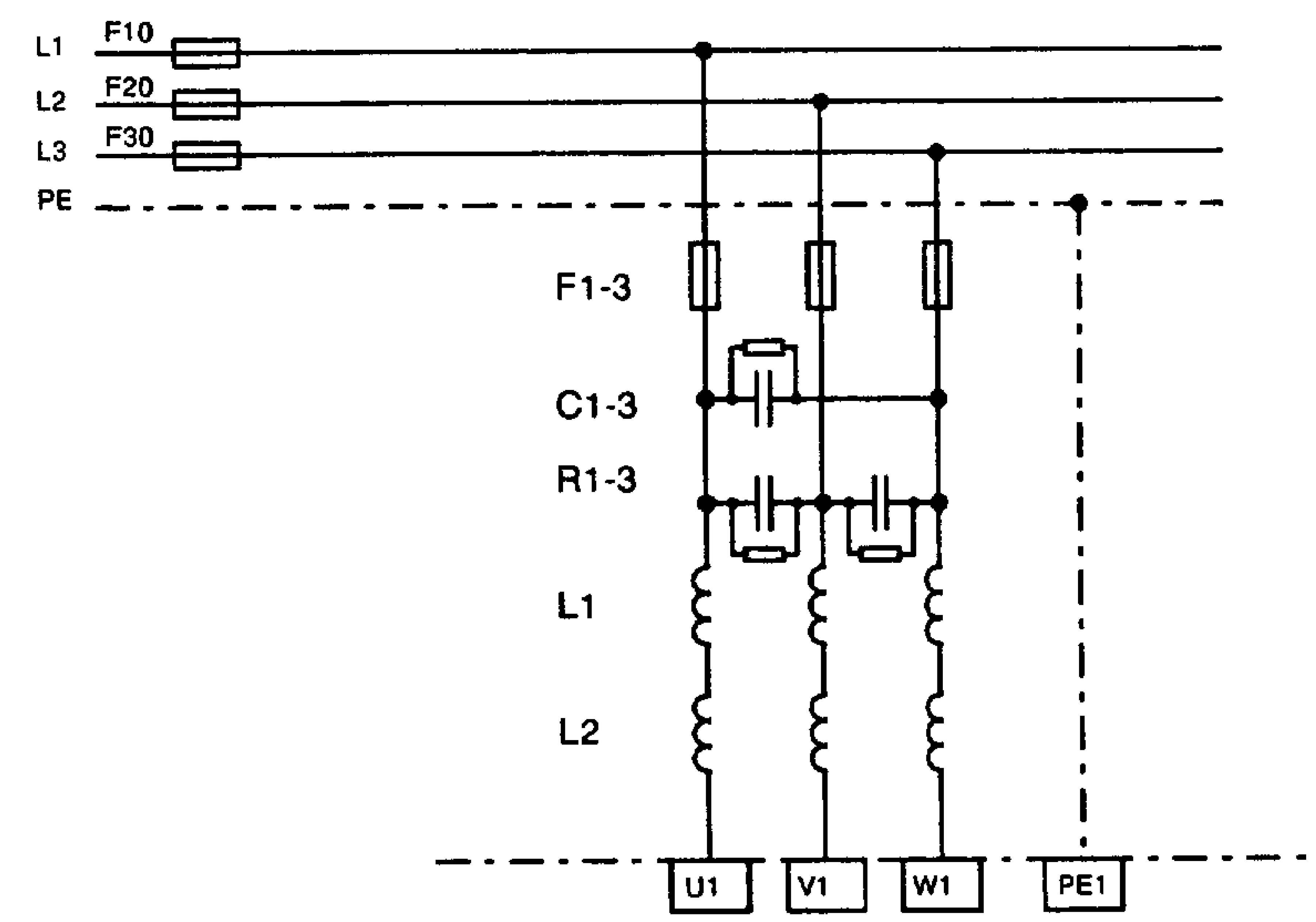
Finally, the individual cable screens should be considered. The speed actual value cables are provided with subminiature D connectors. If the cable screen is connected to the connector housing, this is automatically connected to the module screen potential when the connector is inserted. A connection is now available to the screen connection distribution X361-X381 through the PC board. These modular, isolated potentials are connected with one another using X361 and X371. Two 1.5 mm^2 cables (as short as possible) can be connected. The connector closest to the infeed/regenerative feedback and monitoring module must then be connected with its connection X313 or X312. In this case, a system-specific decision can be made regarding the measures to improve the smooth running characteristics. Generally this is the case when connecting to X312.

An additional 4-pin plug connector is now available with X381 to connect additional screens leading to the module. Experience has shown, that this is especially valid for the speed setpoint. This must always be fed from the NC to the module using a screened cable.

Generally, a fault-free system is obtained when the above points are precisely followed. If, in spite of this, sporadic faults occur, then a check should first be made for loose electrical connections, especially in the ground circuit or with additional plug connectors, also in the power circuit (DC link). Further, all screen connections should be checked to ensure that they have a good connection. In exceptional cases, a different screen concept can be tried (screen connections at X313; motor grounds connected at the central grounding point; X131 directly grounded; speed setpoint screen grounded at both ends; speed actual value screen not grounded or connected with the largest surface area to the cubicle rear panel etc.) to obtain satisfactory operating conditions.

5.13 EMC measures

All measures described here are only valid for supply systems which do not conform to VDE! In normal industrial supply networks, it is guaranteed that noise and disturbance values lie below the permissible limits, thus ensuring fault-free operation without any additional measures.



Additional EMC meausres

The converters are designed for connection to industrial supply networks, according to VDE 0160. A P_N/P_K ratio of 1/100 is assumed. The series reactor limits, under this condition, supply dips to permissible values so that other loads connected to the supply can still operate.

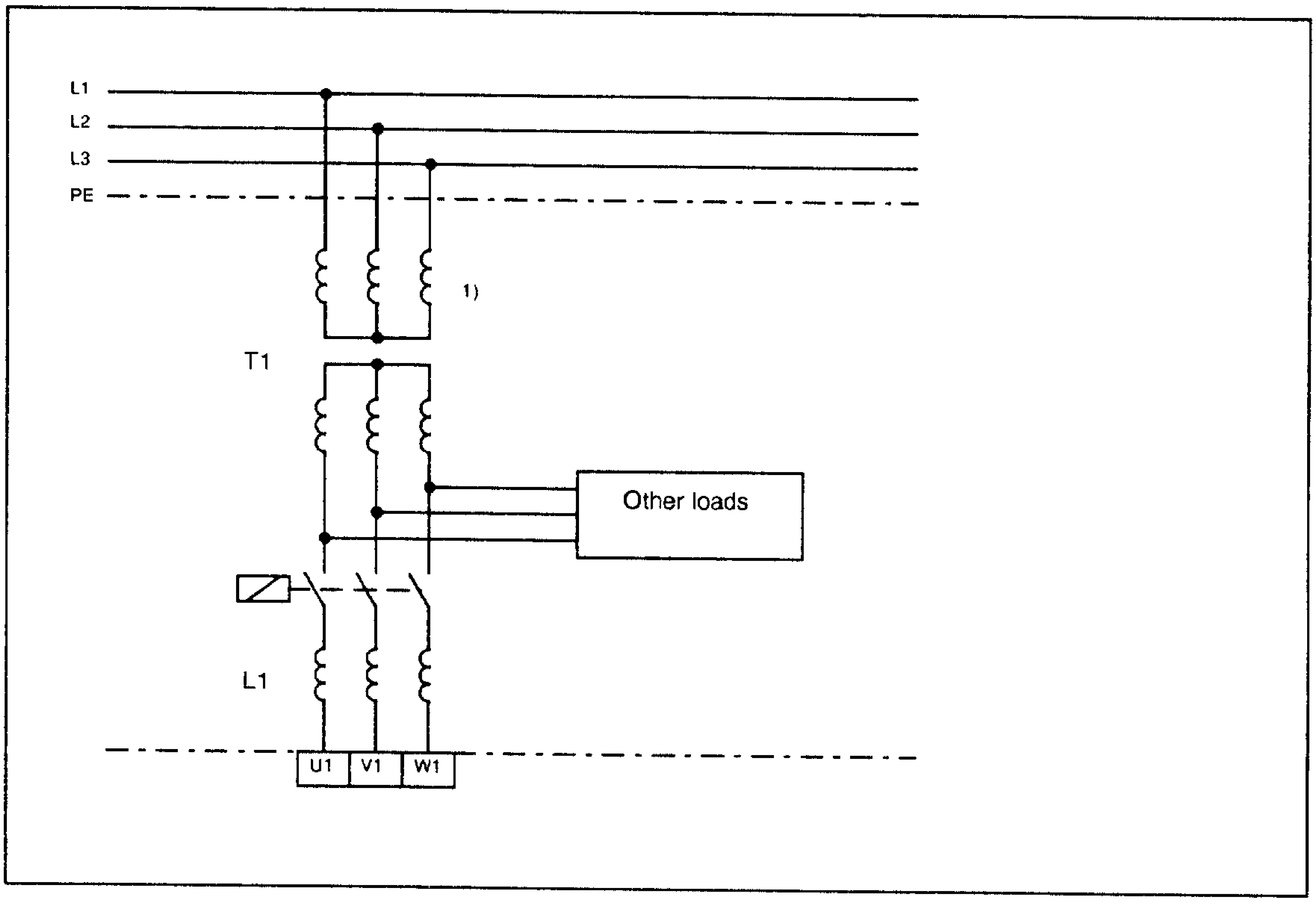
Further, additional effective measures are incorporated in the unit as standard in order to eliminate noise being radiated to other equipment. With unfavorable supply or grounding situations (e.g. in suburban areas), in exceptional cases, cable-related faults can occur as a result of the excessive supply inductance. In such cases, the line commutating reactor must be matched by connecting a second reactor of the same type in series so that the voltage dips are reduced.

Resistors R1 to R3 should be 180 kΩ to 330 kΩ to discharge capacitors C1 to C3.

It may be necessary to include a pulsed resistor module, as in this case, the dynamic performance of the supply converter is restricted (changeover time, motor/generator operation). In order to estimate this, the most unfavorable dynamic operating situation should be selected for the drive system (as many axes as possible are simultaneously braked), and a check should be made to see whether the DC link voltage reaches inadmissibly high values (fault message $V_{DC\ link}$> >).

If a second reactor is not sufficient to eliminate unit faults, three capacitors (10 µF/450 V MKV) can be connected in a delta configuration at the supply in front of the reactor. This measure however, can lead to disturbances being amplified due to resonance effects and should be checked from installation to installation.

5.14 Supply connection through isolating/autotransformer



An isolating/autotransformer should be used if the converter is to be operated from supplies with voltages other than those specified for the equipment.

If additional loads are to be operated on the secondary side of the transformer, the V_K of the transformer should be selected to be ≤ 1 % in order to protect these loads from inadmissibly high supply dips.

If these loads have their own supply, the transformer in series with the converter can have a V_K of 2 to 3%. In any case, the transformer size should be designed to cope with the peak power of the infeed/regenerative feedback unit or a pulsed resistor should be used in the module network.

With this pulsed resistor, it is also possible to operate other loads from the same supply (V_K of 2 to 3%), by supplementing the commutating reactor with a second one (refer to Section 5.13).

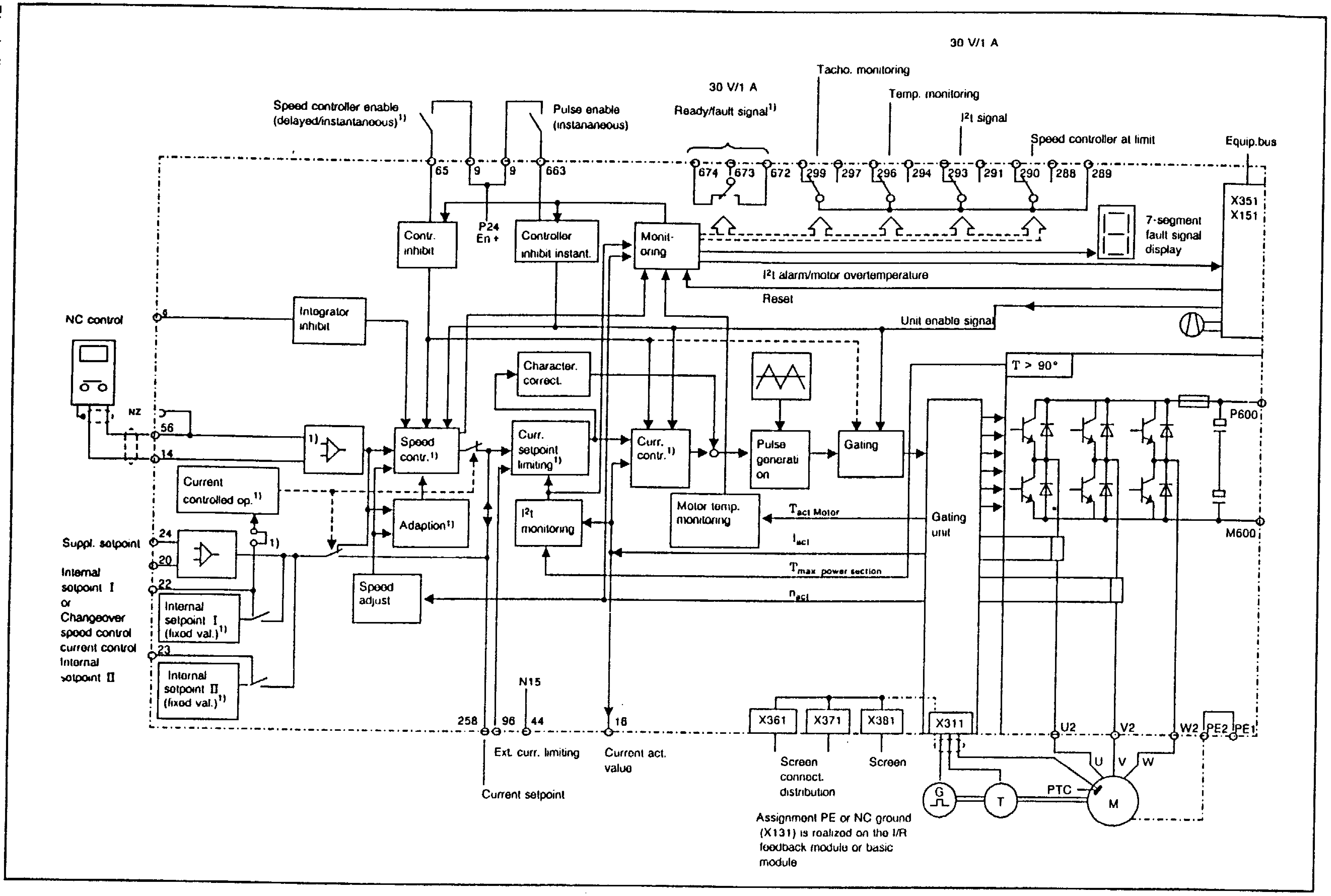
When the transformer is disconnected from the supply, it should be ensured that the converter is disconnected from the transformer using a contactor prior to this (inductive voltage).

---

1) For transformers with separate windings, M600 must be grounded at the infeed/regenerative feedback module using the links provided.

6 Block diagrams

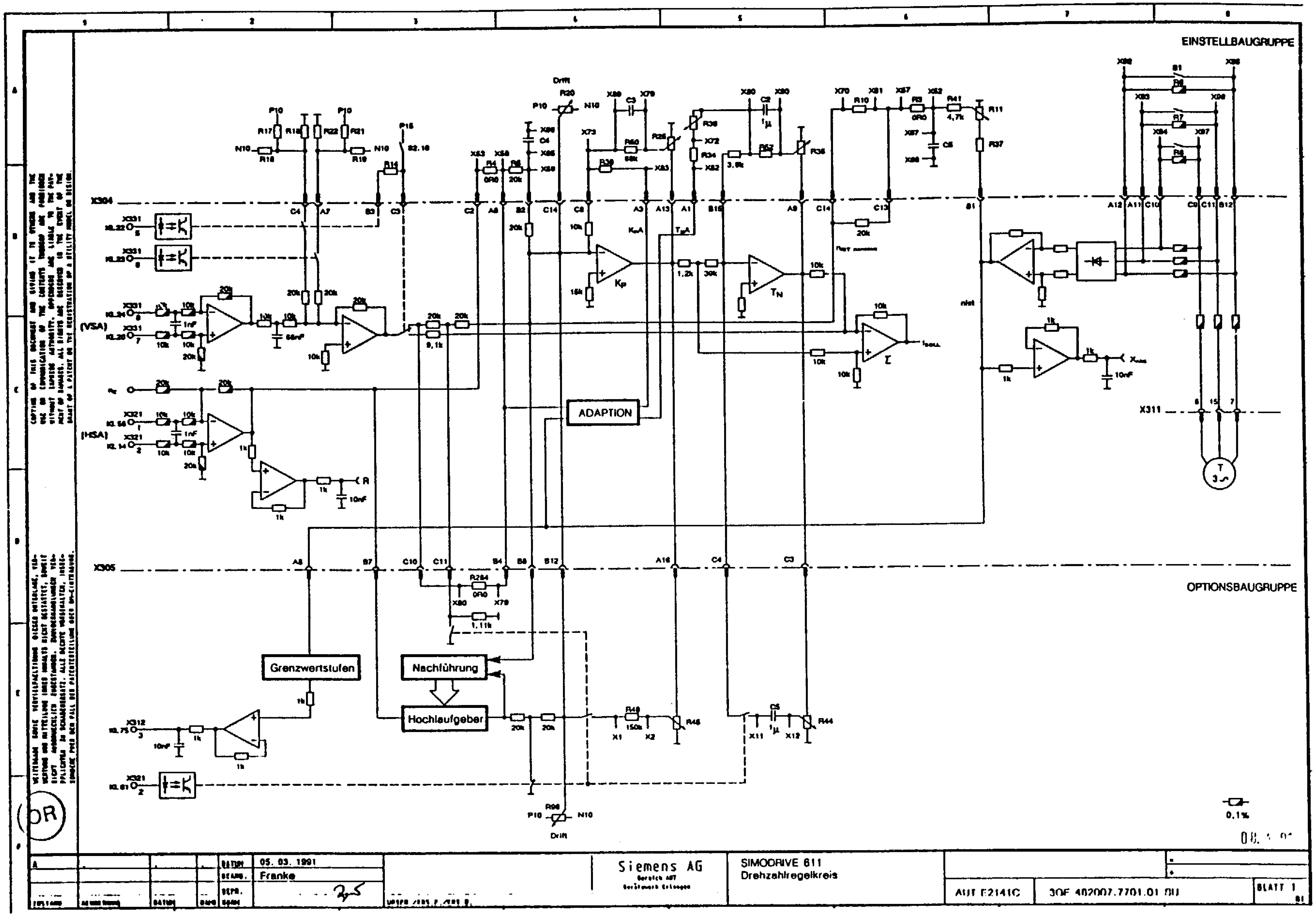
6.1 Block diagram, feed module

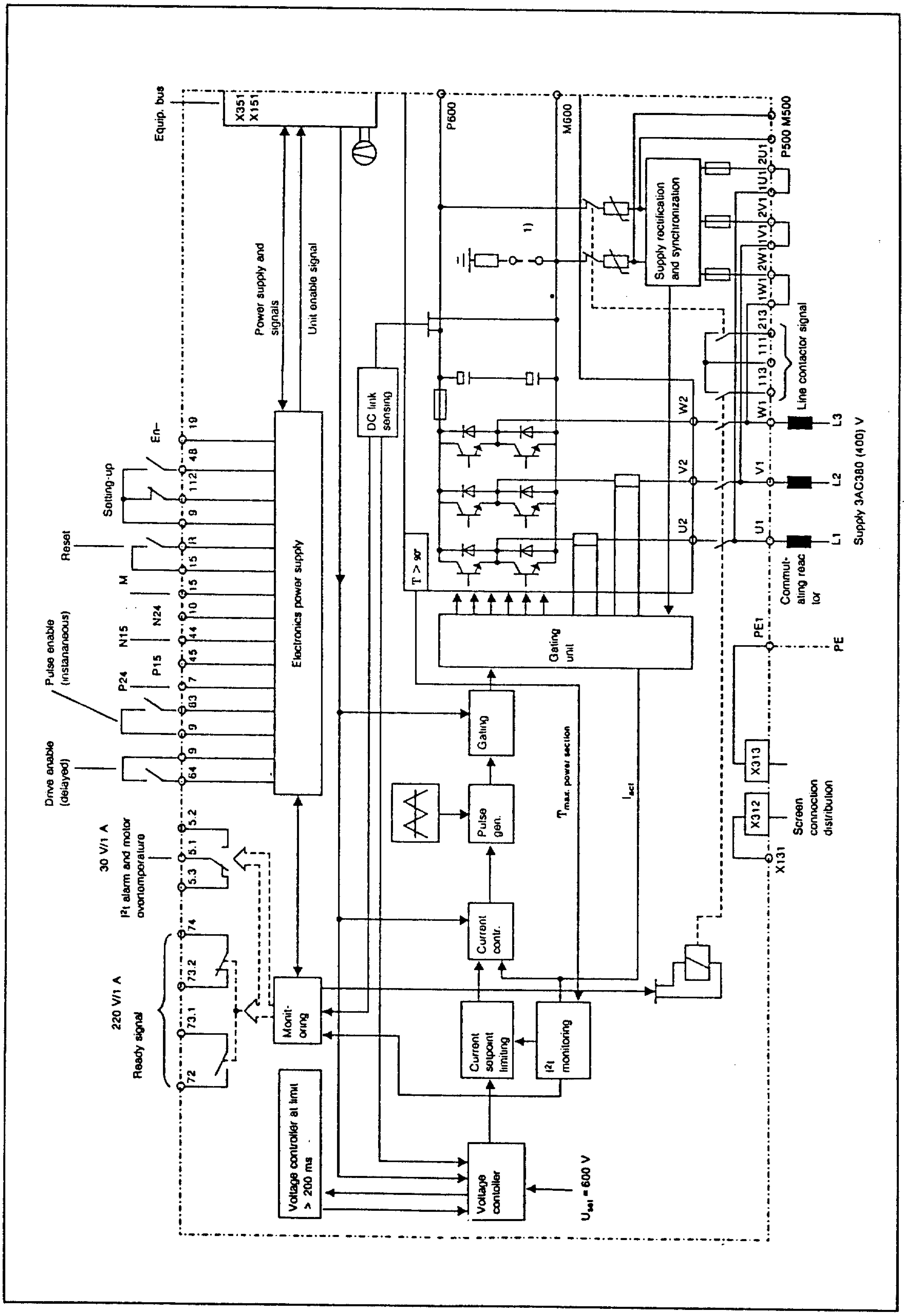


Block diagram of the SIMODRIVE 611 PWM converter feed module

1) Can be changed on the parameter board.

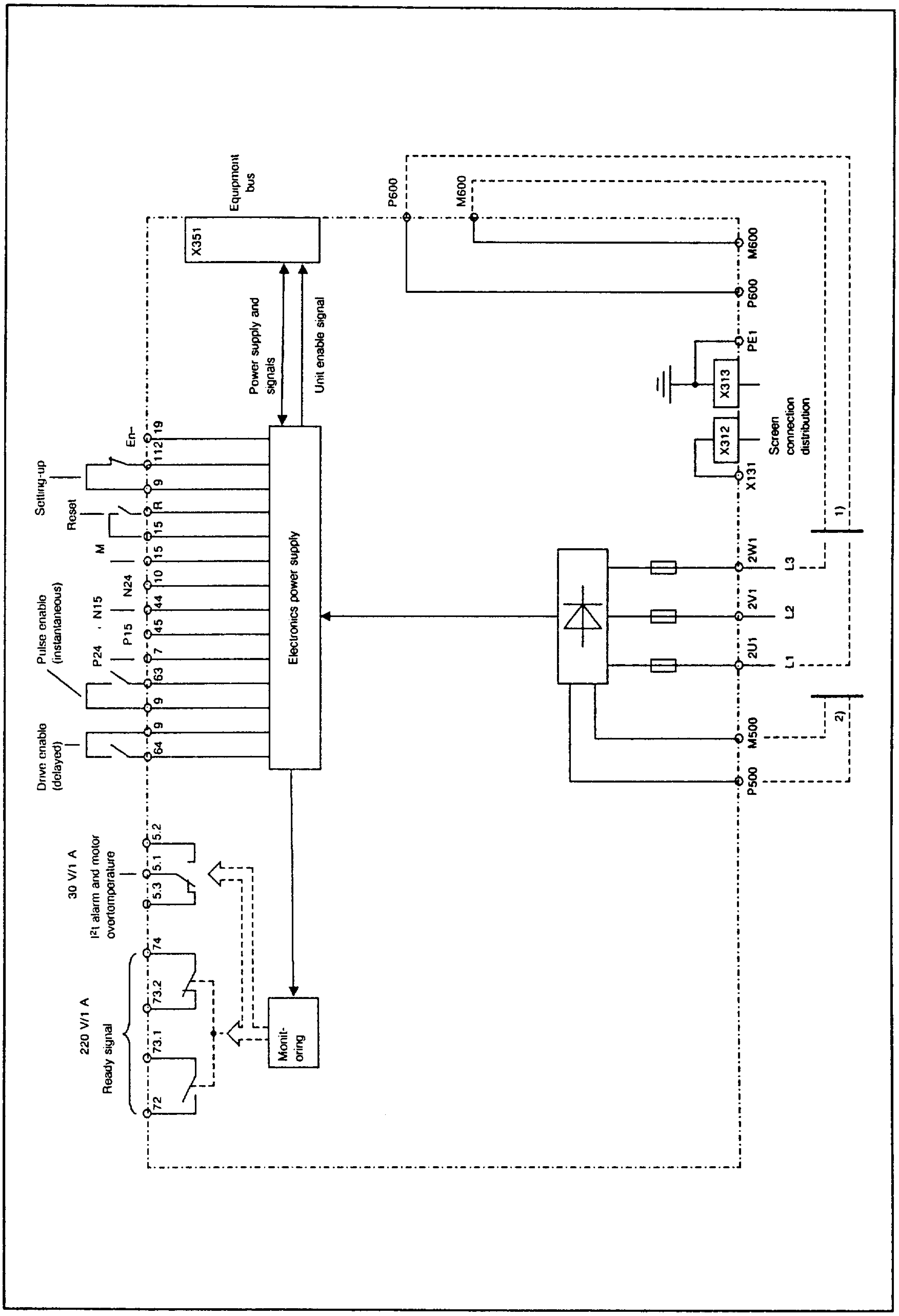
6.1.1 Block diagram, speed control loop





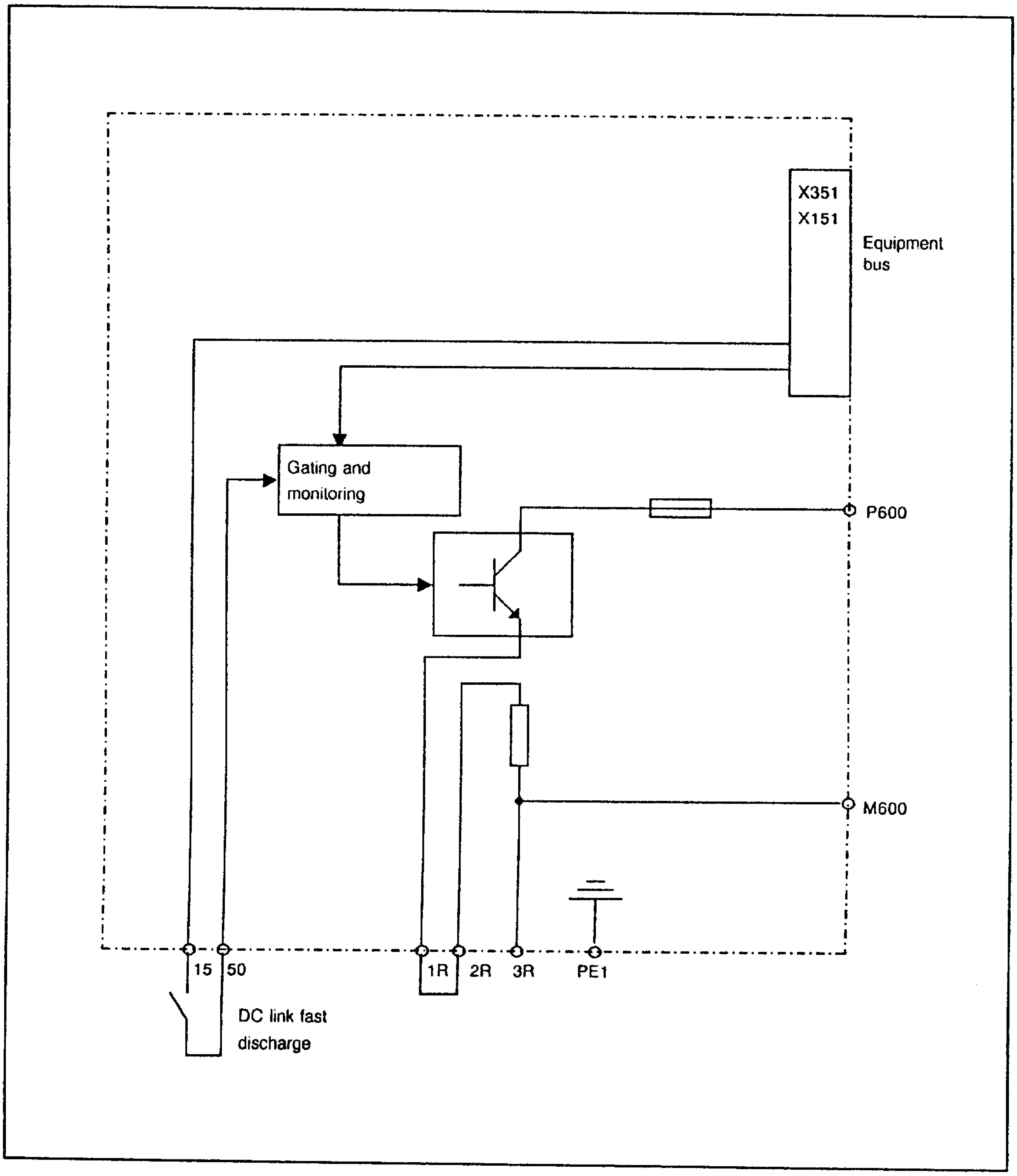
Block diagram of the infeed/regenerative feedback module

1) *Open when supplied*

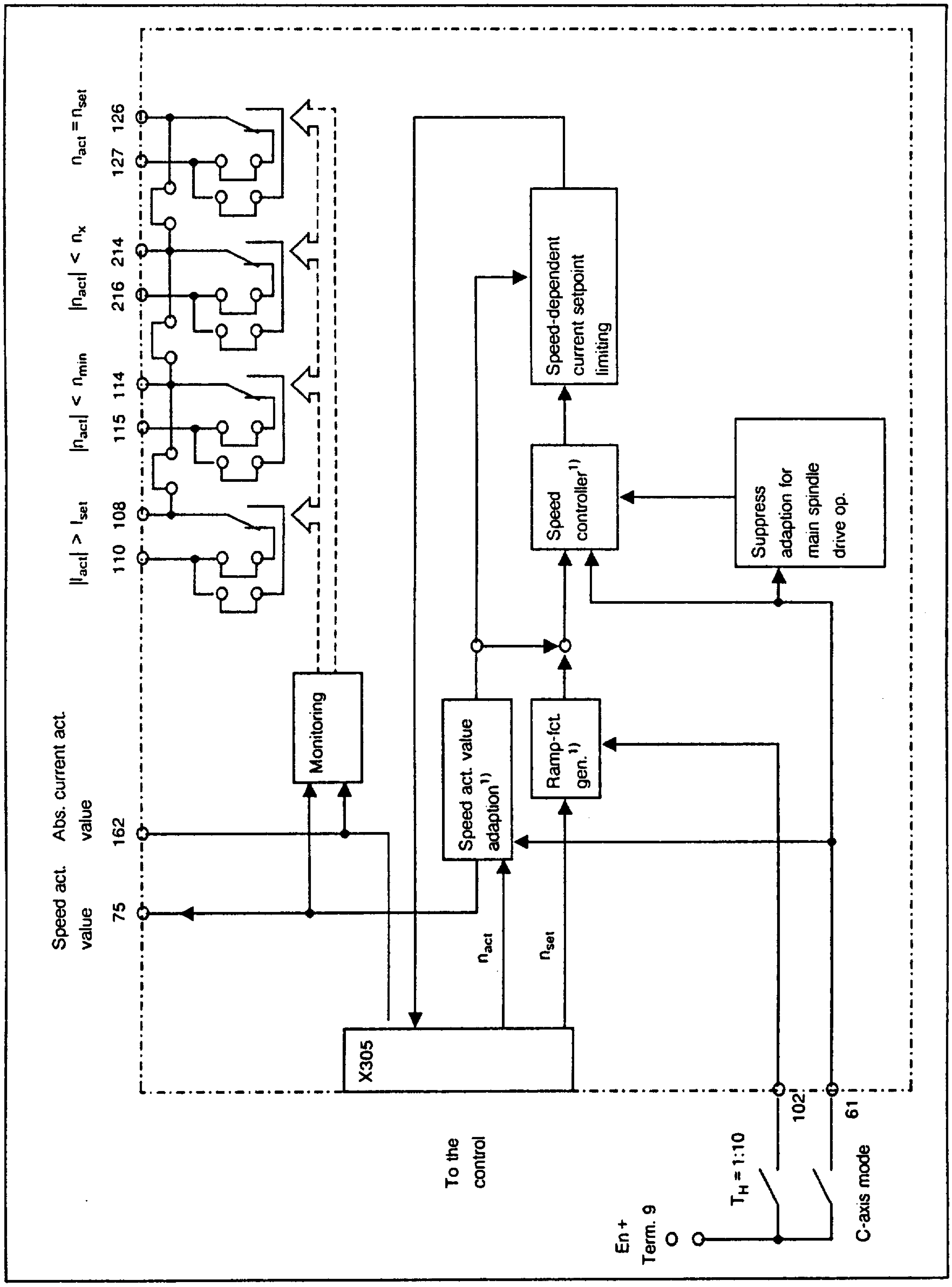


Block diagram of the monitoring module

1) *Alternative infeed from the power DC link*
2) *Infeed which is only effective during supply failure*



Block diagram of the pulsed resistor module



Block diagram of the option board, main spindle function for SIMODRIVE 611 PWM converters

1) *Can be adjusted on the option board*

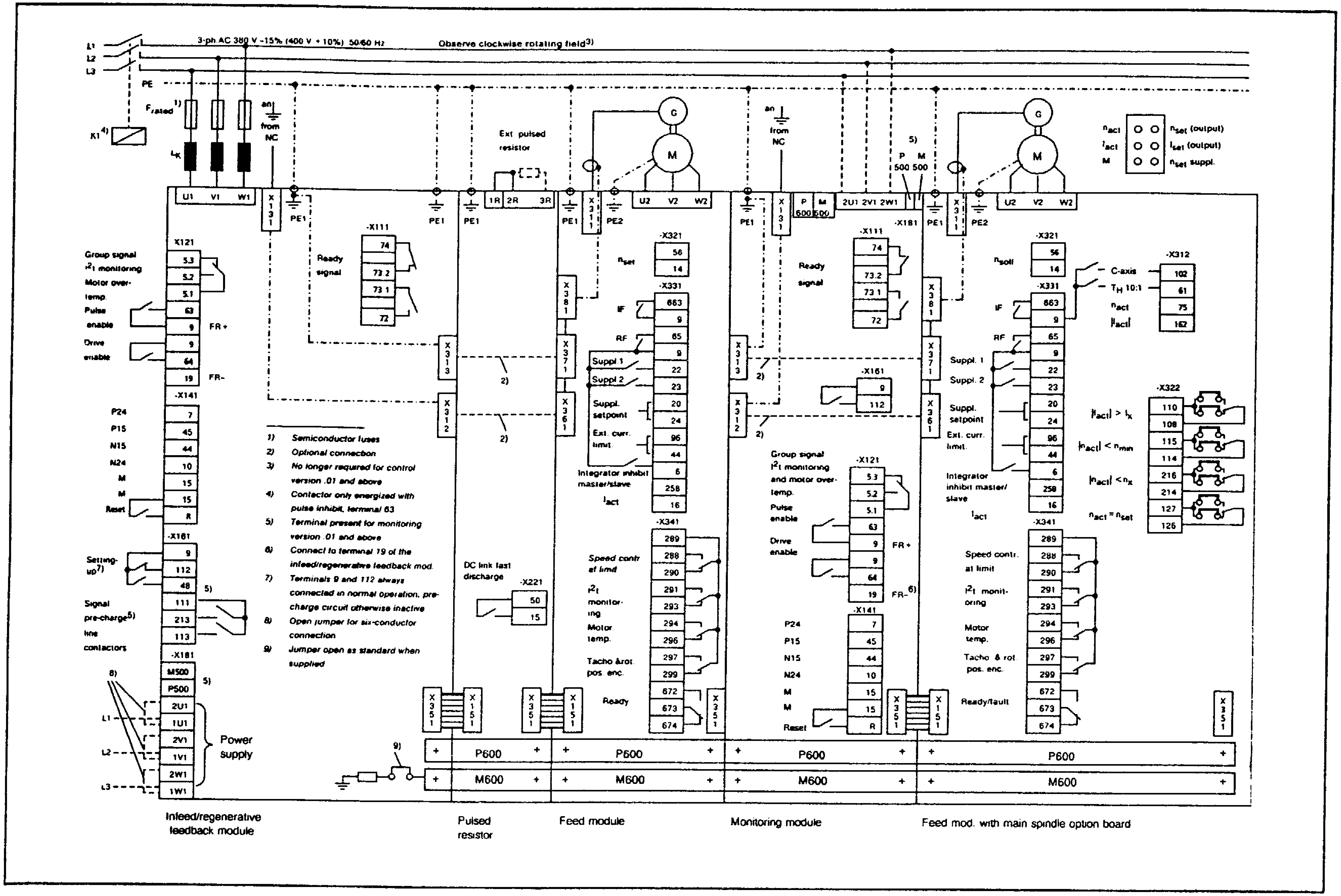
7 Connecting diagrams

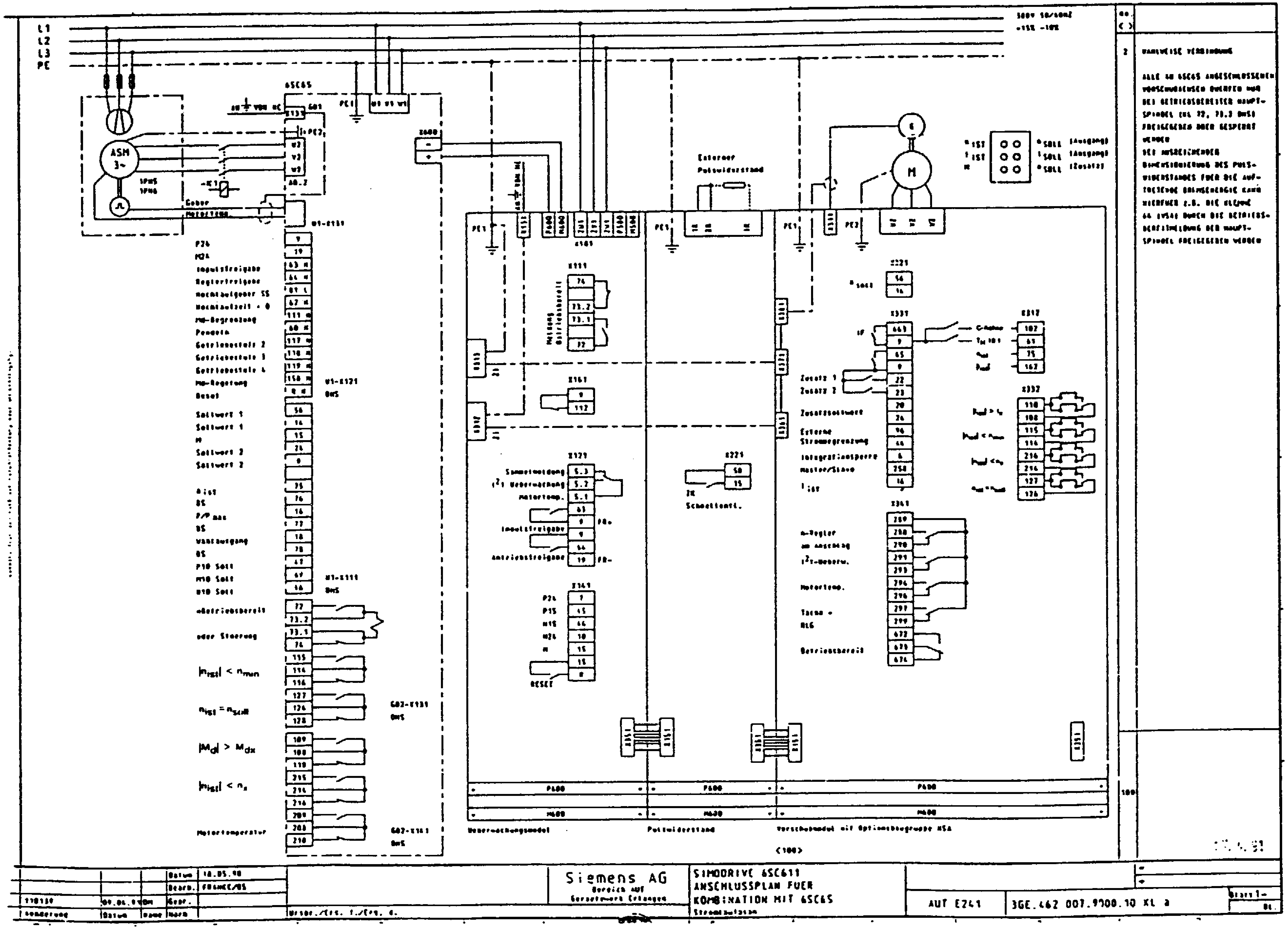
7.1 SIMODRIVE 611

- Connecting

7.2 Combination of SIMODRIVE 611 and SIMODRIVE 650/660

  (The connection diagram is also essentially valid for the SIMODRIVE 6SC611 and 6SC660 combination).


3-ph AC 380 V -15% (400 V + 10%) 50/60 Hz
Observe clockwise rotating field3)
L1
L2
L3
PE
F rated 1)
K1 4)
LK
from NC
Ext. pulsed resistor
G
M
U1 V1 W1
U2 V2 W2
1R 2R 3R
PE1
PE2
X121
X111
X141
X161
X181
X221
X321
X331
X341
X312
X322
Group signal I²t monitoring Motor over-temp.
Pulse enable
Drive enable
FR+
FR-
P24
P15
N15
N24
M
Reset
Setting-up 7)
Signal pre-charge 5) line contactors
Ready signal
n set
IF
RF
Suppl. 1
Suppl. 2
Suppl. setpoint
Ext. curr. limit
Integrator inhibit master/slave
I act
Speed contr. at limit
I²t monitoring
Motor temp.
Tacho & rot. pos. enc.
Ready
Ready/fault
C-axis
T H 10:1
n act
n set (output)
I set (output)
n set suppl.
DC link fast discharge
Power supply
P600
M600
1) Semiconductor fuses
2) Optional connection
3) No longer required for control version .01 and above
4) Contactor only energized with pulse inhibit, terminal 63
5) Terminal present for monitoring version .01 and above
6) Connect to terminal 19 of the infeed/regenerative feedback mod.
7) Terminals 9 and 112 always connected in normal operation, pre-charge circuit otherwise inactive
8) Open jumper for six-conductor connection
9) Jumper open as standard when supplied
Infeed/regenerative feedback module
Pulsed resistor
Feed module
Monitoring module
Feed mod. with main spindle option board


L1
L2
L3
PE
6SC65
ASM
3~
M
Siemens AG
SIMODRIVE 6SC611
ANSCHLUSSPLAN FUER
KOMBINATION MIT 6SC65
AUT E241
3GE.462 007.9300.10 XL a

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Suggestions

Corrections

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Manufacturers Documentation

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