SIMODRIVE 611
Modular Transistor PWM Inverters for AC Drives
Software Release 3.00

Instruction Manual — Edition 06.92

Manufacturer Documentation

SIMODRIVE 611
Modular Transistor PWM Inverters for AC Drives
Software Release 3.00

Instruction Manual

Manufacturer Documentation

Valid for:

	Software release
SIMODRIVE 611	3.00

Edition 06.92

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**
12.91	6SC6111-6AD76 (GWE 462 007.9602.76 J-101)	**A**
06.92	6SC6111-6AD76 (GWE 462 007.9602.76 Ja-101)	**C**

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

Preliminary remarks

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).

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 (permissible according to DIN VDE 0113 Part 1, Section 13.2). This measure prevents sensitive electronic components from being damaged.

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.)

The circuit diagrams in this manual are block diagrams and do not necessarily represent the actual circuit design.

This Instruction Manual is available in the following foreign languages:

French	Order No.: 6SC6111-6AD77
Spanish	Order No.: 6SC6111-6AD78
Italian	Order No.: 6SC6111-6AD72
German	Order No.: 6SC6111-6AD00

CAUTION

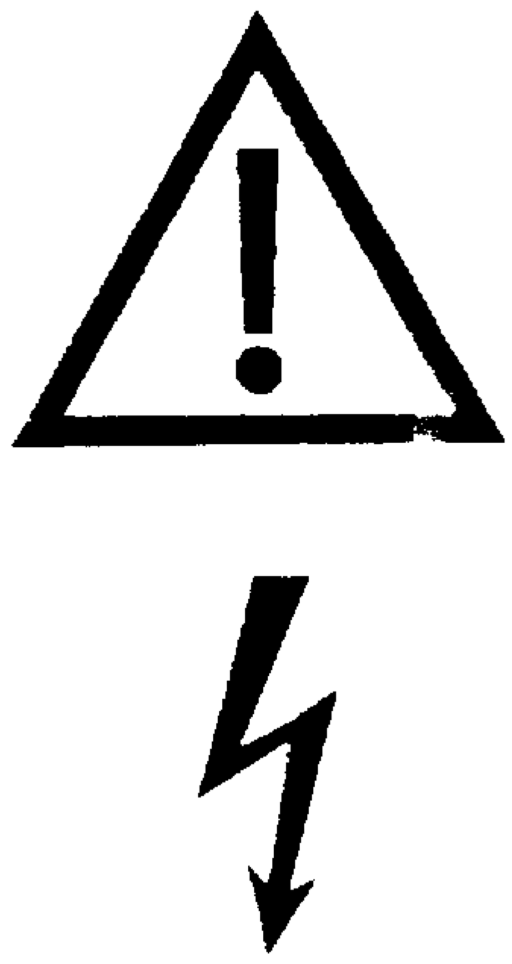
The boards contain components which are sensitive to electrostatic discharge. The human body must be electrically discharged before an electronic board is touched. This can be simply done by touching a conductive, grounded object immediately beforehand (e.g. bare metal cubicle components, socket outlet protective conductor contact).

This Instruction Manual does not claim to cover all equipment details or versions for every conceivable operational situation or application.

If further information is required or if special problems occur which are not described in enough detail for your particular application, please contact your local Siemens office.

The contents of this Instruction Manual are not part of an earlier or an existing agreement, confirmation or legal contract and also do not modify this. The actual purchase agreement represents the complete responsibility of Siemens AG. The only warranty accepted by Siemens AG is the warranty agreed between the parties in the contract. The contractual warranty conditions are neither modified nor changed by the contents of this Instruction Manual.

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 <u>first</u> 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.

Under fault conditions, the signal electronics, with all of its terminals, test sockets and connectors, including the metallic collars of the front connectors, could be at a hazardous voltage level.

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 **will** 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.

Product Description 1

Installation 2

Start-Up 3

Parameter Description 4

Faults and Diagnostic Aids 5

Software Module 6

Option Board 7

Maintenance/Spare Parts 8

Appendix 9

Contents

Page

1	**Product description**	1–1
1.1	Application	1–1
1.2	Design	1–1
1.3	Mode of operation	1–4
1.4	Technical data	1–5
1.5	Overview of ordering data	1–7
2	**Installation**	2–1
2.1	Converter mounting	2–1
2.2	Converter connection	2–2
2.2.1	Screen connection	2–3
2.2.2	Connecting terminals	2–4
2.2.3	Relay functions	2–5
2.2.4	Connecting cable between the PWM inverter and the PG 750/PG 730 programming units	2–6
2.2.5	General information	2–7
3	**Start-up**	3–1
3.1	Operating control and display elements, parameter adjustment	3–1
3.2	Function of the enable terminals	3–4
3.3	Start-up instructions	3–5
3.3.1	Initialization	3–5
3.3.2	Motor data	3–6
3.3.3	Closed-loop control data	3–7
3.3.4	Post optimization	3–9
3.3.5	Setting the limits, open-loop controlled range	3–13
3.3.6	Flowchart for start-up	3–14
3.3.7	Machining-specific data sets	3–21
3.3.8	Module replacement	3–21
4	**Parameter description**	4–1
4.1	Display parameters	4–1
4.1.1	Operating display, P-000, P-100	4–1
4.1.2	Measured value displays, P-001 to P-010, P-101, P-102	4–4
4.1.3	Status displays, P-011, P-254, P-255	4–4
4.1.4	Displaying the executed self-tuned functions P-020	4–7
4.1.5	Software release P-099	4–7
4.2	Handling the D/A converters, test sockets P-012, P-013, P-066 to P-069	4–7
4.2.1	Test sockets, current actual values I_R, X1	4–8
4.2.2	Test socket, voltage setpoint X2	4–8
4.2.3	D/A converters DAU 1 and DAU 2 (P-011, P-013, P-066 to P-069, P-078, P-079)	4–8

4.3	Speed setpoints	4–12
4.3.1	General information	4–12
4.3.2	Standard setpoint selection, P-113	4–13
4.3.3	Ramp-function generator (P-016, P-017, P-018, P-042, P-043)	4–13
4.3.4	Parameterization of the analog setpoint channels P-014, P-015, P-019, P-024, P-025	4–14
4.3.5.	Fixed setpoints P-114.1 to P-114.7	4–15
4.3.6	Motorized potentiometer function, P-114.8	4–16
4.3.7.	Speed setpoint from the oscillation generator, P-154 to P-157	4–16
4.3.8	Steady-state minimum speed and speed range inhibit	4–17
4.4	Motor data	4–18
4.5	Controller data	4–21
4.5.1	Current controller	4–21
4.5.2	Speed controller	4–22
4.5.3	Field controller	4–24
4.5.4	Other controllers	4–24
4.5.5	Open-loop control range	4–26
4.6	Limits	4–28
4.7	Key and control words	4–30
4.7.1	Braking to standstill without overshoot	4–30
4.7.2	Initialization	4–30
4.7.3	Memory functions	4–32
4.7.4	Other control parameters	4–33
4.8	Freely-programmable terminal functions	4–37
4.8.1	2nd torque limit	4–38
4.8.2	Oscillation	4–38
4.8.3	Fault acknowledgment	4–38
4.8.4	0 ramp-up time	4–38
4.8.5	Machining-specific parameters, gearbox stage	4–39
4.8.6	Clockwise/counter-clockwise rotation	4–39
4.8.7	Ramp-function generator 2	4–39
4.8.8	Motorized potentiometer function	4–40
4.8.9	Setpoint enable	4–40
4.8.10	Fixed setpoints	4–40
4.8.11	Motor selection	4–41
4.9	Freely-programmable relay functions	4–42
4.9.1	Relay function, $\lvert n_{act}\rvert < n_{min}$	4–43
4.9.2	Acceleration completed, $n_{act} = n_{set}$, $\lvert M_d\rvert < M_{dx}$	4–43
4.9.3	Relay function, $\lvert n_{act}\rvert < n_x$	4–46
4.9.4	Relay function, I^2t pre-alarm	4–46
4.9.5	Relay function, heatsink overtemperature	4–46
4.9.6	Variable relay functions	4–47
4.9.7	Relay functions, motor ... active	4–48
4.9.8	Relay function control word P-247	4–49
5	**Faults and diagnostic aids**	5–1
5.1	Faults after power-up	5–1
5.2	Fault messages and fault mode	5–1
5.3	Fault acknowledgement	5–3
5.4	Diagnostic aids	5–4
5.4.1	Test sockets	5–4
5.4.2	Transistor diagnostics	5–4
5.4.3	Minimum and maximum value monitoring	5–5
5.4.4	Transient recorder function	5–5

6 Software module 6–1

6.1 Application 6–1
6.2 Software upgrade 6–1
6.3 Overview of ordering data 6–2

7 Option board 7–1

7.1 Application 7–1
7.2 Installation and connection 7–1

8 Maintenance/spare parts 8–1

8.1 Maintenance information 8–1
8.2 Software upgrade and initialization 8–2
8.3 Overview of ordering data, spare parts 8–3

9 Appendix 9–1

9.1 Block diagram 9–3
9.2 Connecting diagram 9–4
9.3 Circuit diagrams 9–5
9.4 Dimension drawings 9–7
9.5 Locations of terminals and connectors 9–11
9.6 Manual post-optimization 9–12
9.6.1 Current controller 9–12
9.6.1.1 Converter switching frequency, P-036 9–12
9.6.1.2 Phase current controller, base speed range, P-115 9–12
9.6.1.3 Phase current controller, field-weakening range P-116 9–12
9.6.2 Adjusting the power offset (addresses 11D0H, 11D2H) 9–13
9.6.3 Rounding-off, P-018 9–13
9.6.4 Speed controller 9–14
9.6.4.1 Speed controller, P gain P-031 9–14
9.6.4.2 Speed controller, integral action time P-032 9–14
9.6.5 Field controller, P gain P-034 9–14
9.6.6 No-load current, P-166 9–15
9.6.7 Main field reactance, P-171 9–15
9.6.8 Moment of inertia, P-159 9–16
9.6.9 Rotor resistance, P-168 9–17
9.6.10 Faults on the analog setpoint channel 9–18
9.6.11 Field weakening speed, P-173 9–18
9.7 Parameter list 9–19
9.8 Setting and check data 9–26
9.9 ECB instructions 9–43
9.10 Standards and specifications 9–44

1 Product description

1.1 Application

The induction motor module for the modular **SIMODRIVE 6SC611** transistor PWM inverter system is used for four-quadrant, closed-loop speed control of induction motors without encoder. By omitting the encoder, any induction motor can be used which is suitable for converter operation. Depending on the particular motor, motor speeds exceeding 24000 RPM can be achieved. In spite of the fact that there is no position encoder or tachogenerator, the drive system fulfills higher demands regarding the dynamic closed-loop control performance and stability than conventional converter drives with voltage/frequency characteristic control. Extremely short acceleration times can be achieved due to high dynamic performance provided by the field orientation. However, the high speed control accuracy of main spindle drives with encoders cannot be achieved; also, in the low speed range somewhat less dynamic control performance must be expected.

Positioning is not possible without encoder. The main applications for the induction motor module are for special high-speed induction motors (e.g. for woodworking), for grinding applications, for punch or press drives or for variable-speed pump drives with standard motors. The modular design permits the unit to be easily combined with feed-, main spindle and additional induction motor drives. The induction motor module is equipped with a microprocessor which allows a whole range of auxiliary-, open-loop and protection functions as well as numerous relay signals to be individually configured by the user.

1.2 Design

The induction motor module is a component of the modular SIMODRIVE 611 drive system. The following modules are available in the SIMODRIVE 611 system:

- Infeed/regenerative feedback module
  Provides the DC link voltage and supply voltages for the module group, capable of regenerative feedback and central monitoring functions.
- Monitoring module
  Provides the supply voltages for the module group for external DC links or provides the supply voltages for part of the module group if the infeed/regenerative feedback module supply is not sufficient for all modules of the DC link, and in addition, central monitoring functions.
- Pulsed resistor module
  Absorbs regenerative DC link power when the supply fails, for an external DC link which cannot feed energy back into the supply, or where the dynamic regenerative peak feedback power of the infeed/regenerative feedback module used is not sufficient.
- Feed module
  Complete unit for operating permanent-field synchronous feed drives in 4-quadrant operation.
- Main spindle module
  Complete unit for operating main spindle induction motors with rotor position sensing in 4-quadrant operation.
- Induction motor module
  Complete unit for operating any induction motor in 4-quadrant operation.

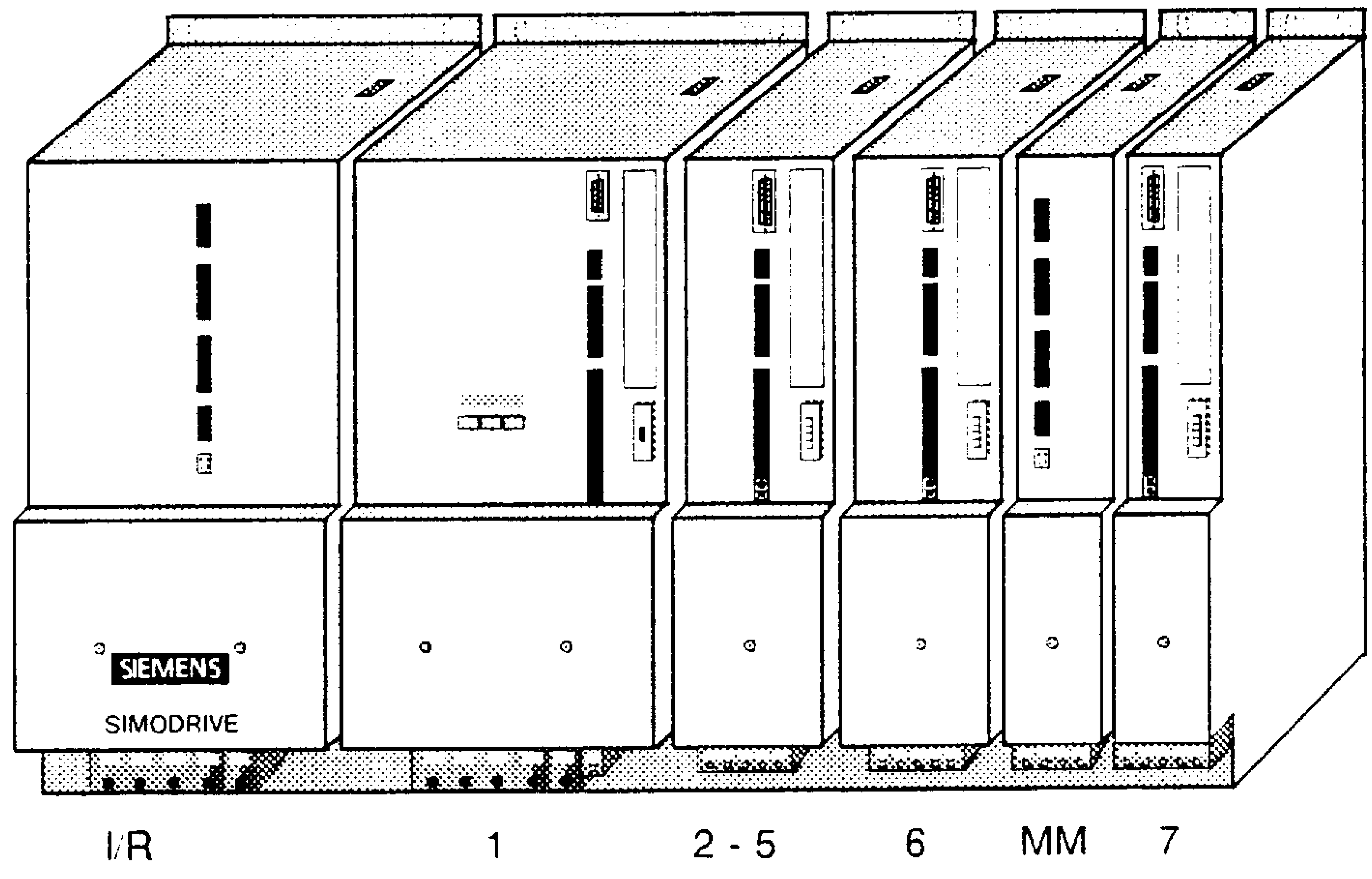
The drive system has the following characteristics:

- Modular axis design
- Direct supply connection
- Regenerative feedback
- Individual axis fault messages
- Controlled DC link voltage
- Codable customer terminals (plug-in terminals)
- Rugged and safe connection technology

The SIMODRIVE 611 system can be operated as autonomous system with an active infeed/regenerative feedback module, or can be connected to an external DC link (e.g. SIMODRIVE 650 transistor PWM inverter).

When operated as autonomous system, a drive module is required for each axis (induction-, feed- or main spindle module), and, depending on the particular design, an infeed/regenerative feedback module for several associated axes. If an existing DC link is to be used, a monitoring module is required instead of the infeed/regenerative feedback module, and, depending on the regenerative power and DC link capacitance, also a pulsed resistor module. If a SIMODRIVE 650 transistor PWM inverter is used, a higher-output unit must be selected as a result of the additional infeed power for the external axis drive modules.

The power supply integrated in an infeed/regenerative feedback module or monitoring module is designed for supplying several axis modules. An additional monitoring module is required for larger expansion stages and the equipment bus is continued from this point. All modules are mounted next to each other. In order to complete the equipment wiring, only the DC link jumpers and the equipment bus must be connected from module to module. Both are located under a cover which must be replaced after start-up. A label is located under this cover which indicates the versions of the boards used.



SIMODRIVE 611 as drive system

I/R... Infeed/regenerative feedback module
1... Induction motor module
2-6... Feed drive modules
MM... Monitoring module
7... Feed drive module

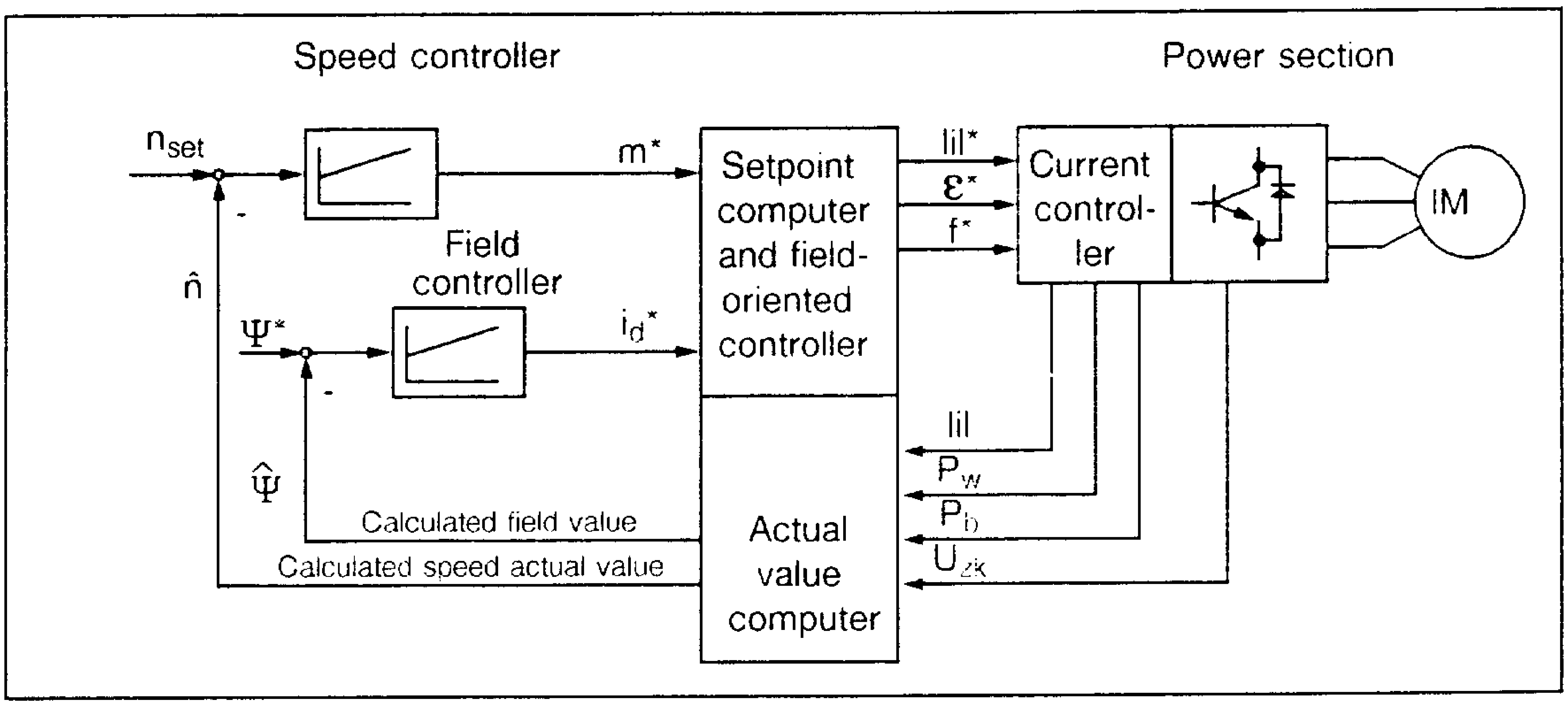
The power terminals are always located in the lower half of the module, and the control and actual value terminals in the upper half of the module. All the necessary connectors are already inserted when the equipment is supplied.

The mounting holes for the different modules are in a 50 mm horizontal grid pattern, so that modules can be replaced by other modules at a later date. A 100 mm clearance should be maintained above and below the modules and between the module rows to ensure that the cooling air flow is not restricted.

The software for the induction motor module microprocessor is stored in a plug-in software module. An operator control and display system is integrated into the induction motor module front panel, which consists of three keys and a six-digit, 7-segment LED display. The module also has a serial RS232 interface, which can be used for start-up and parameterization. A free slot is provided to expand the functional scope of the induction motor module using option boards.

1.3 Mode of operation

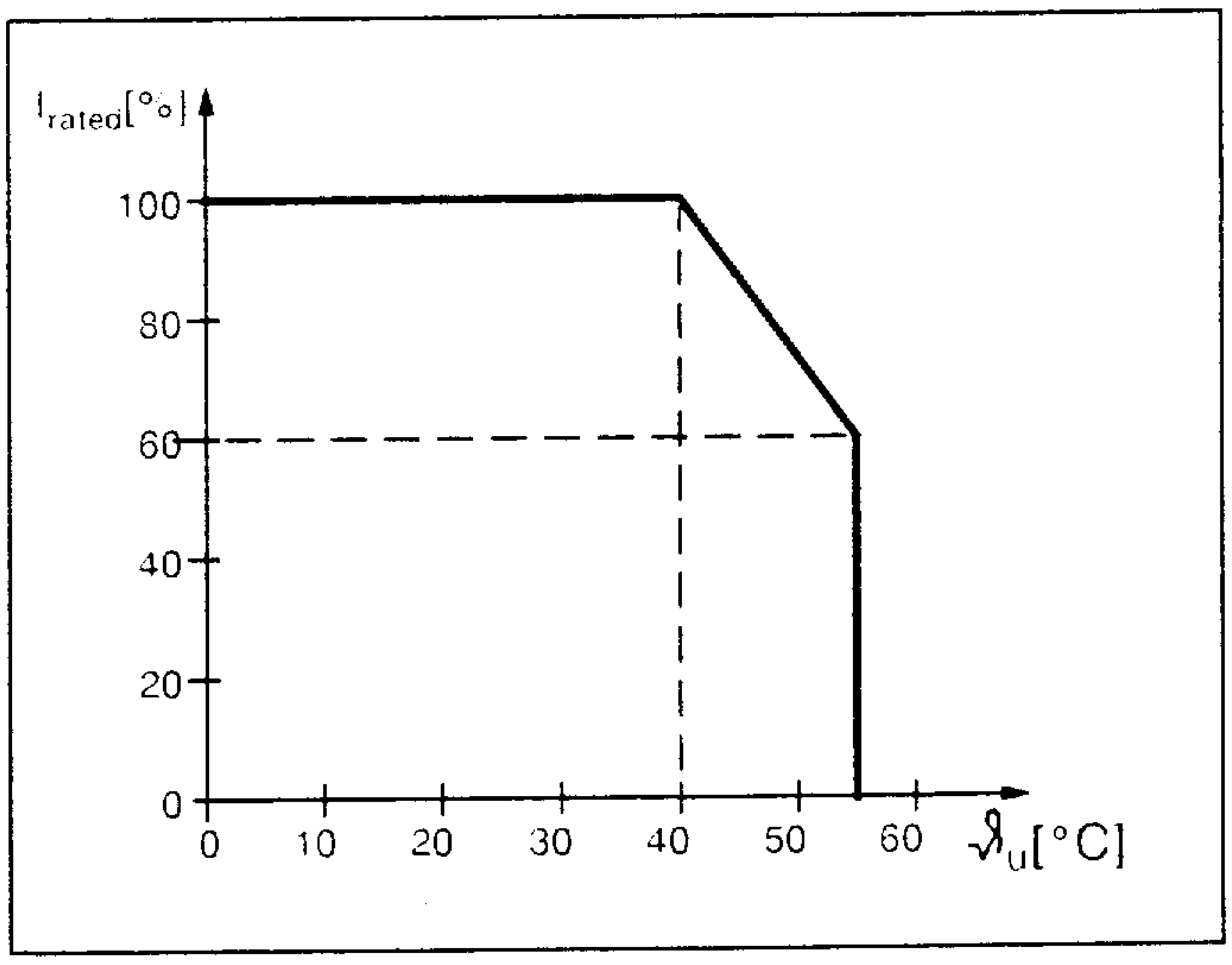
The closed-loop control incorporated in the induction motor module consists of an analog and a digital section. Further, a sequence control with different, programmable functions is also included. The digital section of the closed-loop control is microprocessor-based and includes speed-, field, and field-oriented controllers. The field-oriented controller ensures field-oriented operation of the induction motor, so that the field- and torque-generating current components can be separately influenced. Thus, the induction motor can be controlled similar to a DC motor using the armature and field circuits. A ramp-function generator can be connected in series with the speed controller. Torque feed-forward control ensures that the speed setpoint is optimally approached without overshoot, taking into account the torque limits. Further, the actual speed and field are calculated in the digital computer, as well as the setpoints for the current controller. A changeover is made to open-loop current frequency control at very low speeds. The current controller utilizes analog technology and controls the motor-side transistor inverter using pulse width modulation.



Block diagram of the AC induction motor drive

1.4 Technical data

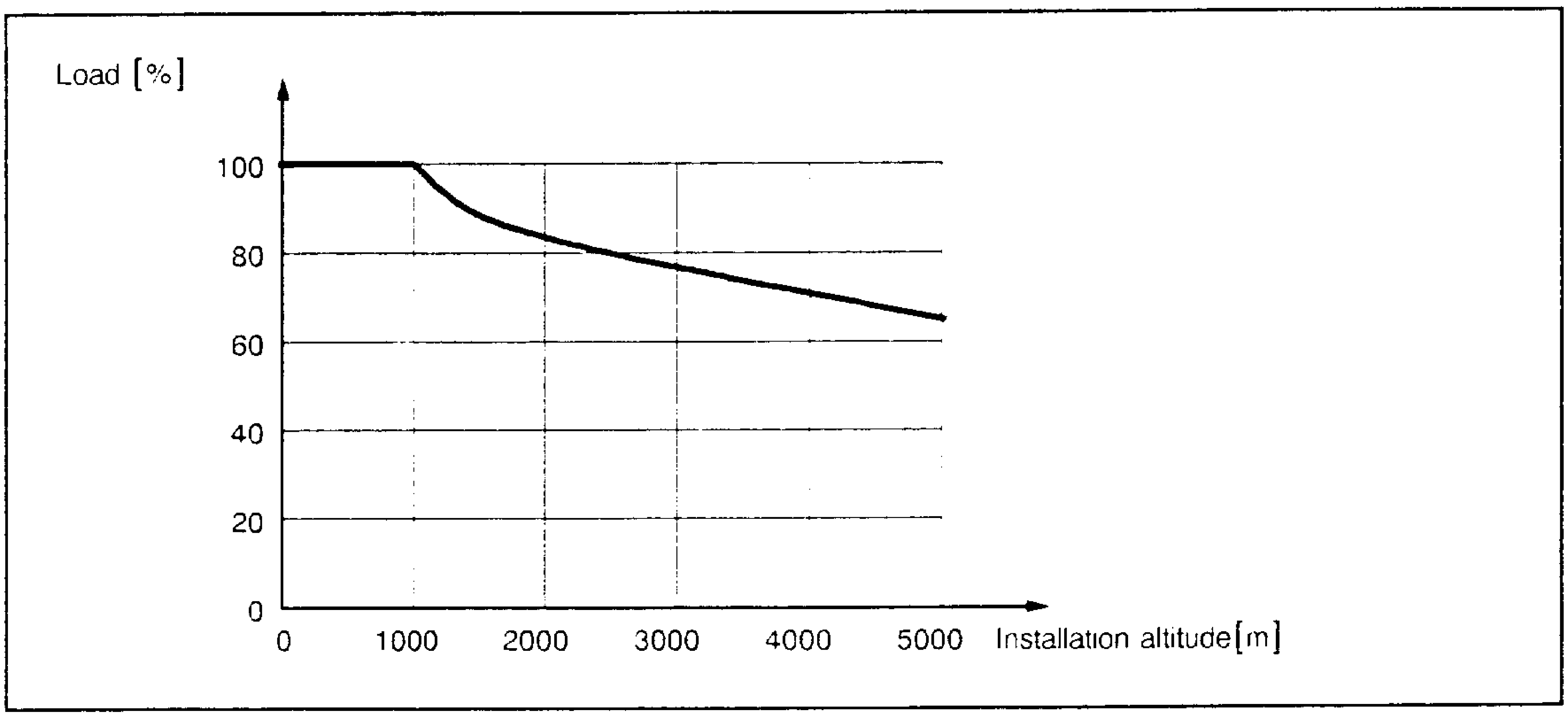
Degree of protection	DIN 40050-IP00
Humidity classification	DIN 40040, Code F
Insulation according to	DIN VDE 0160 for installations, acc. to DIN VDE 0110 insulation group C
Permissible ambient temperature	0 °C to +40 °C (with de-rating up to 55°C)
Permissible storage temperature	-25 °C to +85 °C
Output voltage	3-ph. AC 0 ... 430 V
Output current	Dependent on the power section used (refer to Table)
Output frequency	0 to 480 Hz
Efficiency at rated operation	approx. 98 %
DC link voltage	600 V DC, controlled
Pulse frequency	3.3 kHz / 4 kHz (can be selected), 4 kHz with derating
Power loss	Dependent on the power section used (refer to Table)
Cooling type	Forced ventilated



De-rating for increased air intake temperature

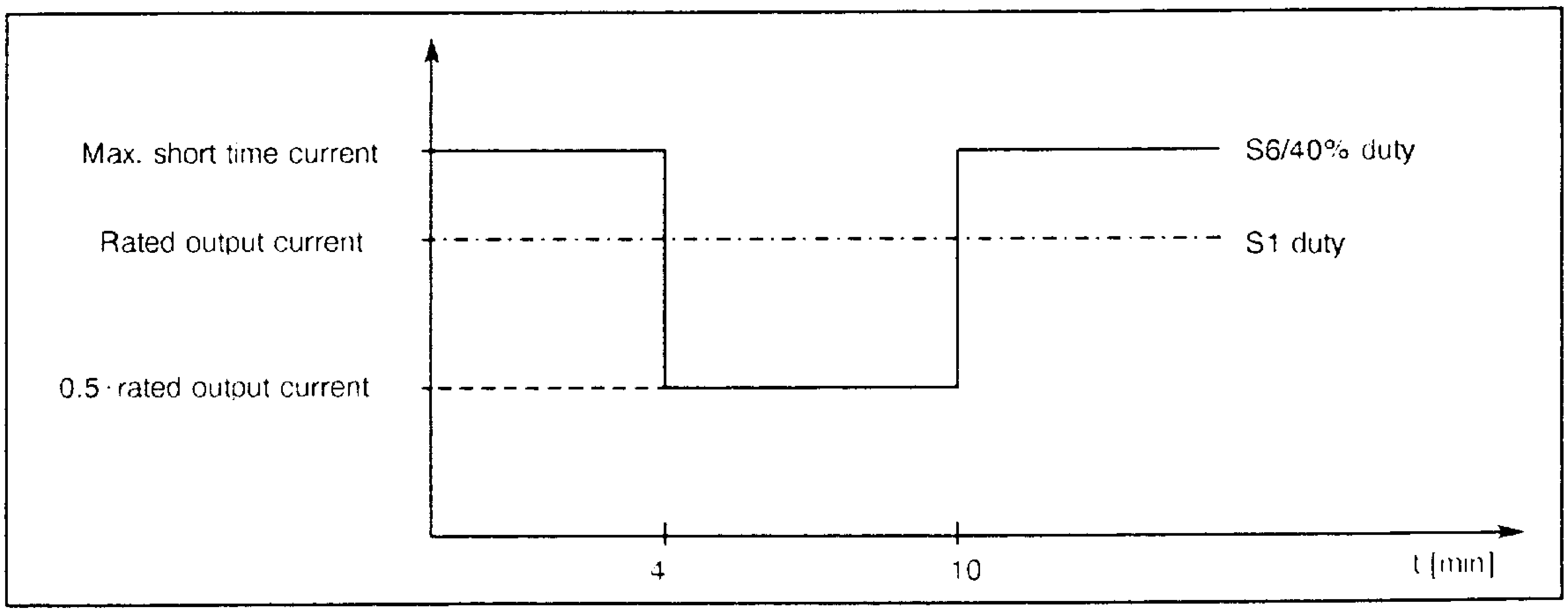
Installation altitude

The specified ratings refer to installation altitudes up to 1000 m above sea level. De-ratings apply, according to the diagram below, for installation altitudes exceeding 1000 m.



De-rating for installation altitudes > 1000 m above sea level

Order No. 6SC611	0-5DA00	1-5DA00	2-4DA00	3-0DA00	4-5DA00	6-0DA00
Rated output current [1]	5 A	15 A	24 A	30 A	45 A	60 A
Max. short-timecurrent	7 A	20 A	32 A	40 A	60 A	80 A
Power loss [1]	100 W	250 W	440 W	650 W	800 W	1100 W
Weight, approx.	7.8 kg	7.8 kg	11.7 kg	15.6 kg	15.6 kg	20 kg



Permissible duty cycle for the induction motor power sections

1) *at 3.3 kHz pulse frequency*

1.5 Overview of the ordering data

- Induction motor modules

6SC6110-5DA00	5/7 A module
6SC6111-5DA00	15/20 A module
6SC6112-4DA00	24/32 A module
6SC6113-0DA00	30/40 A module
6SC6114-5DA00	45/60 A module
6SC6116-0DA00	60/80 A module

- Software module

  The following is required to operate the induction motor modules:

  6SC6110-0EDXX Programmed software module

  XX = Dependent on software release

  e.g.: XX = 03, current software release 3.00

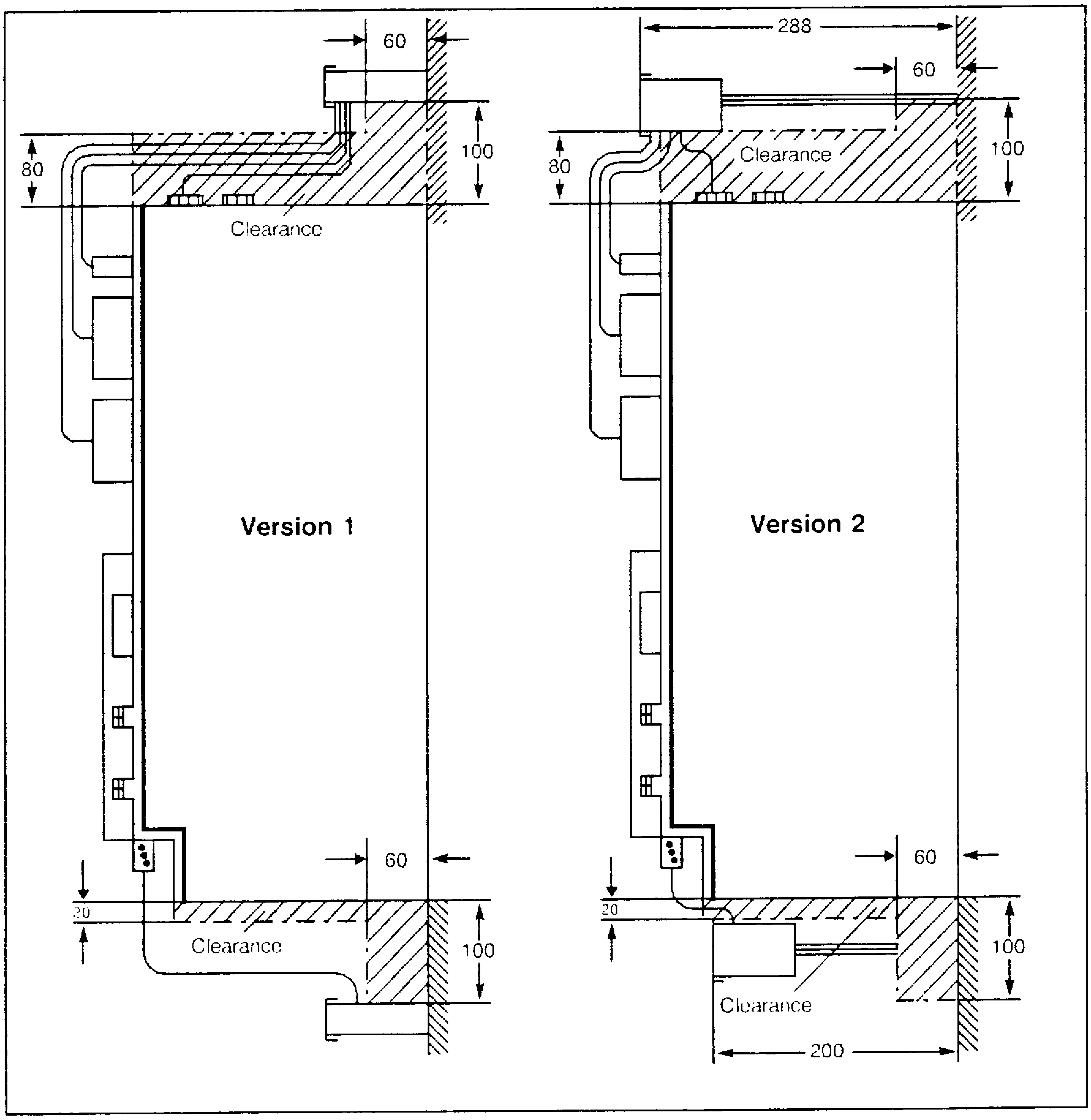
2 Installation

2.1 Converter mounting

The converters are designed for vertical mounting in cubicles or machine racks. They should be mounted with the motor connections below.

It should be ensured that the cooling air intake and outlet are unrestricted. A clearance of 100 mm should be provided above and below the converters in the rear section of the modules (cooling air flow) which should also not be restricted by cables. A compact design in the cubicle can be achieved by routing the cable duct along a bridge at the front of the module. This also increases the cable protection and improves cable routing to the module.

The converters should be installed so that they are protected from conductive dust deposits and vapors (degree of protection DIN 40050-IP00).



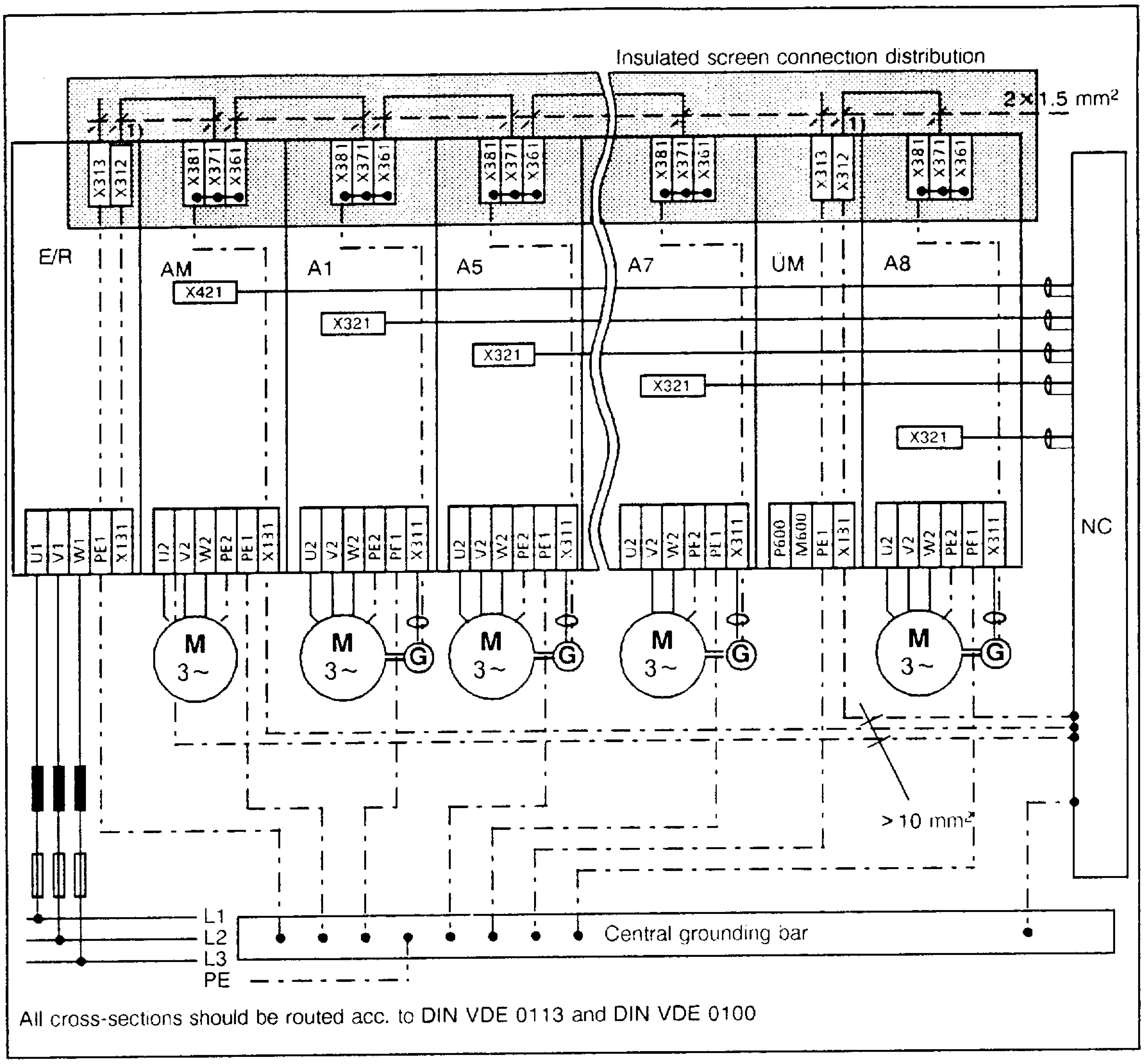
- *Mounting dimensions, refer to the dimension drawings*
- *Protection against contact with live components according to DIN VDE 0106, Part 7 comprises of the DC link cover.*

2.2 Converter connection

The modules must be grounded in operation. They should be connected-up as recommended and according to the customers circuit diagram. The converter is adapted to the motor by initializing (Section 4).

- *The setpoint and actual value cables are screened and routed separately from the load cables.*
- *Drilled cables are recommended for the motor feeder.*
- *Control cables for the enable signals should be routed away from the contactor control cables.*
- *If noise problems occur, it is possible to connect the ground to the NC.*
- *The ground connection between the NC and induction motor module should be as short as possible:*
  Minimum 10 mm² cable cross-section. Connector X131 on the induction motor module is used to make the connection.

The power connection screws should be checked to ensure that they are tight.



Grounding concept

I/R	:	Infeed/regenerative feedback module
MM	:	Monitoring module
IM	:	Induction motor module
A1 ... 8	:	Feed modules

2.2.1 Screen connection

Four connecting points are available for each module at connector X381, to connect additional screen cables.

The screen potential is transferred from module to module via connectors X361 and X371. By selecting either connector X313 or X312 at the infeed/regenerative feedback module and monitoring module, it can be selected as to whether the screen cables are connected to PE or connector X131.

X313 (infeed/regenerative feedback module) is connected to PE.
X312 (infeed/regenerative feedback module) is connected to X131.

---

1) Depending on the system, is connected to X313 or X312.

2.2.2 Connecting terminals

Term. No.	Location	Function	Type 1)	Typ. voltage	max. cross-section
U2					16 mm² (5/7A mod.)
V2		Motor connection	O	3-ph. AC	16 mm² (15/20A mod.)
W2					16 mm² (24/32A mod.)
PE1		Protective conductor	I	0 V	25 mm² (30/40A mod.)
PE2		Protective conductor	I	0 V	25 mm² (45/60A mod.)
					50 mm² (60/80A mod.)
P600		DC link	I/O	+ 300 V	Busbar
M600		DC link	I/O	- 300 V	Busbar
	X131	Electronics M	I/O	0 V	16 mm²
	X151/351	Equipment bus	I/O	Various	Ribbon cable
	X361-X381	Screen connection distribution	I/O	0 V	1.5 mm²
56	X421	Speed setpoint 1	I	± 10 V	1.5 mm²
14	X421	(differential input)	I	± 10 V	1.5 mm²
24	X421	Speed setpoint 2	I	± 10 V	1.5 mm²
8	X421	(differential input)	I	± 10 V	1.5 mm²
663	X431	Axis-specific pulse enable	I	+ 13 V... + 33 V	1.5 mm²
65	X431	Controller enable	I	+ 13 V... + 33 V	1.5 mm²
81	X431	Ramp-function generator fast stop	I	+ 13 V... + 33 V	1.5 mm²
E1 2)	X431	Freely-programmable, terminal 1	I	+ 13 V... + 33 V	1.5 mm²
E2 2)	X431	Freely-programmable, terminal 2	I	+ 13 V... + 33 V	1.5 mm²
E3 2)	X431	Freely-programmable, terminal 3	I	+ 13 V... + 33 V	1.5 mm²
E4 2)	X431	Freely-programmable, terminal 4	I	+ 13 V... + 33 V	1.5 mm²
E5 2)	X431	Freely-programmable, terminal 5	I	+ 13 V... + 33 V	1.5 mm²
E6 2)	X431	Freely-programmable, terminal 6	I	+ 13 V... + 33 V	1.5 mm²
E7 2)	X431	Freely-programmable, terminal 7	I	+ 13 V... + 33 V	1.5 mm²
E8 2)	X431	Freely-programmable, terminal 8	I	+ 13 V... + 33 V	1.5 mm²
E9 2)	X431	Freely-programmable, terminal 9	I	+ 13 V... + 33 V	1.5 mm²
9	X431	Enable voltage	O	+ 24 V	1.5 mm²
A91	X451	Analog output, D/A conv. 1	O	± 10 V	1.5 mm²
901	X451	Reference potential for D/A conv. 1	O	0 V	1.5 mm²
A92	X451	Analog output, D/A conv. 2	O	± 10 V	1.5 mm²
902	X451	Reference potential for D/A conv. 2	O	0 V	1.5 mm²

Function description of the permanently-wired enable terminals

- Terminal 663: Axis-specific pulse enable
  The inverter is enabled (motor is fed) when 24 V is connected to terminal 663 (axis-specific pulse enable) and terminal 65 (controller enable). The inverter is inhibited and the motor coasts down in a no-current condition if the axis-specific pulse enable is withdrawn when the motor is rotating (0 V).
  Prerequisite: The enable signals are still available at the infeed/regenerative and monitoring modules.

1) *I ≙ Input O ≙ Output*
2) *Can be freely programmed via operator control parameters (Section 4.8)*

- Terminal 65: Controller enable
  The inverter is enabled when terminals 663 and terminal 65 are energized. If terminal 65 is de-energized when the motor is rotating, the drive brakes along the ramp-function generator ramp. When the absolute value of the n_{min} threshold (P-022) is fallen below, the inverter is inhibited and the motor is braked to standstill without overshoot.
- Terminal 81: Ramp-function generator fast stop
  The speed setpoint is enabled when 24 V is connected to terminal 81. If 0 V is connected, the speed setpoint becomes digitally zero. The drive brakes without ramp-function generator along the torque limit. If bit 1 is set in parameter P-053, the pulses are inhibited after zero speed has been reached.

2.2.3 Relay functions

Term. No.	Location	Function	Type [1]	Typ. voltage	Max. cross-section
289	X441	Signals, center contact	I	30 V/1.0 A max[3]	1.5 mm²
A11[2]	X441	Freely-program., relay function 1	NO	30 V/1.0 A max	1.5 mm²
A21[2]	X441	Freely-program., relay function 2	NO	30 V/1.0 A max	1.5 mm²
A31[2]	X441	Freely-program., relay function 3	NO	30 V/1.0 A max	1.5 mm²
A41[2]	X441	Freely-program., relay function 4	NO	30 V/1.0 A max	1.5 mm²
A51[2]	X441	Freely-program., relay function 5	NO	30 V/1.0 A max	1.5 mm²
A61[2]	X441	Freely-program., relay function 6	NO	30 V/1.0 A max	1.5 mm²
672	X441	Ready/ axis-specific fault	NO	30 V/1.0 A max	1.5 mm²
673	X441		I	30 V/1.0 A max	1.5 mm²
674	X441		NC	30 V/1.0 A max	1.5 mm²

Description of the permanently-wired relay function

- Terminals 672 to 674: Relay, axis-specific ready/fault
  The relay function can be changed over using P-053.
  For an explanation, refer to Section 4.7.4.

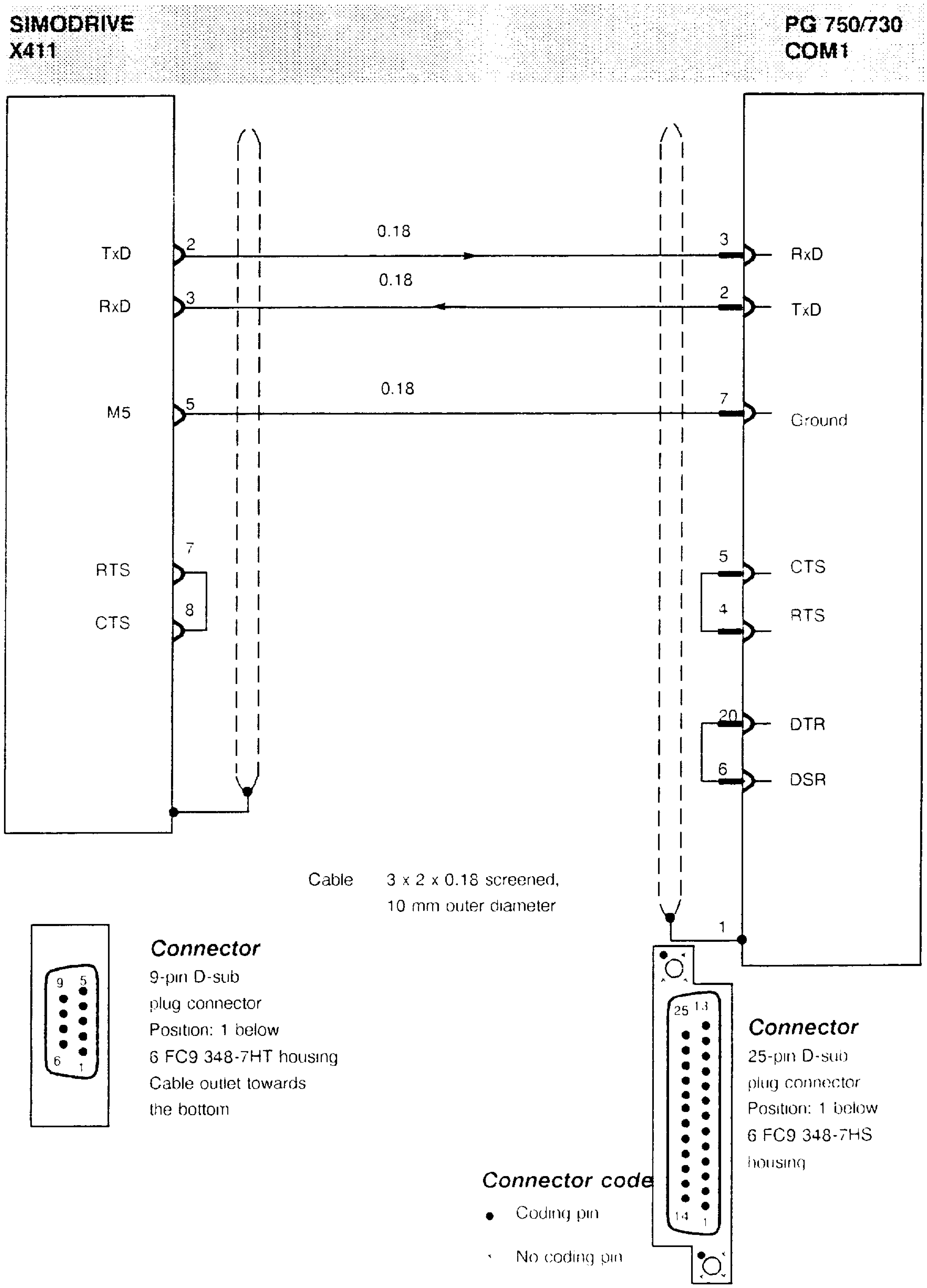
1) *I ≙ Input NC ≙ Normally closed contact NO ≙ Normally open contact*

2) *Can be freely programmed via operator control parameter (Section 4.9)*

3) *The total current of 1A must not be exceeded when several relays are used.*

2.2.4 Connecting cable between the PWM inverter and the PG 750/PG 730 programming units

Cable designation: PG 750/PG 730 data cable
Order No.: **6FC9 348-2T□**[1)]



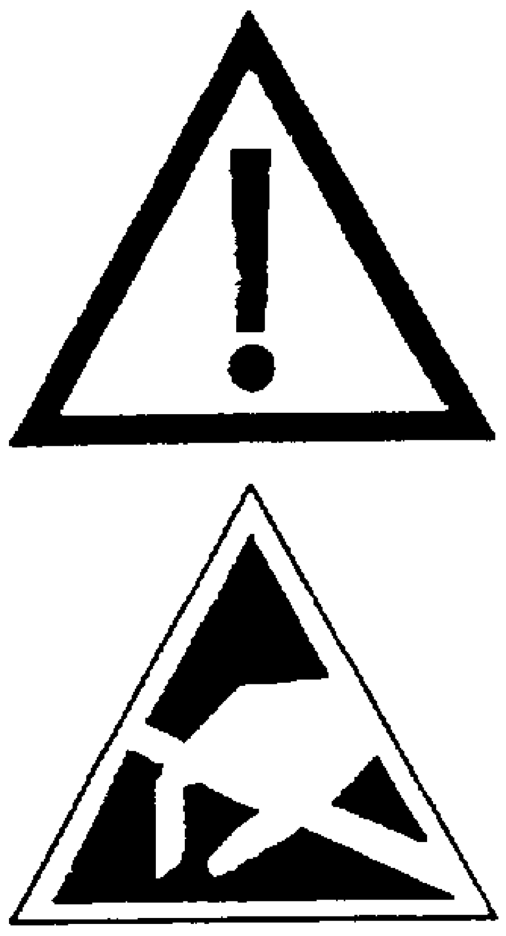
1) *Cable lengths: B = 5 m C = 10 m*

2.2.5 General information

If external 24 V power supplies are used for the modules (enable signals, relay functions), then these should be connected with their ground potential at the enable signal reference potential (terminal 19, infeed/regenerative feedback module).

When using numerical controls with non-floating electronic outputs, terminal 19 must be connected to the NC reference potential (connect terminal 19 to terminal 15 of the infeed/regenerative feedback module).

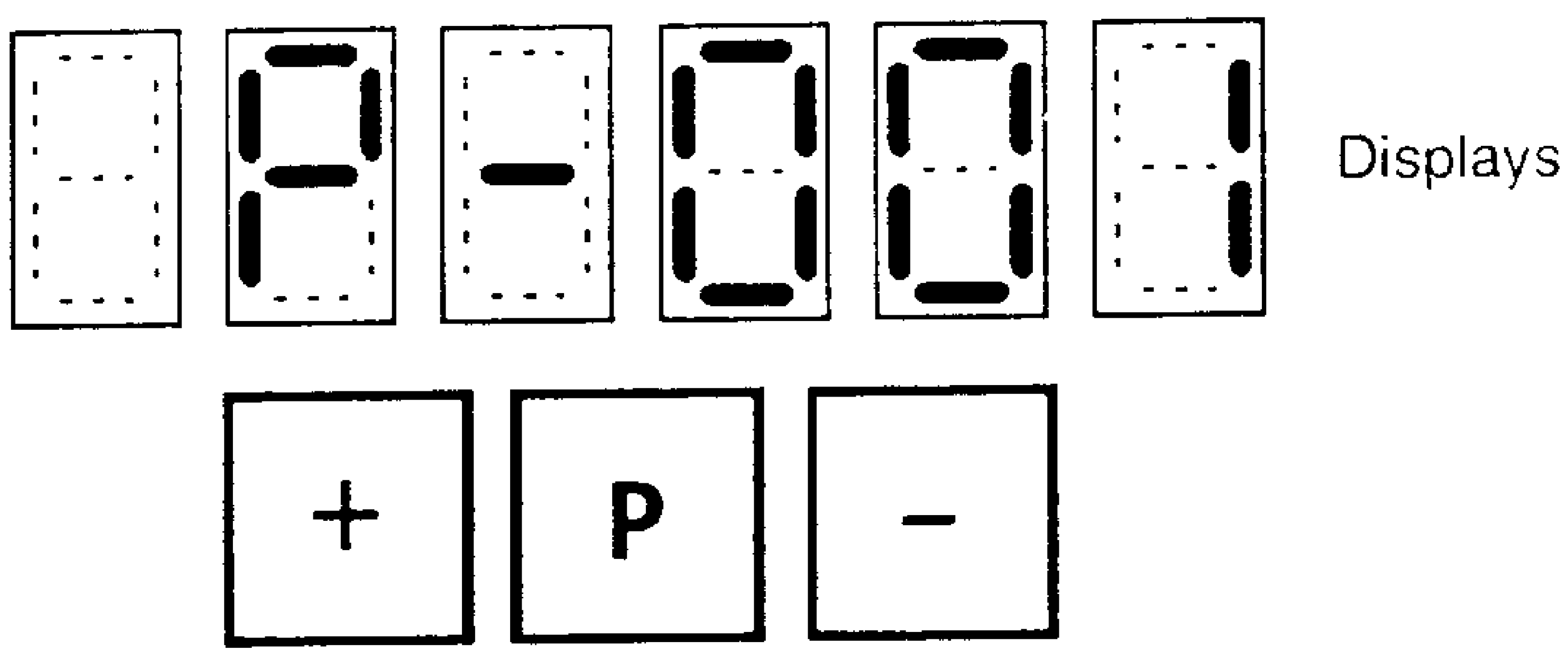
3 Start-up



	WARNING
	Perfect and safe operation of this converter requires that the unit is professionally transported, installed and mounted as well as careful operator control and maintenance. If the warning notes are not observed, this can result in severe personal injury or material damage. The boards contain components which can be destroyed by electrostatic discharge. The human body must be electrically discharged before touching an electronic board. This can be simply realized by touching a conductive, grounded object immediately beforehand (e.g. bare metal cubicle components, outlet socket protective conductor contact).

3.1 Operating control and display elements, parameter adjustment

The operating control and display system consists of three keys and a display (six-digit 7-segment display).



Operating control and display board

The mode can be switched between the following using the "P" key:

- Display of the parameter number
- Display of the sub-parameter number (if available)
- Display of the parameter contents

The displayed value (parameter number, sub-parameter number or the parameter contents, depending on the mode) can be changed using the " + " and "–" keys, whereby the " + " key increases the value and the "–" key reduces the value. The value is changed at a higher rate if the P key is depressed together with the " + " or "–" key. The parameter number, and if available, the sub-parameter number can always be changed, on the other hand, the parameter contents can only be changed if the write protection (P-051) is cancelled. This is realized by entering 4H in P-051. Several parameter contents can only be adjusted, if 10H is entered into P-051 (special write protection). The contents of the display parameters are generally write-protected as it makes no sense to change them

 6SC6111 6AD76
SIMODRIVE 611 (BE)

Key	Function in the operating control mode
"P"	Changeover from: Parameter number to parameter value, Parameter value to parameter number, Parameter number to sub-parameter number, Sub-parameter number to parameter value or Parameter value to sub-parameter number
" + "	Increasing parameter numbers, sub-parameter numbers or parameter values
" – "	Decreasing parameter numbers, sub-parameter numbers or parameter values
" + " and "P"	Quickly increasing parameter numbers or parameter values
" – " and "P"	Quickly decreasing parameter numbers or parameter values

Function of the keys in the operator control mode

A fault number is displayed when specific faults occur. In the fault mode, the functions of the operator control keys change, as can be seen in the table "Function of the keys in the fault mode". More detailed information regarding fault handling is provided in Section 5 (Faults and diagnostic aids).

Key	Function in the fault mode
"P"	Fault acknowledgement with controller inhibited
" + "	Proceed to the next fault message if several fault messages are present
" – "	Brief changeover (approx. 1 minute) into the operator control mode

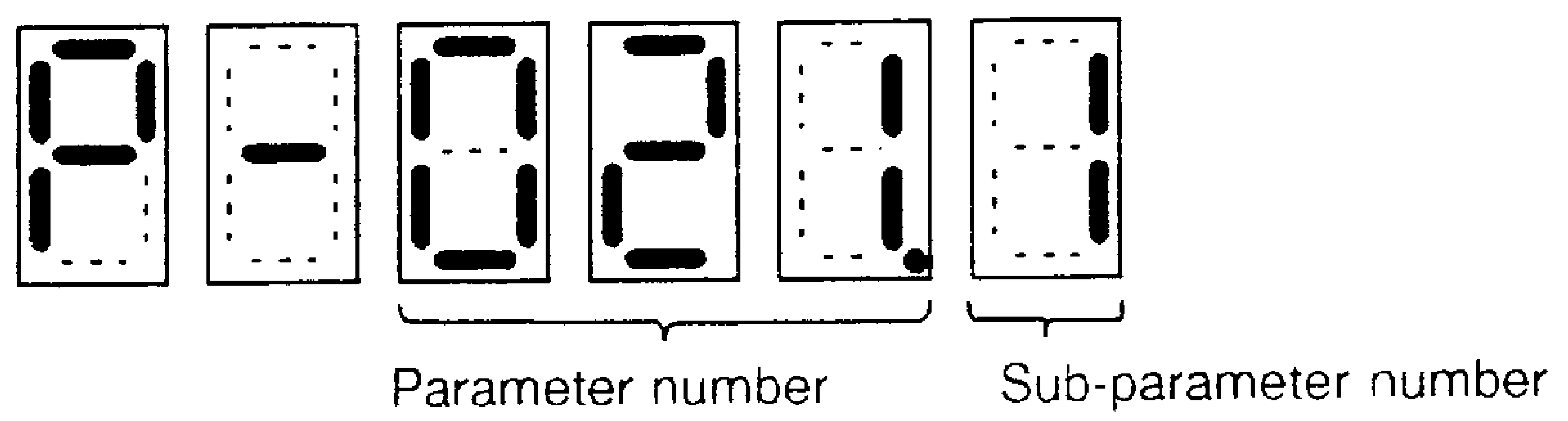
Table 5.2 Function of the keys in the fault mode

The subsequent example should clarify how a parameter value is changed:
Changing the speed setpoint normalization (P-024) from 10.0 V to 8.0 V.

	Action		Display
1.	Changeover from parameter display to parameter number display with the "P" key	e.g.	P-000
2.	Set the parameter display to P-051 with the "–" key or " + " key		P-051
3.	Changeover to parameter contents display with the "P" key	e.g.	0H
4.	Set the hexadecimal value 4H with the " + " key		4H
5.	Changeover to parameter number display with the "P" key		P-051
6.	Set parameter P-024 (normalization channel 1) with the "–" key		P-024
7.	Changeover to the parameter contents display with the "P" key and the actually set value 10.0 (≙ 10.0 V) is then displayed.	e.g.	10.0
8.	Change this value to 8.0 with the "–" key. The change is immediately effective, but is still not stored in the EEPROM, i.e. it is lost at switch-off (refer to Section 4).		8.0

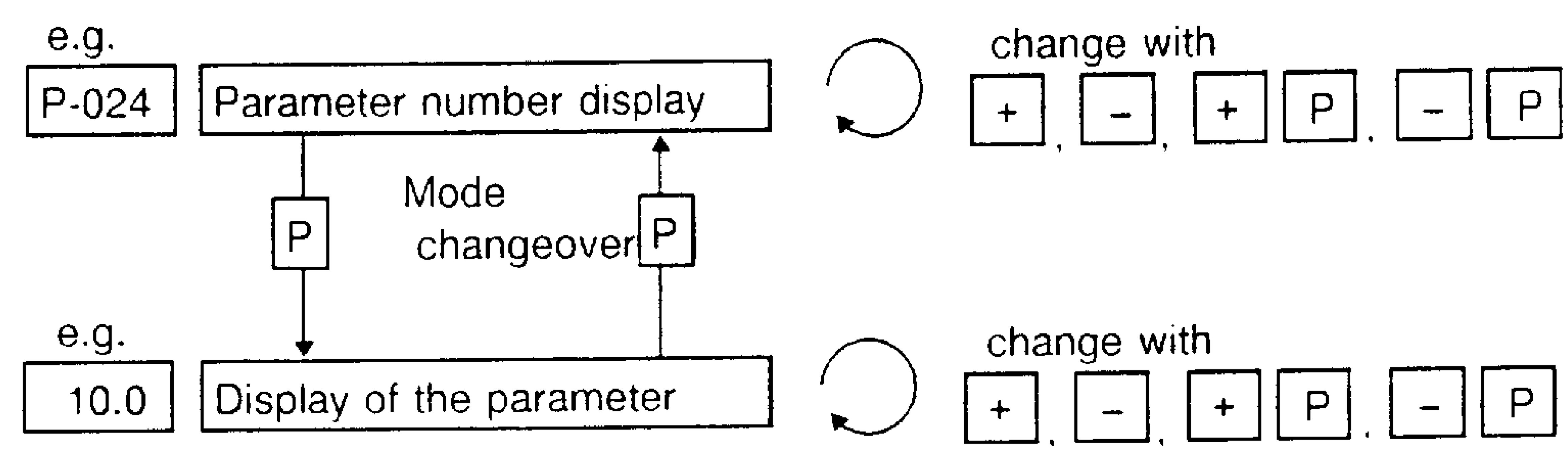
In some cases, the parameter contents should be understood as being physical quantities. Further, there are setting limits (minimum and maximum values) for the parameter contents. They can only be changed within these limits. For several parameters, the parameter contents are displayed in the decimal notation and others in the hexadecimal notation. For the hexadecimal display, the letter "H" appears in the last digit of the display. For parameters, the physical units, the setting range as well as the numerical system are specified in the display.

Sub-parameters are available for several parameter numbers to specify different parameter values for the individual motor- or machining-specific data sets. There are four sub-parameters for motor-specific parameter sets and eight sub-parameters for machining-specific parameter sets. Without sub-parameter, the parameter number display can be changed over to display the parameter contents using the "P" key. With sub-parameters, when the "P" key is depressed with the parameter number display selected, then the parameter number is again displayed, however the sub-parameter number is additionally displayed at the last position, separated by a point from the parameter number.

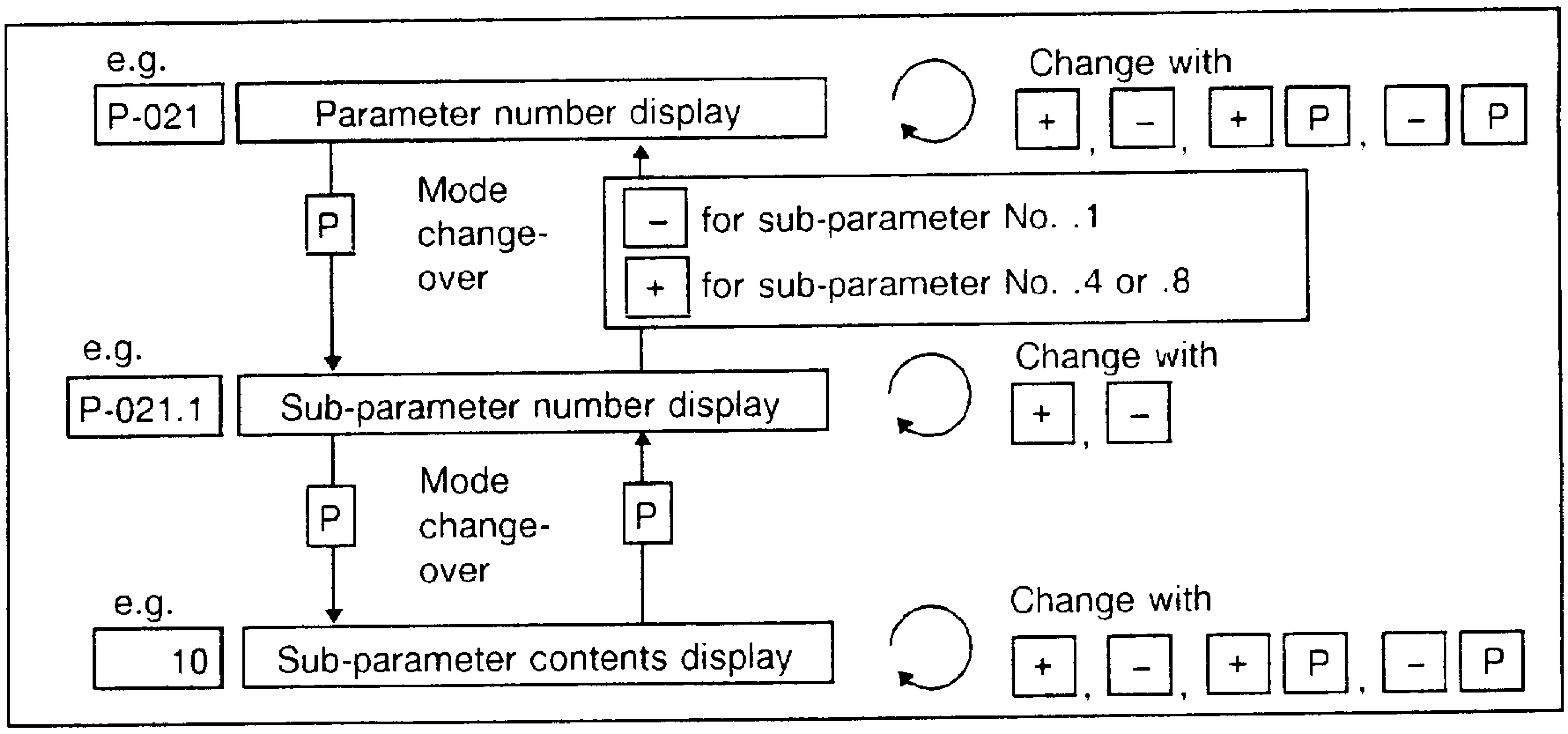


Display when entering sub-parameter numbers

The sub-parameter number can now be changed by pressing the " + " and the "–" key. The display switches back to the parameter number display (Fig., operator control and display board) when the smallest sub-parameter number is fallen below (.1) or when the highest sub-parameter number is exceeded (.4 or .8). By depressing the "P" key, instead of the sub-parameter number display, the parameter contents are displayed with the selected sub-parameter number. The setting is realized as usual.
The sub-parameter number display re-appears after the "P" key is depressed.



Parameter adjustment without sub-parameter



Parameter change with sub-parameter

A change of the parameter contents is effective immediately, but is however lost at switch-off, if it wasn't stored with P-052 in the EEPROM. Parameter P-052 (writing into the EEPROM) must be set to 1H to store the instantaneous settings so that they cannot be lost. The write protection button of the software module must then be depressed. During writing the LED of the software module is lit. After the settings have been transferred, the LED goes dark, and P-052 is automatically set to 0. It is not permissible to switch-off the unit while the EEPROM is being written into. If the write protection button is not depressed, fault signal F-26 appears after a certain time. The fault is acknowledged by depressing the write protection button.

Note: The EEPROM is reset into the initialized status if data save is interrupted as a result of supply failure or the supply being disconnected.

3.2 Function of the enable terminals

The induction motor module has three terminals, with fixed functions (terminals 663, 65, 81), the so-called axis-specific enable terminals, and also 8 freely-programmable terminals. The freely-programmable terminals will be discussed in Section 4.8. Further, there are also enable terminals on the infeed/regenerative feedback module and the monitoring module (terminals 63, 64), which are used for the complete module group (central enable terminals). The drive can only be accelerated when all enable signals are present. Parameter P-000 (operating display) indicates which enable signals are still missing (refer to Section 4).

The effect when the specific enable terminals are no longer energized will be discussed in the following:

- Pulse enable signal, axis-specific, terminal 663
  The motor pulses of the associated module are immediately cancelled after terminal 663 is opened, i.e. the motor is switched to a no-current condition. If the motor was rotating before this, it coasts down.
- Pulse enable signal from the infeed/regenerative feedback module or monitoring module, terminal 63
  Terminal 63 acts just like terminal 663, the only difference is that all modules of the module group are involved.
- Controller enable signal, axis-specific, terminal 65
  The motor is braked via the ramp-function generator with the set deceleration time (P-017) after terminal 65 is opened. The motor pulses are cancelled after the minimum speed, set in P-022, is fallen below. The motor is then in a no-current condition.

- Drive enable signal from the infeed/regenerative feedback module and monitoring module, terminal 64.
  The effect of terminal 64 is identical with that of terminal 65, but in this case, all modules of the module group are involved.
- Ramp-function generator fast stop, terminal 81
  The drive is braked as fast as possible, taking into account the set limits (P-039, P-059, P-060), but without the ramp-function generator, after terminal 81 is opened. Even at stanstill, the pulses are generally still enabled, and current still flows in the motor so that the motor shaft can only be rotated when a torque is applied. However, pulse cancellation can be realized using terminal 81 after the minimum speed has been fallen below (P-022), if bit 2 is set in control parameter P-053.

3.3 Start-up instructions

The induction motor module must be connected to the DC link and the DC link bus and motor must be connected to the induction motor module (refer to Section 9.2). The DC link cover should then be re-located. Before switching-on, pulse enable should first be disabled using terminal 663.

3.3.1 Initialization

If a completely new software module is inserted in the induction motor module, P-095 appears after switch-on. Initialization is now expected. At initialization, a number, which is assigned to the converter current rating, must be entered in P-095 (refer to Table "Assignment, module current rating/converter number for P-095"). Further, it is possible to load motor data for several motors from a stored motor data list. In this case, the associated numbers must be entered into P-096. If the motor is not included in the motor list, P-096 is left unchanged at 0. In order to start initialization, a 1 is entered into P-097, and the write protection button is depressed. "Initialize" appears in the display. At initialization, all parameter contents are preset with defined values, and stored in the EEPROM. The default values of the individual parameters are specified with the parameter description. If an already initialized software module is inserted into a converter having a different current rating, then it must be re-initialized. Under certain circumstances, it is practical to re-initialize if start-up is realized with defined initial settings. If an already initialized software module is to be re-initialized, then P-097 must be set to 0 (if required, prior to this set write protection P-051 to 4H), and the setting is stored in the EEPROM (P-052 = 1, depress the write protection button). P-095 then appears after switch-off and switch-on which prompts initialization.

Module	Current	Number in P-095
6SC6110-5DA00	5/7 A	4
6SC6111-5DA00	15/20 A	5
6SC6112-4DA00	24/32 A	6
6SC6113-0DA00	30/40 A	7
6SC6114-5DA00	45/60 A	8
6SC6116-0DA00	60/80 A	9

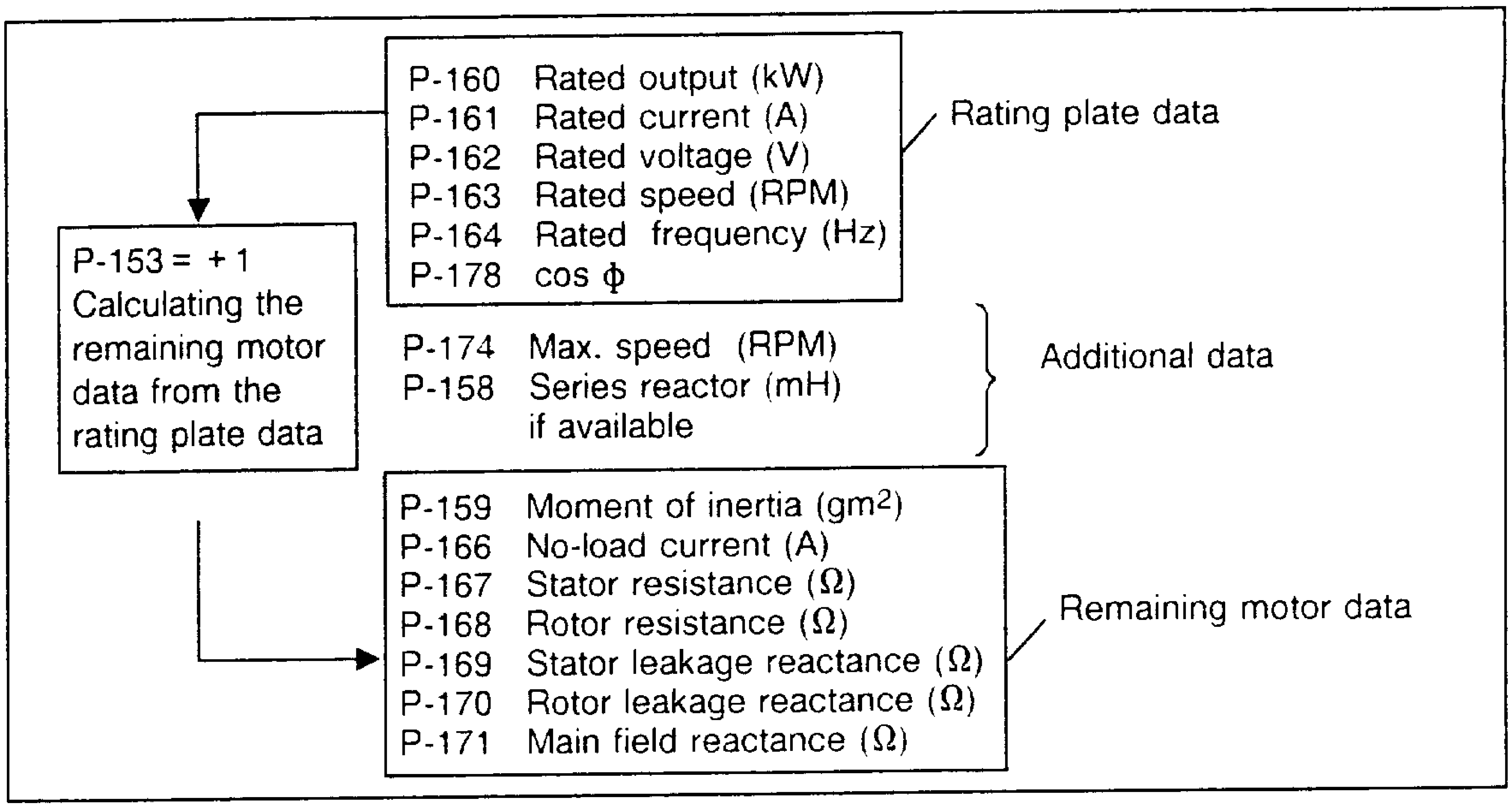
Assignment of the module current rating - converter number for P-095

3.3.2 Motor data

With the induction motor module, it is possible to simultaneously store four complete motor data sets. The currently valid data set can be selected using freely-programmable terminals or parameter P-056. There is one relay function for each of the four motor data sets, which indicates whether the associated motor is the currently valid one. If it is required to operate the various motors one after another from the induction motor module, then this function can be used for motor changeover. Generally, when a request is made to changeover the motor, the motor data is only re-loaded after the induction motor module pulses have been cancelled. The user can select which enable terminals are used for pulse cancellation. Pulse cancellation is interlocked during data changeover (approximately 20 ms). The interlocking is then cancelled, and the motor relay of the selected motor pulls-in. Thus, this relay signal can also be used for controlling the contactor for changing over the motor terminals. The currently valid motor data set is then displayed in the first position from the left of the operating display (P-000, P-100). If bit 1 is set in control parameter P-053, the motor data sets are also transferred when the pulses are enabled. This capability can be used to adapt motor data, if no other functions have been provided for this purpose.
There are various ways of parameterizing the motor data:

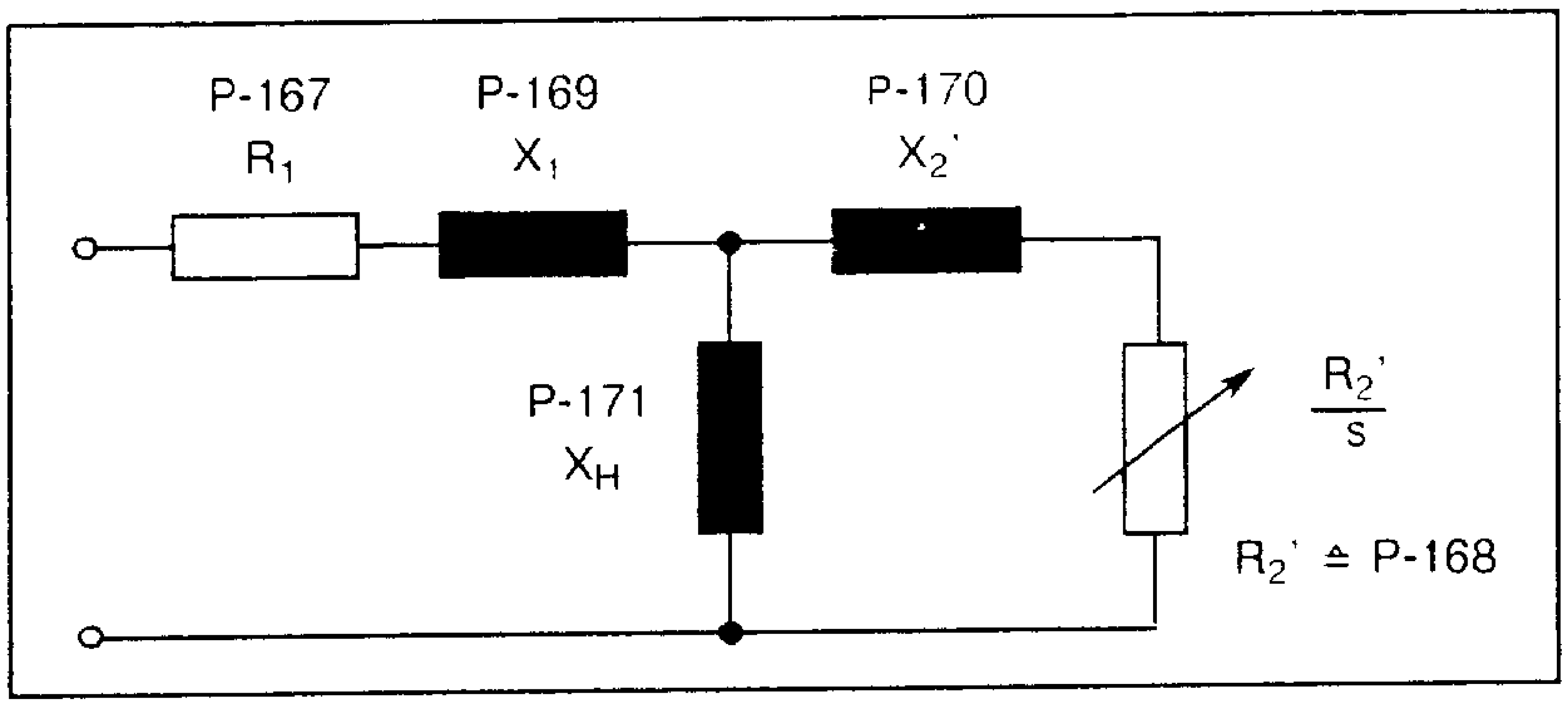
- If the motor used is included in the stored motor list, the motor data can be completely loaded at initialization. This capability is only provided from software releases 3.0 onwards.
- If the motor data is known, it can be manually entered
- Often, the user only knows the rating plate data of the motor used. Thus, a help function is provided, which roughly determines the still missing motor data from the rating plate data. This help function is started by setting P-153 to 1. The currently valid motor data sets are then calculated, and the appropriate parameters changed (P-166 to P-171, P-159). P-153 is automatically reset to 0 after the calculation; if at least some of the motor data is known, then the additional information should be entered after calculation. Please note that the motor data is dependent on whether the motor is connected in a star or delta configuration.

  If the power factor cos ϕ is unknown, the calculation can first be executed with the default value (0.800). In this case, the no-load current P-166 might be incorrectly calculated. This error can be eliminated by manually setting the no-load current (refer to Section 3.3.4).



Parameterization of the motor data

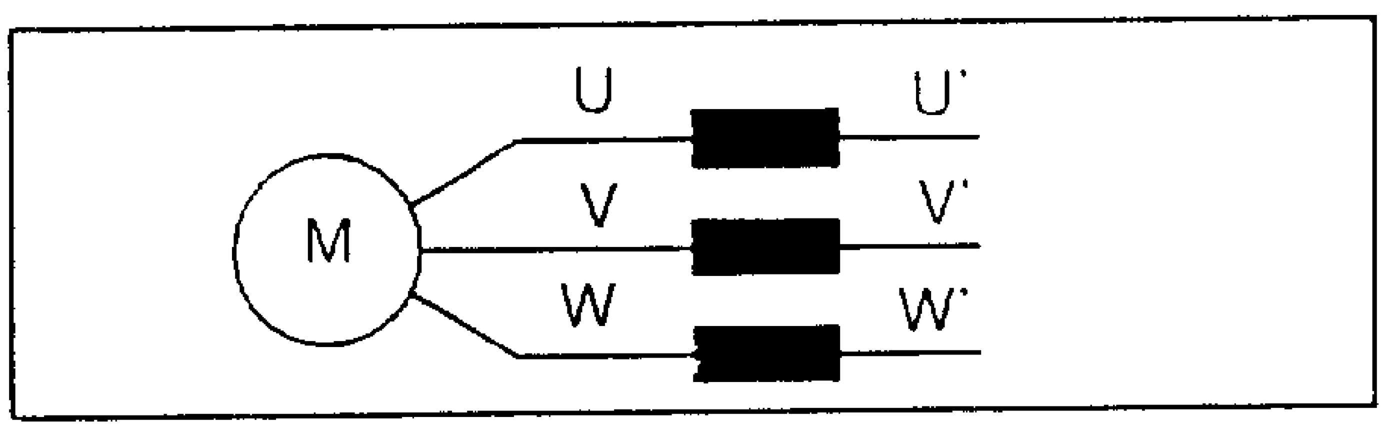
The motor impedances (P-167 to P-171) refer to the single-phase transformer equivalent circuit of the induction motor. The rotor-side impedances are referred to the stator side.



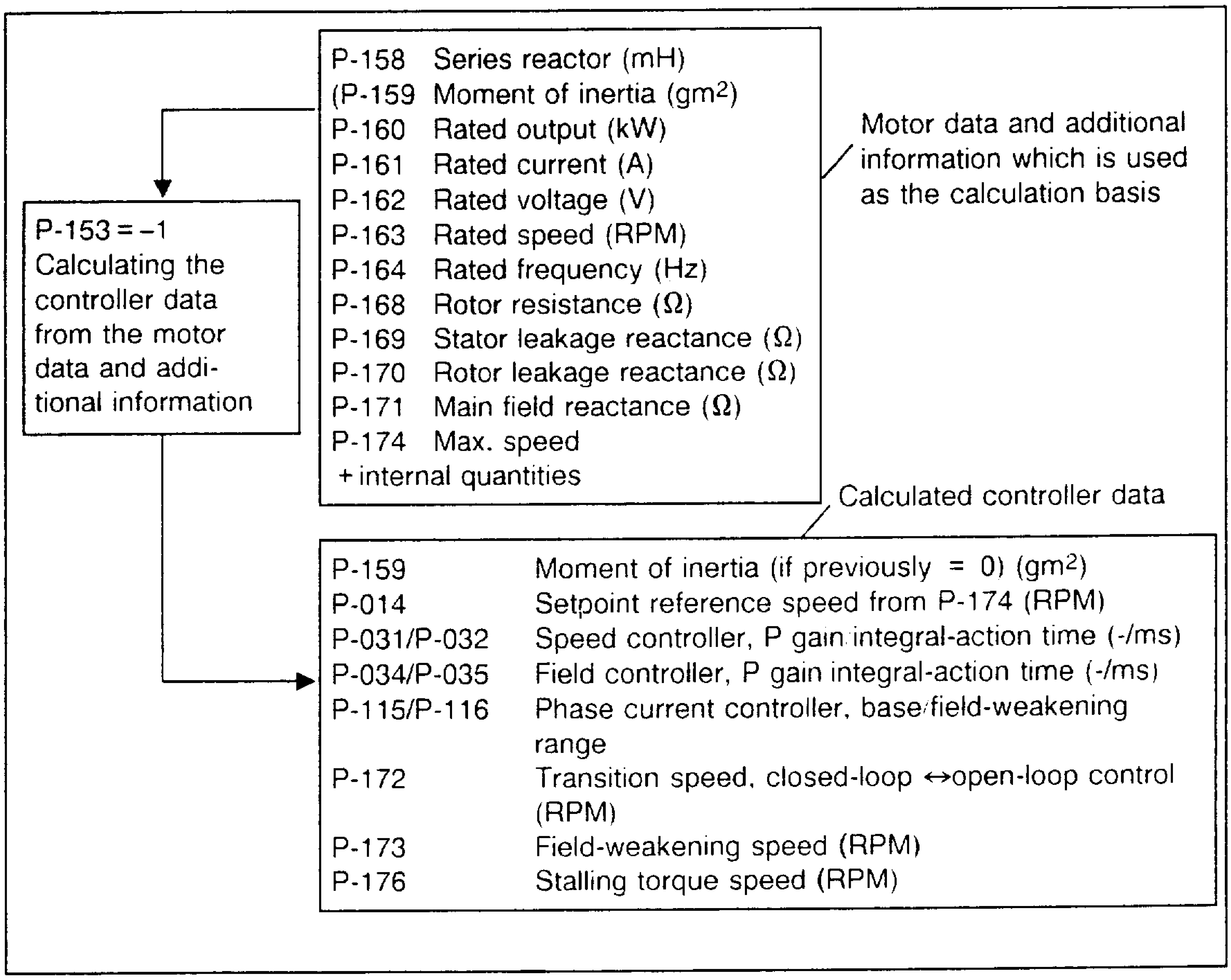
Single-phase transformer equivalent circuit diagram

3.3.3 Closed-loop control data

Additional data in the form of the maximum speed (P-174) and the series reactor (P-158) are indicated in the diagram "parameterization of the closed-loop control data". A series reactor is recommended for special high-speed motors ($\geq$150 Hz). In this case, reactors must be used, which are suitable for high switching frequencies (7 kHz) (e.g. commutating reactors which are used for the infeed/regenerative feedback units). The reactor rated current must be at least as high as the rated motor current. The reactor is simply switched in series with the motor. The reactor reduces the motor losses, and permits stable operation at higher frequencies.



If a series reactor is used, the reactor inductance must be entered into P-158, otherwise 0 (pre-setting value) is entered. In order to operate the induction motor module, closed-loop control data is required in addition to the motor data and the additional information. A help program is also available in this case, which calculates the closed-loop control data from the motor data and the above mentioned additional information. This help program is started by setting P-153 to -1. These calculations are also calculated here for the currently-valid motor data set, and the associated parameters are changed. P-153 is set to 0 after the calculation. A precise calculation is not always possible, so that subsequent changes can bring improvements. The significance of the appropriate parameters and the procedure for post optimization is explained in Sections 3.3.4 and 4.



Parameterization of the closed-loop control data

The monitoring module does not have, contrary to the infeed regenerative feedback module, DC link voltage sensing. If the induction motor module is connected to the DC link bus of a monitoring module, the DC link voltage must be entered into P-061 (600 V for the SIMODRIVE 611 DC link).

3.3.4 Post-optimization

The start-up engineer is additionally supported by the software for post-optimization. In this case, functions are provided which identify the important motor parameters and automatically execute the controller settings. Each function can be individually selected and started however, the specified sequence must be maintained. Further, it is necessary that all enable signals are available, and the motor is operated at no load. The speed or current setpoints are input from the optimization software and the responses measured and evaluated until the required setting has been found, or the search is terminated with an error message. Current flows through the motor which in turn rotates. The enable terminals (terminals 81, 65, 663, 64, 63) can still be used for an emergency stop. The settings of the ramp-function generator and limits for reducing the stressing on the mechanical system also remain effective with the self-tuning, however, the results when identifying the moment of inertia and the rotor resistance are so much less precise, the lower the accelerating torque is. With self-tuning, all setpoints are entered for clockwise rotation. If only counter-clockwise direction of rotation is possible for mechanical reasons, then this can be achieved with the freely-programmable terminal function "clockwise/counter-clockwise rotation", which is also valid for self-tuning. The search is terminated with the F-60 fault message when the motor pulses are cancelled.

The write protection (P-051/P-151) must be set to 10H to select automatic post-optimization. A number for the required function is entered into P-204, which can then be started by setting P-205 to 1.

The following function assignment is valid for P-204:

0: No function
1: Setting the phase current controller
2: Offset compensation for power sensing
3: Identification of the no-load current
4: Identification of the main field reactance
5: Identification of the moment of inertia
6: Identification of the rotor resistance

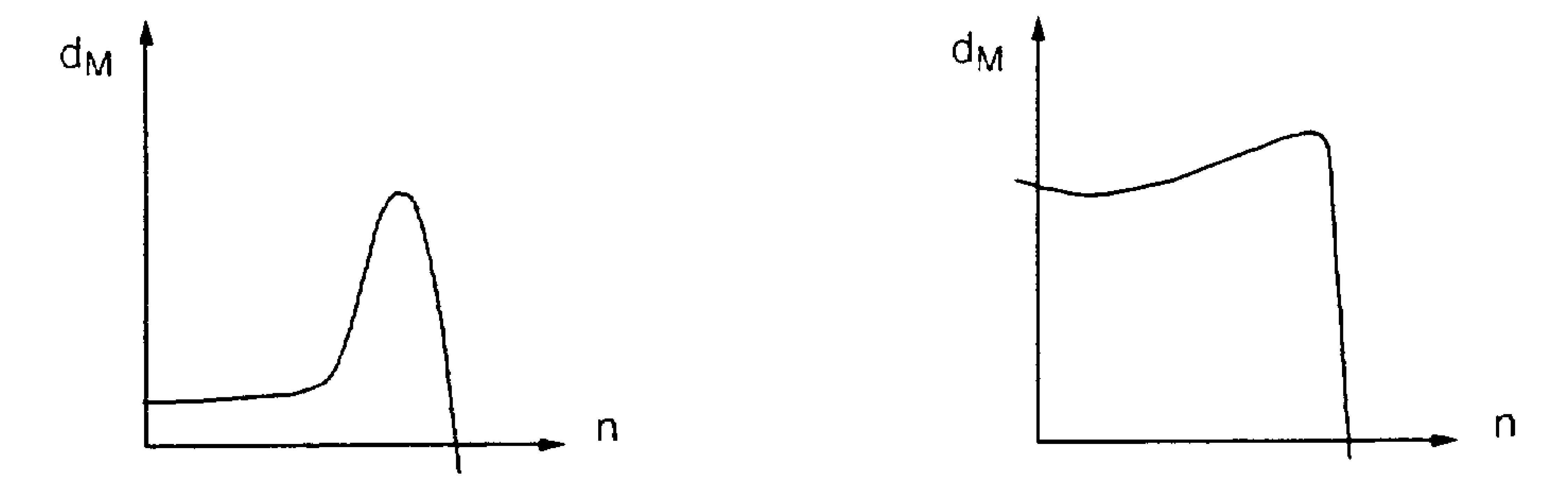
During self-tuning, " □I" is displayed at the fifth position of the operating display (setpoint source), and the parameter for setpoint selection (P-113) is 10 (i.e. setpoint from self-tuning). During the search sequence, the parameter display is changed-over to the parameter contents to be changed, so that the changes can be seen. The parameter contents of P-204 are displayed after self-tuning has been completed.

If errors occur during self-tuning, then this is terminated with the fault message F-60 and the initial value is re-entered into the changed parameter. Possible causes are subsequently explained, depending on the selected function. A search run might be unsuccessful for the following reasons:

- Completely incorrect motor data
- One of the controllers is incorrectly set
- One of the controllers operates at the control limit
- Rated motor current and rated converter current differ significantly
- The load connected to the motor shaft tends to oscillate
- Previous self-tuning operations were inaccurate

A manual post-optimization can be realized if the self-tuning was partially or completely unsuccessful. The background to the post-optimization is explained in Section 9 for this purpose, and the manual setting instructions are specified.

Induction motors with deep-bar, squirrel-cage rotors are a special case when post-optimizing. Deep-bar, squirrel-cage rotors are characterized by a high starting torque when operated from a rigid network (refer to the diagram "speed-torque characteristic for operation on a rigid network"). Most standard motors are equipped with deep-bar, squirrel-cage rotors.



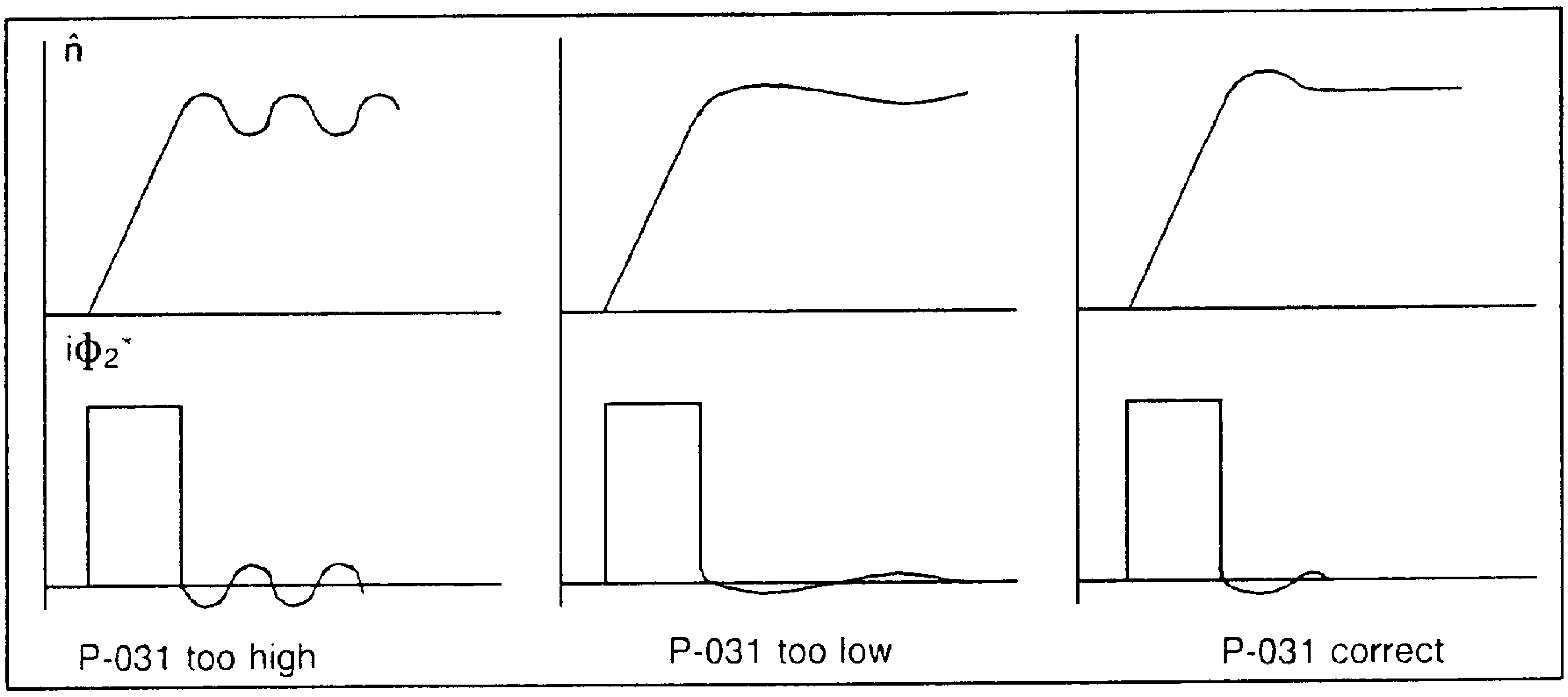
Speed-torque characteristic for operation on a rigid network

For deep-bar, squirrel-cage rotors, torque rounding-off (P-018) must be increased (nominal value: Approx. 30.00 ms). Further, for deep-bar, squirrel-cage rotors, the rotor resistance cannot be identified.

The post-optimization procedure is as follows:

1. Rounding-off, P-018
   For deep-bar squirrel-cage rotors, the rounding-off should be increased (nominal value, approximately 30.00 ms).
2. Converter switching frequency
   For special high-speed motors (frequencies >150 Hz), it is recommended that P-036 is set to 1. Thus, the converter switching frequency is increased (0≙3.3 kHz, 1≙4 kHz), however, the converter switching losses increase, so that only approximately 80% of the continuous converter output can be used. Further, a series reactor should also be used with these motors.
3. Automatic setting of the phase current controller, P-115, P-116
   Automatic phase current controller setting is selected by setting P-204 to 1 and is started by setting P-205 to 1. The phase current controller setting is of special importance for the stability of the complete closed-loop induction motor control. If the values are too low, this can lead to problems at high frequencies (torque surges, uneven no-load running characteristics), and excessive values can lead to fault F-11 (stalling) in the closed-loop controlled range
   (n > P-172 + 200 RPM).
4. Automatic compensation of the offset for the power sensing
   Automatic compensation of the offset for the power sensing is selected by setting P-204 to 2, and is started by setting P-205 to 1. If the software module is inserted in another converter, this adjustment should be repeated.
5. Checking the field current controller setting P-034, P-035
   When calculating the controller data, the P gain and the integral-action time of the field controller are set. Under certain circumstances, subsequent adjustment of the P gain (P-034) can result in an improvement.
   - If P-034 is too low, then this leads to a tendency to stall (F-11) especially in the field-weakening range with speed setpoint steps.
   - If P-034 is too large, then the speed controller loop can be influenced at no-load. This is manifested, depending on the deviation from the optimum value, by increased speed ripple up to torque surges. If P-034 is far too high, then this can result in stalling (F-11) under no-load conditions. In order to check this, the torque-generating current (address 10D2H) can be fed to one of the D/A converters (P-066, P-068), and observed on an oscilloscope.

6. Checking the speed controller setting, P-031, P-032
   - P gain, P-031
     To adjust the speed controller, the speed (address 1110H or 11B6H), and the torque-generating current (address 10D2H) should be fed to the D/A converters (P-066 + P-068), and the converted quantities observed on an oscilloscope. A speed setpoint step can be used as excitation, and the overshoot observed after the setpoint has been reached. The controller is correctly adjusted if a maximum of two overshoots occurs (refer to the following diagram). Post oscillations with a high period (>1s, depending on the moment of inertia), are caused by the value in P-031 being too low, and post oscillations with a low period 8 (<500 ms, depending on the moment of inertia), by the value in P-031 being too high (refer to the following diagram).



Checking the speed controller setting

     At higher motor frequencies, the dynamic performance of the speed controller loop decreases, thus P-031 should be set to the maximum speed. If it is not possible to optimize the speed controller at the maximum speed with the specified measures, then it can be assumed, that functions which were subsequently optimized, are completely incorrect. In this case, P-031 should be set to a low value (e.g. 10.0), and P-031 should be set after the remaining points.
   - Integral-action time, P-032
     Generally, P-032 must not be changed unless the load tends to oscillate. A tendency to oscillate can occur, for example, with a large external moment of inertia compared with the intrinsic motor moment of inertia (above a ratio of 1:5), and an elastic coupling. In this case, the integral-action time of the speed controller must be increased. Under certain circumstances, it will not be possible to automatically set the moment of inertia.
7. Automatic setting of the no-load current, P-166
   Automatic setting of the no-load current is selected by setting P-204 to 3, and started by setting P-205 to 1. If there are very large deviations between the no-load current and the calculated value, it should be checked as to whether the correct converter number was entered (P-094), or whether the parameterized motor data coincides with the selected motor circuit configuration (star or delta configuration). Fault F-60 can indicate that voltage limiting occurred during the search sequence. In this case, a setting should be made with a lower value in P-166. F-60 also occurs, when speed limiting prevents the no-load speed being used. This can be rectified by removing the limit. Further, F-60 is output, if a no-load current is determined, which is greater than the rated current. F-17 indicates when the no-load current is greater than the available converter current.

8. Automatic setting of the main field reactance, P-171
   Automatic setting of the main field reactance is selected by setting P-204 to 4, and is started by setting P-205 to 1. Also here, F-60 can indicate that voltage limiting has occurred. In this case, setting should be started with a lower value in P-171. If a main field reactance is determined, which is greater than 327.67 Ω, then the procedure is also terminated with F-60.
9. Automatic setting of the moment of inertia, P-159
   Speed-torque pre-control ensures that a speed setpoint is approached as quickly as possible without overshoot if the moment of inertia was correctly set. Incorrect values in P-159 are, within specific limits, tolerated, but lead to a large overshoot after the speed setpoint has been reached after a step function. Completely incorrect values in P-159 can lead to stalling (F-11) after a step function. It is possible to automatically set the moment of inertia. In this case, 5 must be entered into P-204, and the sequence started by setting P-205 to 1. In this case, the drive is often accelerated up to maximum speed (minimum from P-174, P-029). If this is not desired, the maximum speed can be reduced using P-029 or P-174.

   Caution: P-174 is motor-specific (is defined by the selected motor number), P-029 is machining-specific (is selected depending on the machining-specific data).

   If the acceleration times are shorter than 2 x the speed controller integral-action time (generally, 2 x 140 ms), then inaccuracies should be expected: however, completely incorrect settings are identified and corrected. For speed controller integral-action times exceeding 250 ms, the moment of inertia should be manually adjusted (refer to the Appendix for the procedure).
10. Automatic setting of the rotor resistance, P-168
   For induction motors without deep-bar, squirrel-cage rotors, rotor resistances can be automatically identified. However, a prerequisite is that the moment of inertia was correctly set. The rotor resistance is included in the slip calculation, so that an incorrect value in P-168 can lead to incorrect slip pre-control for the motor torque. Thus, the calculated speed deviates from the actual speed by the slip error, and the setpoint is not precisely maintained under load. After P-168 has been adjusted, the speed setpoint is precisely controlled down to just a few revolutions per minute, although the actual speed is not explicitely measured. A rotor resistance which has only been very roughly set can lead to self-excited speed oscillations. Automatic setting of the rotor resistance is selected by setting P-204 to 6, and is started by setting P-205 to 1. Fault message F-60 can indicate, that a rotor resistance of 0 was identified due to an inaccurately determined moment of inertia.
11. Checking the field-weakening speed, P-173
   The induction motor module can provide a maximum of approximately 420 V RMS (for a 600 V DC link voltage). As additional voltage is required for building-up the torque, the field weakening speed can be set, so that approximately 400 V_{RMS} is output at maximum speed and under no-load conditions. The converter output voltage is displayed in P-010.
   If P-010 indicates less than 400 V at maximum speed, then the motor and converter are not being optimally utilized, and P-173 can be increased. If an attempt is made to increase the voltage above 420 V RMS, the current controller goes into voltage limiting, the current can no longer be impressed, and the motor outputs torque surges. This can then result in stalling (F11). At stator frequencies above 300 Hz, it can be beneficial to reduce P-173, in order to increase the current controller dynamic performance by an increased voltage reserve.

3.3.5 Setting the limits, open-loop controlled range

The following limits can be set:

- P-059 Current limit (% rated motor current) motor-specific
- P-060 Output limit (% rated motor output), motor-specific
- P-039 and P-041 Torque limit (rated motor torque), machining-specific
- P-029 Speed limit (RPM), machining-specific
- P-174 Maximum speed (RPM), motor-specific

The limits are realized, so that they are always simultaneously fulfilled. This means, that an increase in the torque limit has almost no effect, if the current and output limits are also not increased.

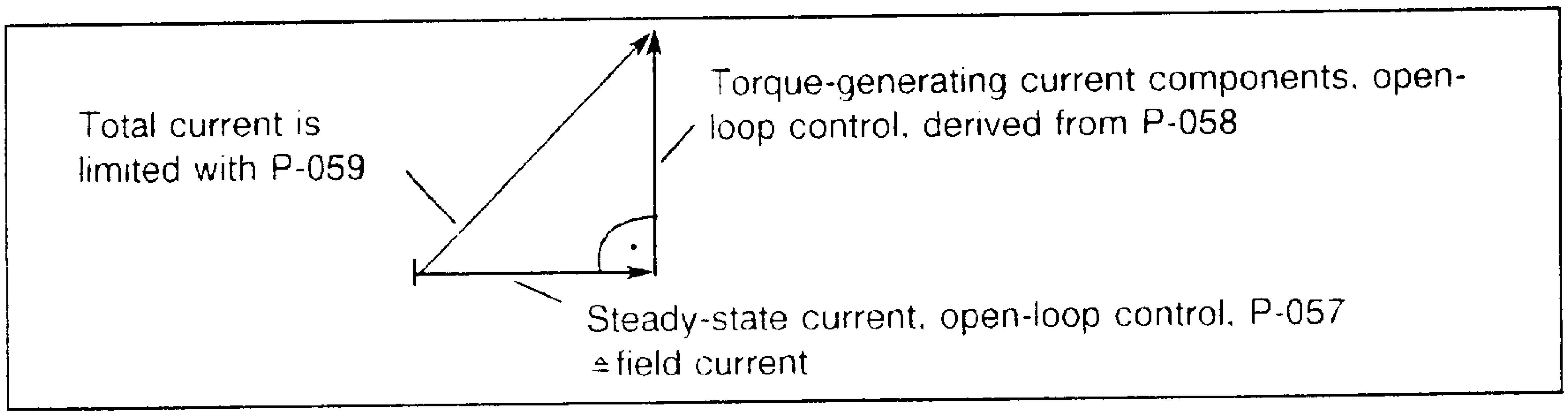
In the lower speed range, the measured outputs are so small and inaccurate, that field-oriented closed-loop control based on these measuring quantities is not possible. Thus, in the lower speed range, the frequency and absolute current value are entered in an open-loop control mode. In this case, the load is not explicitly identified, and slip is not corrected. Further, in the open-loop control mode, it is not possible to influence the tendency of the induction motor to oscillate.

The following parameters define the open-loop controlled mode:

- P-172 Transition speed from closed-loop open-loop control (RPM)
- P-057 Steady-state current, open-loop control (% rated current)
- P-058 Accelerating torque, open-loop control (% rated torque)

P-172 is calculated using P-153 = –1. The calculated value is generally optimal and should not be changed. A hysteresis of approximately 200 RPM is effective for changeover.

More than just the no-load current must be set in P-057, as there is no field orientation and the load is not sensed in the open-loop control mode. If rated torque is to be provided under steady-state conditions, or the drive is to accelerate under load in the open-loop control mode, it is recommended that 100% is entered in P-057. However, in this case, the current limit (P-059) should also be increased (e.g. to 140%), as otherwise, there will hardly be any current for acceleration. A calculation is made as to how fast the frequency should be changed in the open-loop control mode, from the value in P-058 and using the moment of inertia (P-159). If the drive is to accelerate with no load, 100% or more can be entered into P-158. P-058 should be appropriately reduced if the drive is to accelerate with an opposing load torque, as the total torque is not available for acceleration. If this is not done, there is a chance that the drive will stall (F-11). In the closed-loop controlled mode, the maximum torque is used for acceleration. If the parameters for the open-loop control mode are not adapted to the situation, then there will be a torque surge when changing over into the closed-loop control mode, because suddenly other accelerating torques will become effective.

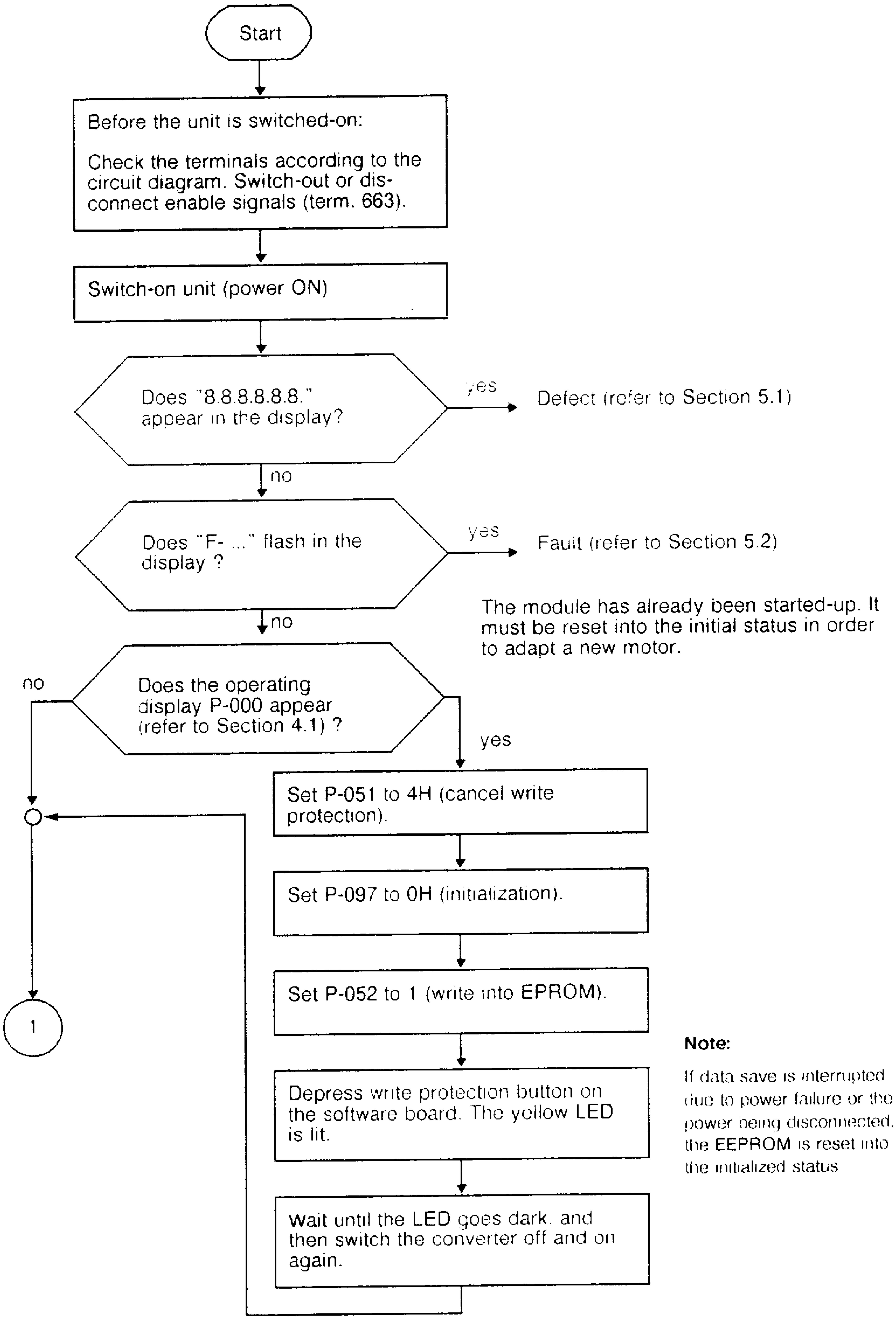


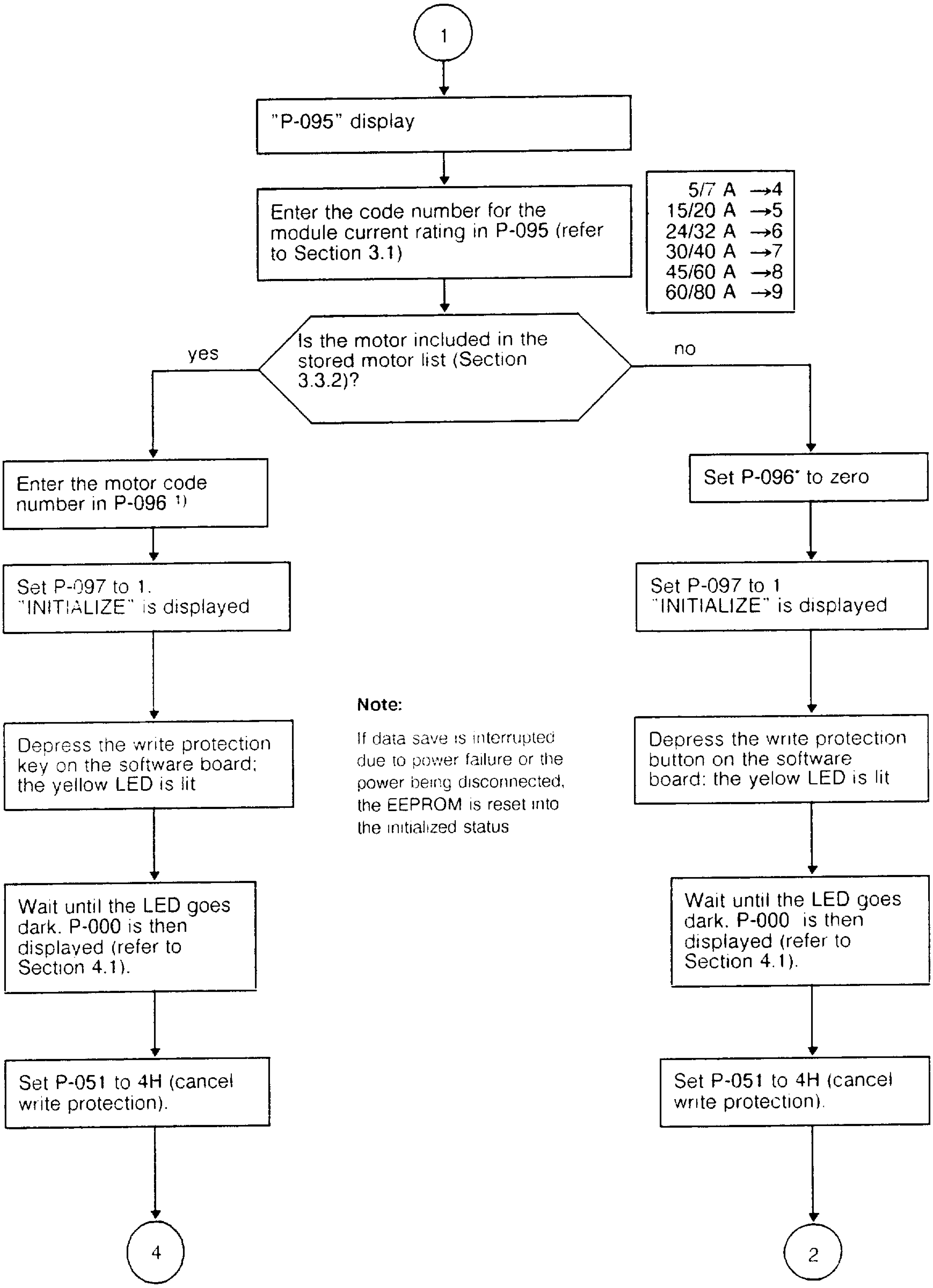
The field generating components have priority at current limiting, so that acceleration is slower.

3.3.6 Flowchart for start-up

WARNING

The drive accelerates up to n_{set} if a fault is aknowledged at the infeed/regenerative feedback module with the induction motor module enabled.

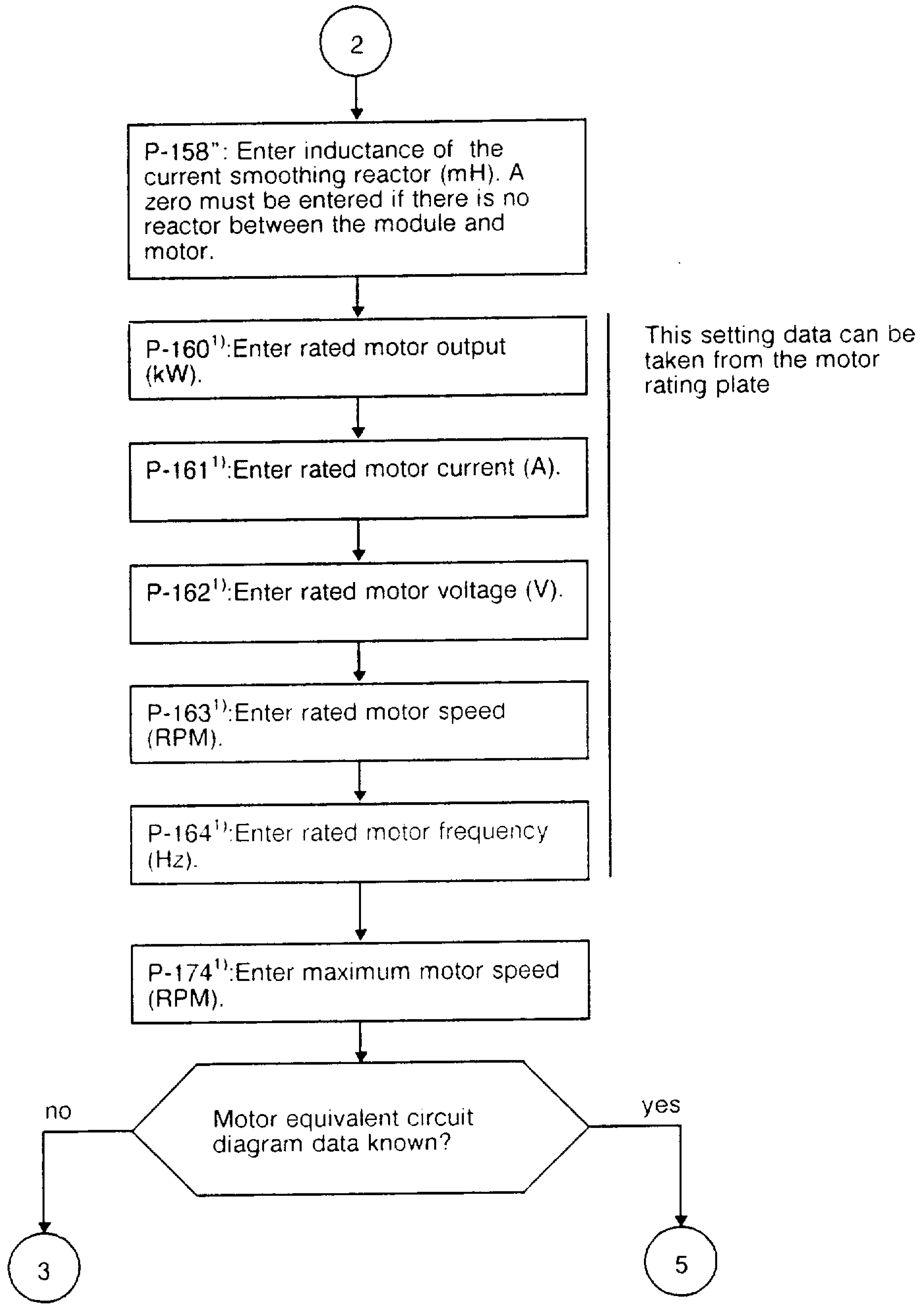




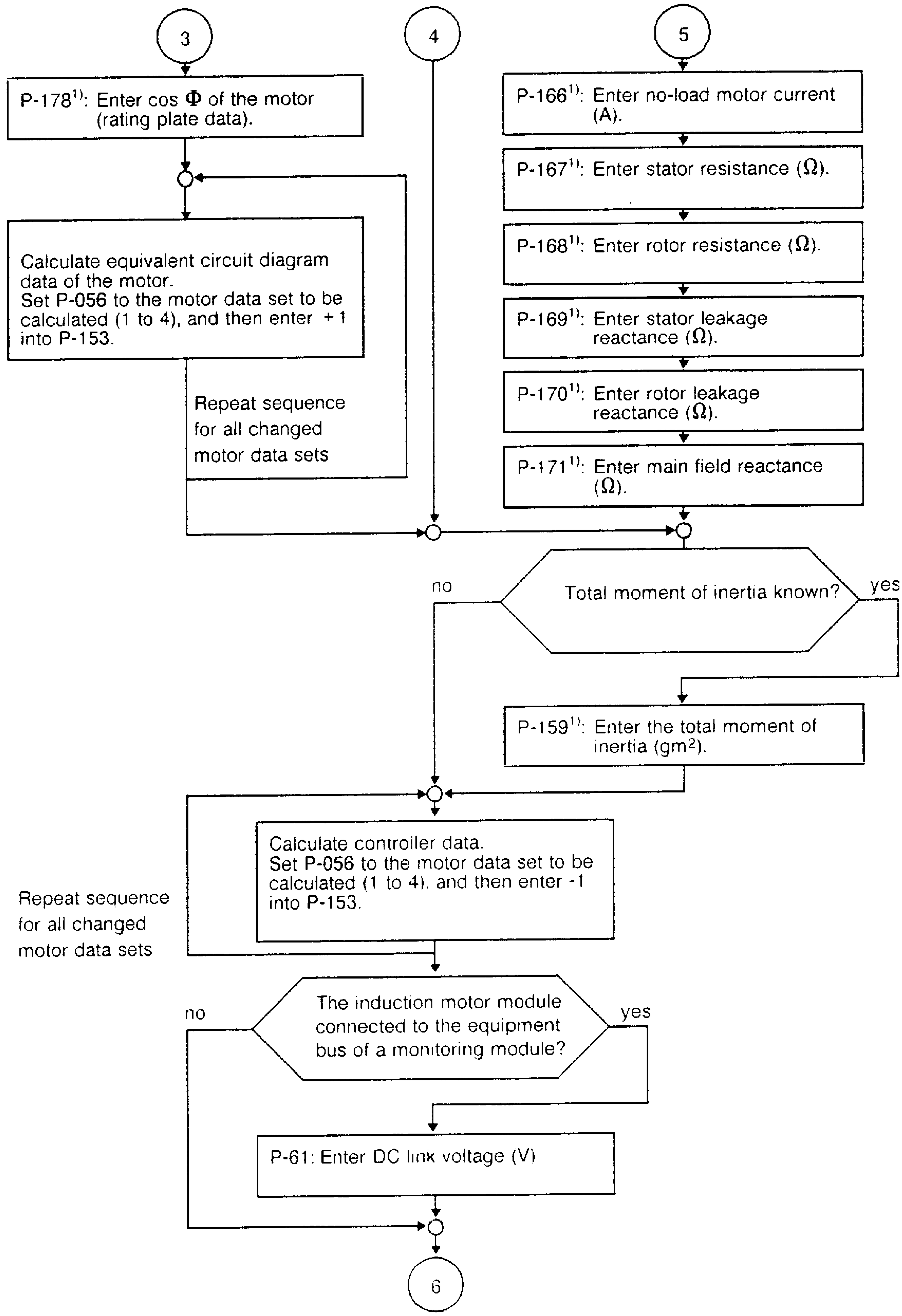
Note:

If data save is interrupted due to power failure or the power being disconnected, the EEPROM is reset into the initialized status

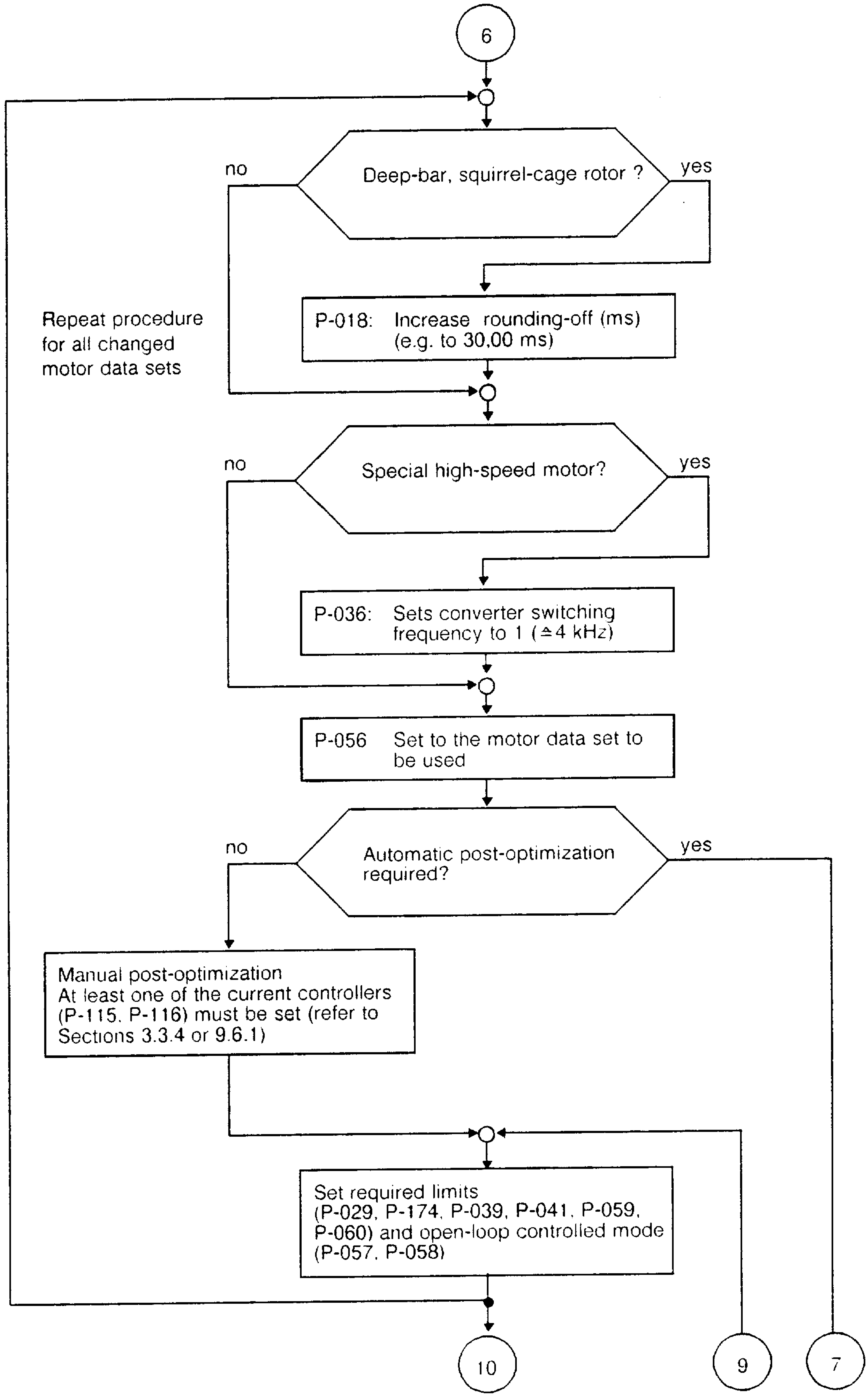
1) *Setting data for up to four different motors can be entered (sub-parameters .1 to .4)*

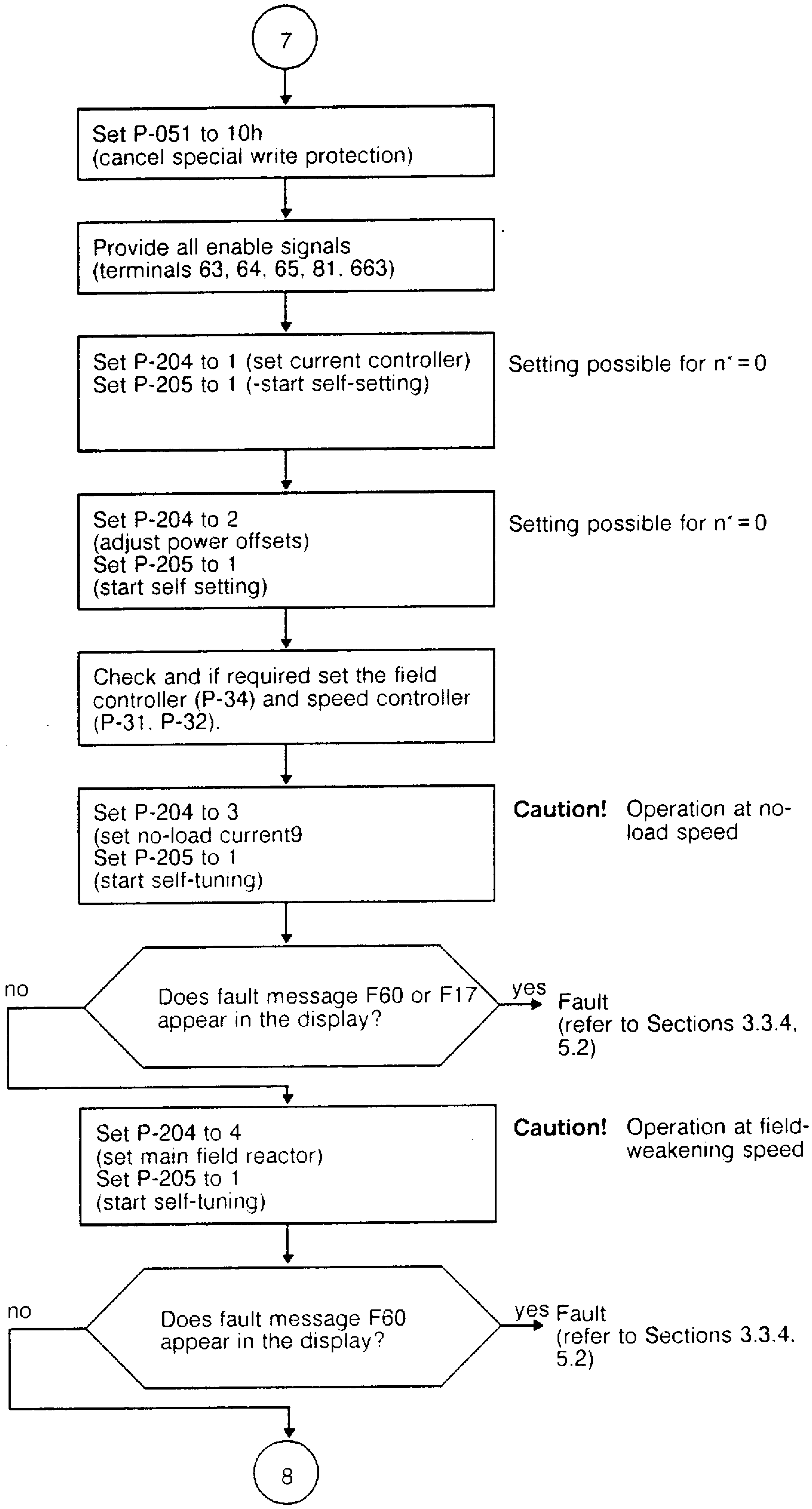


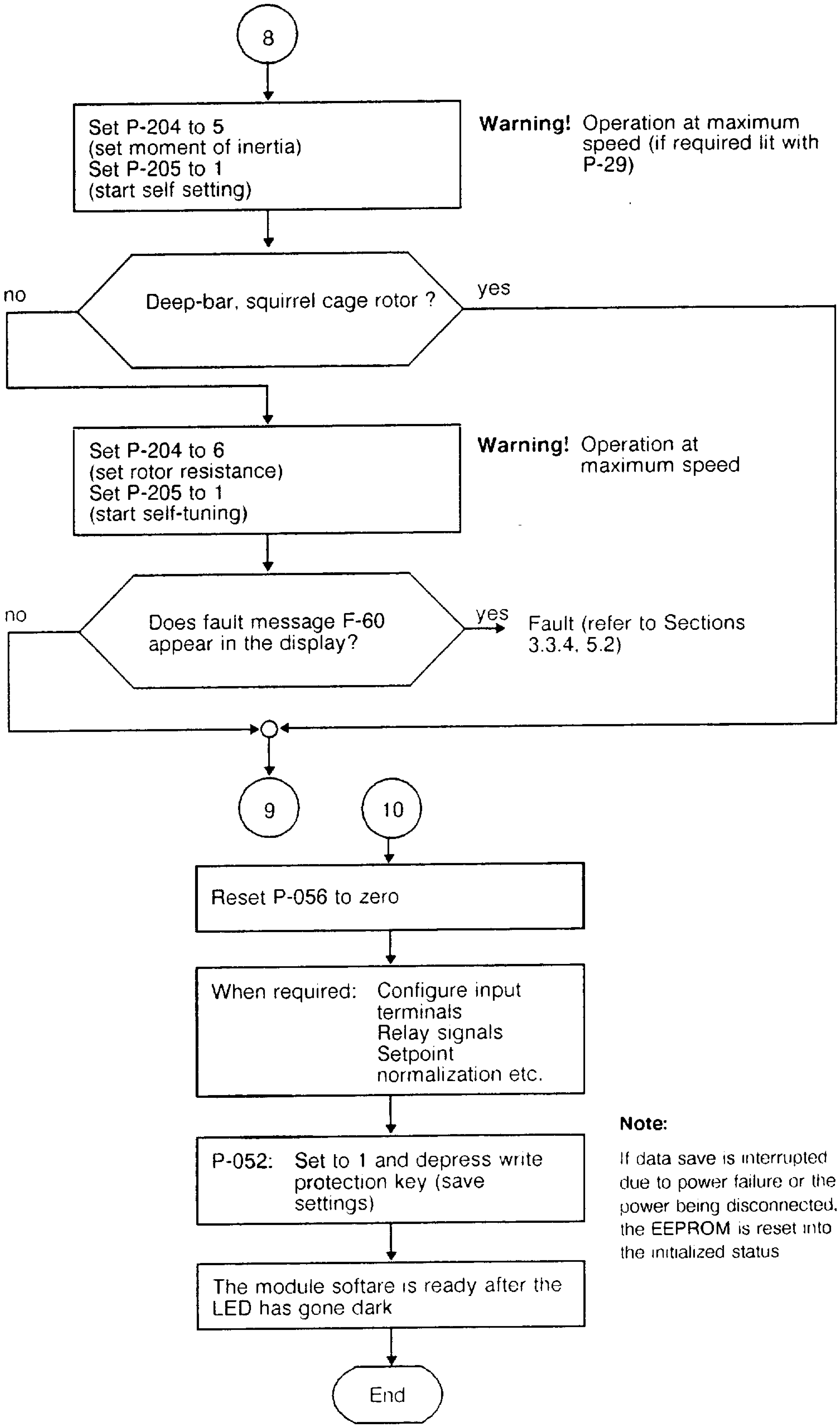
1) *Setting data for up to four different motors can be entered (sub-parameters .1 to .4)*



1) *Setting data for up to four different motors can be entered (sub-parameters .1 to .4)*


6
Deep-bar, squirrel-cage rotor ?
no
yes
P-018: Increase rounding-off (ms) (e.g. to 30,00 ms)
Repeat procedure for all changed motor data sets
Special high-speed motor?
no
yes
P-036: Sets converter switching frequency to 1 (≙4 kHz)
P-056 Set to the motor data set to be used
Automatic post-optimization required?
no
yes
Manual post-optimization
At least one of the current controllers (P-115, P-116) must be set (refer to Sections 3.3.4 or 9.6.1)
Set required limits (P-029, P-174, P-039, P-041, P-059, P-060) and open-loop controlled mode (P-057, P-058)
10
9
7


7
Set P-051 to 10h
(cancel special write protection)
Provide all enable signals
(terminals 63, 64, 65, 81, 663)
Set P-204 to 1 (set current controller)
Set P-205 to 1 (-start self-setting)
Setting possible for n* = 0
Set P-204 to 2
(adjust power offsets)
Set P-205 to 1
(start self setting)
Setting possible for n* = 0
Check and if required set the field
controller (P-34) and speed controller
(P-31, P-32).
Set P-204 to 3
(set no-load current9
Set P-205 to 1
(start self-tuning)
Caution! Operation at no-load speed
no
Does fault message F60 or F17
appear in the display?
yes
Fault
(refer to Sections 3.3.4, 5.2)
Set P-204 to 4
(set main field reactor)
Set P-205 to 1
(start self-tuning)
Caution! Operation at field-weakening speed
no
Does fault message F60
appear in the display?
yes
Fault
(refer to Sections 3.3.4, 5.2)
8



Note:

If data save is interrupted due to power failure or the power being disconnected, the EEPROM is reset into the initialized status

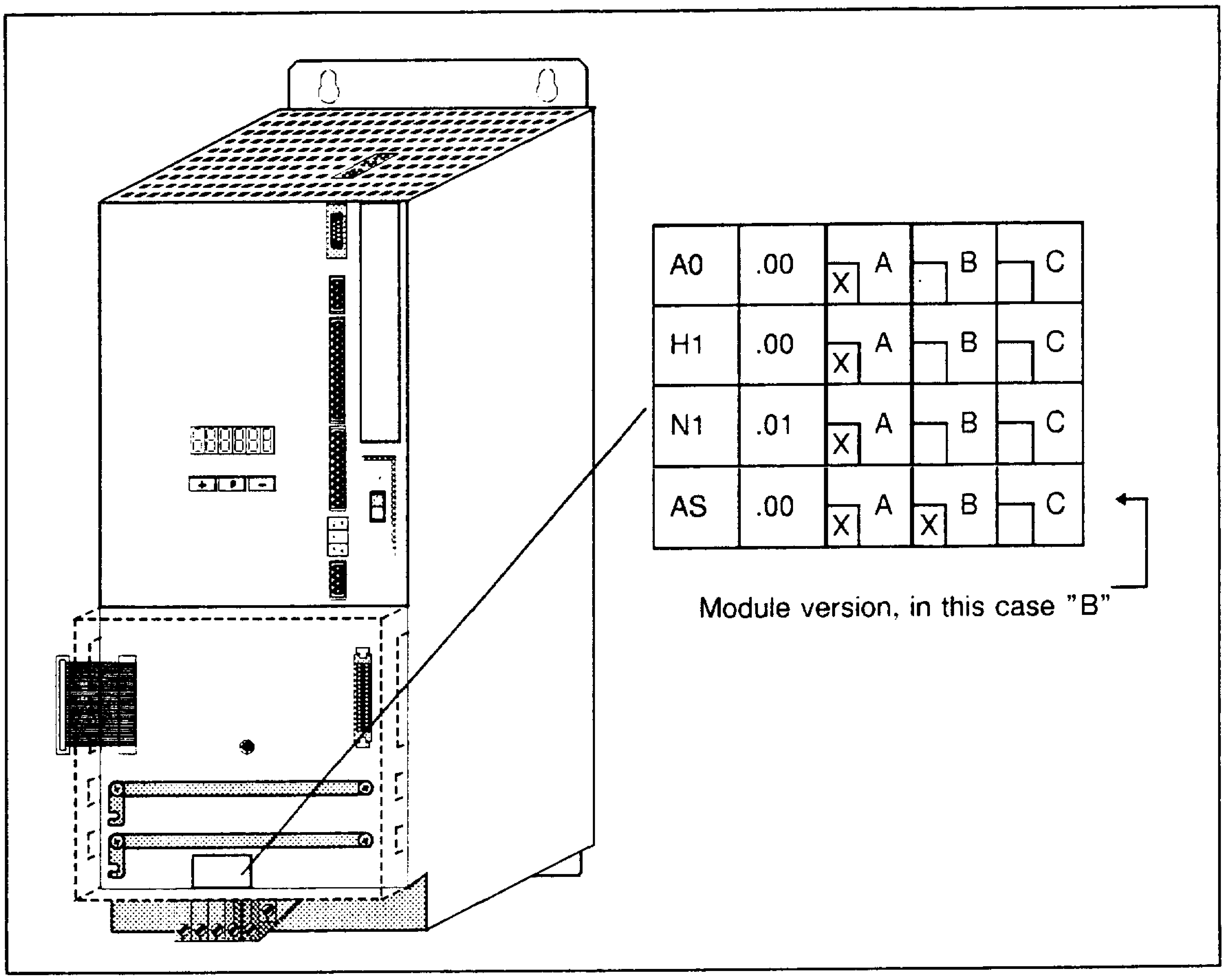
3.3.7 Machining-specific data sets

There are limits (P-029, P-039, P-041) and relay functions (P-021, P-023, P-027, P-047, P-50) which can be parameterized for eight different machining procedures. Freely-programmable terminals are used to select the currently valid machining-specific parameter set. Machining-specific data set 1 is automatically selected if none of the terminals are selected. The sixth digit from the left of the operating display indicates the number of the currently selected machining-specific data set. Please note, that when the motor is changed-over, the machining-specific data does not change. However, changes can result due to the modified reference quantities (the torque limits are specified as a percentage of the rated motor torque).

3.3.8 Module replacement

If a module has to be replaced, then the advantages of the plug-in software module can be fully utilized and, in specific instances, start-up shortened. The complete parameterization of the induction motor module is stored on the software module EEPROM.

Renewed start-up is required if the previously used induction motor module has a different current rating than the new module. In this case, it must be initialized and the previous settings are lost. Start-up can be shortened by noting the existing parameterization which is then entered after initialization. However, changes can be expected for the current controller gain settings (P-115, P-116), and the power offset and the appropriate adjustment must be carried-out (refer to Section 3.3.4).
If an induction motor module is replaced with a module having the same current rating, then it should be ensured, from version C onwards, that a hardware change is made for the phase current controller gain. The change is supported for software releases from 3.00 onwards. The software release of the actual software used is indicated in P-099. The DC link cover must be removed in order to identify the actual version. The actual version is entered on the label located below the DC link buses. **Please note, that the DC link can be at a hazardous voltage level!**



The power offset should always be re-adjusted after a module has been replaced. The following table indicates as to whether it is necessary to change the phase current controller settings:

Module version before replacement	Module version after replacement	P-115/P-116 changes required
A or B	A or B	no
C	C	no [1]
A or B	C	yes For software releases lower than 3.00 it can occur that the increments are unfavorable or P-115/P-116 setting range is too small Remedy: Use software release 3.00 or higher
C	A or B	yes Maybe the increments are unfavorable or P-115/P-116 setting range is too small Remedy: Use module, version C and software release 3.00 or higher

1) *Changes are only involved here if software releases less than 3.00 are upgraded to 3.00 or higher.*

4 Parameter description

WARNING
It is not permissible to change parameter settings which are not specified in the parameter list (refer to Section 9.7).

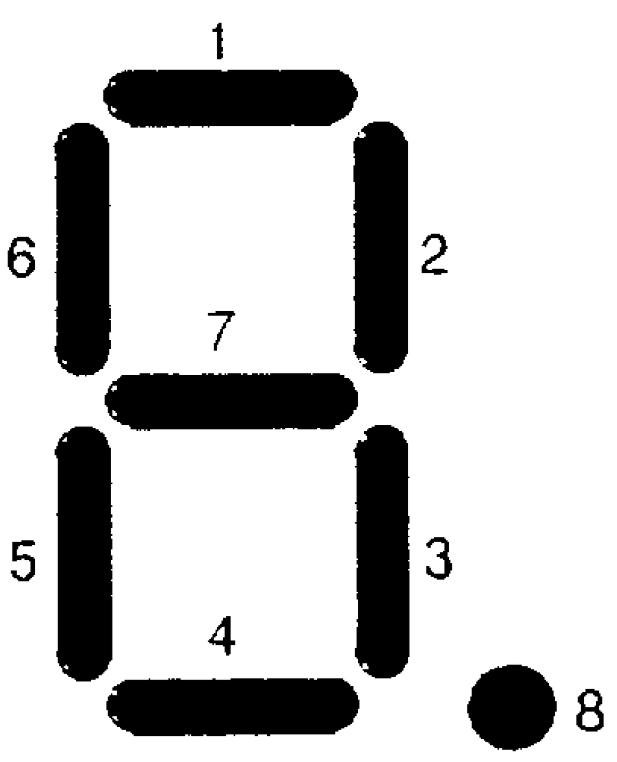
The parameter description is classified into specific subjects. A listing according to parameter number with section references is provided in Section 9.7.

4.1 Display parameters

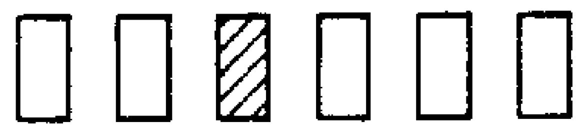
4.1.1 Operating display, P-000, P-100

P-000 and P-100 are completely identical. They indicate the induction motor module version.

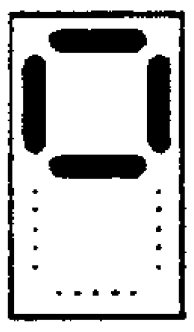
- Significance of the first digit from the left ▨ □ □ □ □ □ :
  This digit specifies the number of the currently effective motor data set (1 to 4) (refer to Section 3.3.2, motor data). The motor data set is selected using the freely-programmable terminal functions P-081 to P-089 or with P-056.
- Significance of the second digit from the left □ ▨ □ □ □ □ :
  The individual segments of this digit are assigned to the relay and light up when the associated relay has pulled-in. The assignment is shown in the following table.

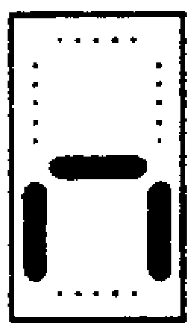


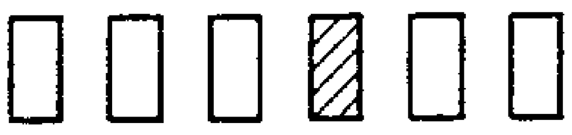
Seg-ment	Significance	Assignment in parameter	Connect. terminals
7	Freely-programmable relay 1	P-241	A11
6	Freely-programmable relay 2	P-242	A21
4	Freely-programmable relay 3	P-243	A31
1	Freely-programmable relay 4	P-244	A41
2	Freely-programmable relay 5	P-245	A51
3	Freely-programmable relay 6	P-246	A61
5	Switched dark	–	–
8	Ready/fault	P-053	672/674

- Significance of the third digit from the left  :

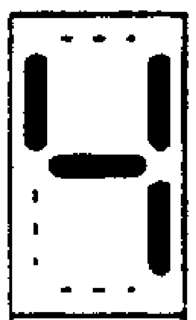
The symbols displayed here and their significance are listed in the following:

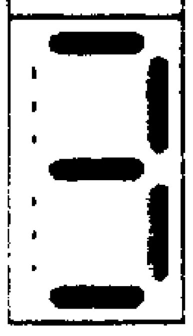
Symbol  : The unit is in the wait condition.
The still missing enable signals are displayed in the next digit.

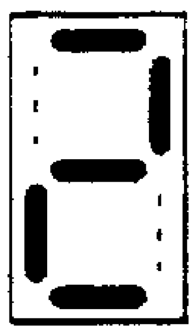
 : All enable signals are available, closed-loop speed control mode is preselected.

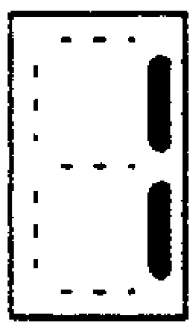
- Significance of the fourth digit from the left  :

If all of the enable signals are not available, then the missing ones are displayed here:

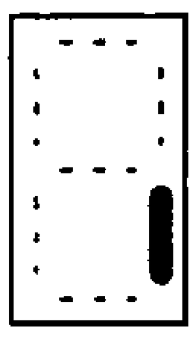
Symbol  : Pulse enable of the input/regenerative feedback module (terminal 63) missing

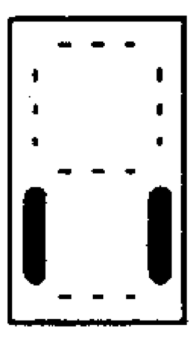
 : Induction motor module pulse enable (terminal 663) missing

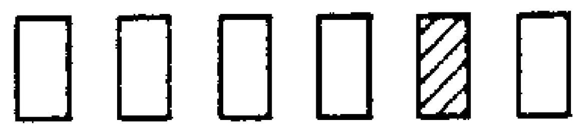
 : Controller enable signal (terminals 65 or 64) missing

 : Ramp-generator fast stop is active (terminal 81)

When all enable signals are available, this digit indicates whether the drive is motoring or generating.

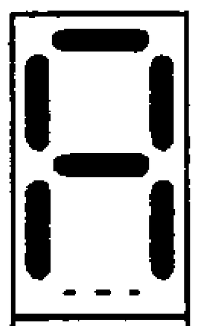
Symbol  : Motor operation

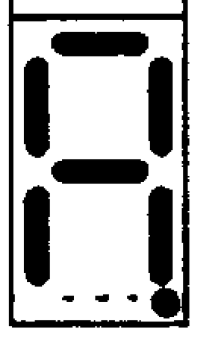
 : Generator operation

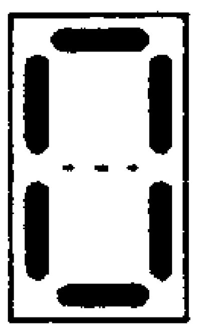
- Significance of the fifth digit from the left  :

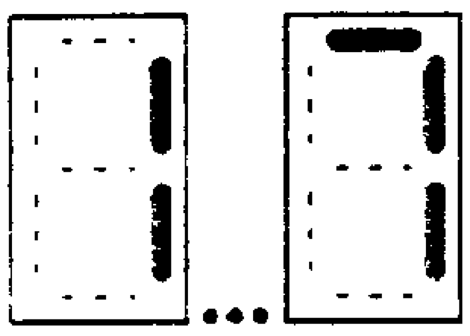
  This digit indicates the actual speed setpoint source.

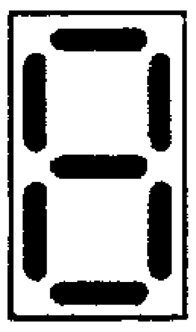
Symbol

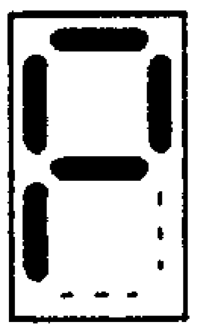

: Analog setpoint (analog setpoint channel 1 or 2 or sum 1 + 2 terminal 56/14 and/or terminal 24 8) Selected with P-113 = 1, 2 or 3

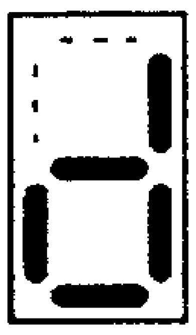

: Sum, analog setpoint channel 1 (terminal 56/terminal 14) plus fixed setpoint (selected using the freely-programmable terminal functions) P-081...P-089, value can be changed via P-114) Selected with P-113 = 9

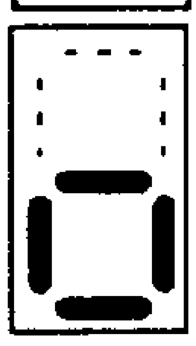

: Setpoint zero as P-113 = 0, 7 or 8


: Fixed setpoint 1 ... 7 (activated via freely-programmable terminal functions P-081...P-089. value can be changed via P-114)

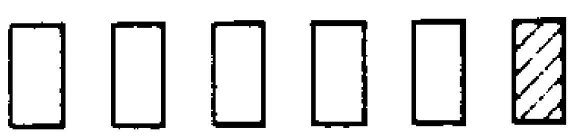

: Setpoint from the mot. pot. function (selected using P-113 = 6; set via P-114.8 or freely-programmable terminal functions P-081 ... P-089)


: Setpoint from oscillation generator (selected using P-113 = 4 or activated with freely-programmable terminal functions P-081...P-089; value can be changed via P-154...P-157)


: Digital setpoint from serial interface X411(selected via P-113)


: Setpoint from the optimization software (activated with P-204, P-205)

(for more detailed information regarding the setpoints, refer to Section 4.3)

- Significance of the sixth digit from the left  :

  This digit specifies the number of the currently effective machining-specific data set (1 to 8). The machining-specific data set is selected using freely-programmable terminal functions (P-081 to P-089).

4.1.2 Measured value displays, P-001 to P-010, P-101, P-102

P-001 to P-010, P-101 and P-102 are display parameters for various measured- and setpoint values, as indicated in the following table:

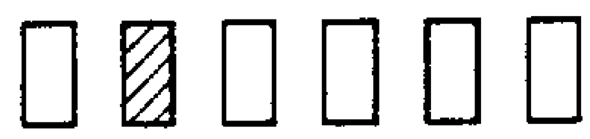
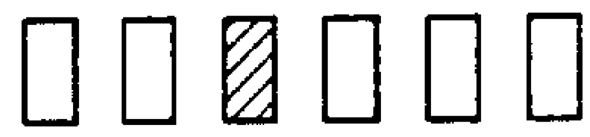
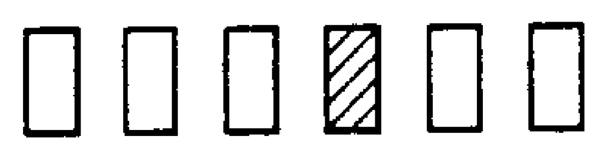
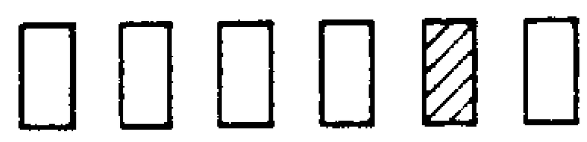
Parameter	Displayed values	Unit	Format
P-001/P-101	Speed setpoint	RPM	-29000 ... +29000
P-002/P102	Speed actual value, calculated	RPM	-29000 ... +29000
P-003	Torque-generating current as a % of the rated motor current	%	-399.0 ... +399.0
P-004	Utilization as a % of the effective power/torque limits	%	0... +100.0
P-005	Motor frequency	Hz	-480 ... +480
P-006	DC link voltage	V	0 ... +700
P-007	Absolute value of the current as a % of the rated motor current	%	0.0 ... +399.0
P-008	Field-generating current as a % of the rated motor current	%	0.0 ... +399.0
P-009	Active power as a % of the rated motor output	%	-399.0 ... +399.0
P-010	Output converter voltage	V_{rms}	0.0 ... +450.0

P-006 only displays the actual DC link voltage, if the induction motor module is connected to the equipment bus (X151) of an infeed regenerative feedback module and P-061 (fixed DC link voltage) is at 0. Information regarding the DC link voltage is not transferred along the equipment bus of a monitoring module. If the induction motor module is connected to the equipment bus of a monitoring module, the DC link voltage used must be permanently set in P-061. The value of P-061 is, if P-061 is not equal to 0, displayed in P-006, even if it deviates from the actual value.

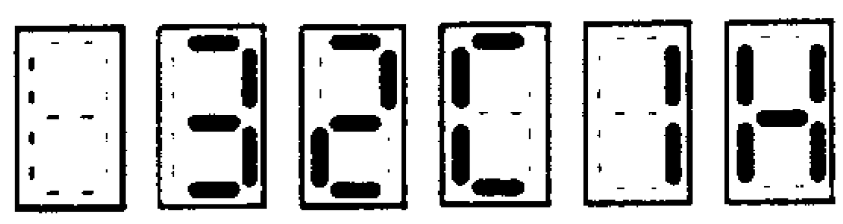
4.1.3 Status displays, P-011, P-254, P-255

The induction motor module evaluates axis-specific, freely-programmable input terminals (E1 to E9), axis-specific enable terminals (terminals 663, 65, 81) as well as global (valid for the complete module group) input and enable terminals. P-011 is used to check which of these terminals is closed. The freely-programmable input terminals are assigned a function by programming P-081 to P-089. P-254 and P-255 provide information, regarding which of these functions are active. A function is active, if it is assigned to one of the freely-programmable terminals, and this terminal is closed. The assignment of the terminals and functions to the individual bits with the contents which are displayed in hexadecimal format, are listed in the following table, together with an example. Please note, that four bits are always combined to form a hexadecimal position.

Significance of P-011 (Status of the terminals)

Terminal	Signal	Signal active for	Bit	Display digit from the left
15 112 64 63	Fault acknowledgement, I/R Setting-up operation, I/R Drive enable, I/R Pulse enable, I/R	H H H H	15 14 13 12	
81 65 663 E9	Ramp-fct. gen. fast stop (HSS) Controller enable Axis-specific pulse enable Freely-programmable terminal 9	H H H H	11 10 9 8	
E8 E7 E6 E5	Freely-programmable terminal 8 Freely-programmable terminal 7 Freely-programmable terminal 6 Freely-programmable terminal 5	H H H H	7 6 5 4	
E4 E3 E2 E1	Freely-programmable terminal 4 Freely-programmable terminal 3 Freely-programmable terminal 2 Freely-programmable terminal 1	H H H H	3 2 1 0	

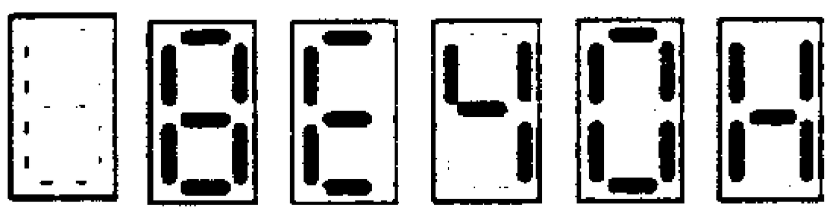
The displays at the second digit from the left refer to the functions of the infeed/regenerative feedback module or monitoring module.

Example: Display in P-011  means:

Drive and pulse enable signals for the infeed/regenerative feedback module are available, the axis-specific pulse enable for the induction motor module is available but the controller enable signal is missing.
The freely-programmable input terminals E8, E7 and E1 are energized.

Significance of P-254 (active functions)

Display position	Bit	Function
5th from the left □□□□▨□	0 1 2 3	Torque limit 2 Oscillation (selected via terminal) Fault acknowledgement (selected via terminal) Reserved
4th from left □□□▨□□	6 7	$T_h = 0$ (ramp-function generator) Reserved
3rd from the left □□▨□□□	8 9 10 11	Machining-specific parameter set. bit 0 Machining-specific parameter set. bit 1 Machining-specific parameter set. bit 2 Clockwise/counter-clockwise rotating field
2nd from the left □▨□□□□	12 13 14 15	Ramp-function generator 2 Increase n_{set} Decrease n_{set} Setpoint enable

Example: Display in P-254  means:

Setpoint is enabled,
counter-clockwise rotating field is selected,
machining-specific parameter set 7 is active.
acceleration/deceleration times are zero (ramp-function generator).

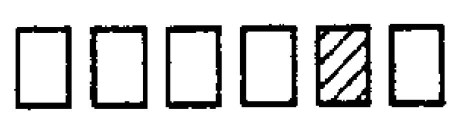
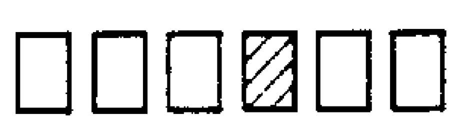
Significance of P-255 (active functions)

Display position	Bit	Function
5th from the left □□□□▨□	0 1 2 3	Fixed setpoint. bit 0 Fixed setpoint. bit 1 Fixed setpoint. bit 2 Motor. bit 0
4th from left □□□▨□□	4	Motor. bit 1

4.1.4 Displaying the executed self-tuned functions P-020

At start-up, the user is supported by various functions to enable him to set the controllers or identify machine parameters. These functions are handled using P-204 and P-205, and can be individually called-up. P-020 is used to display which of the self-tuned functions have been executed for each specific motor. In this case, a bit is set for each executed self-tune function (refer to the table for the assignment). The display is in the hexadecimal format, and if 3 FH is displayed, then all self-tuned functions were executed.

Significance of P-020 (executed self-tuned functions)

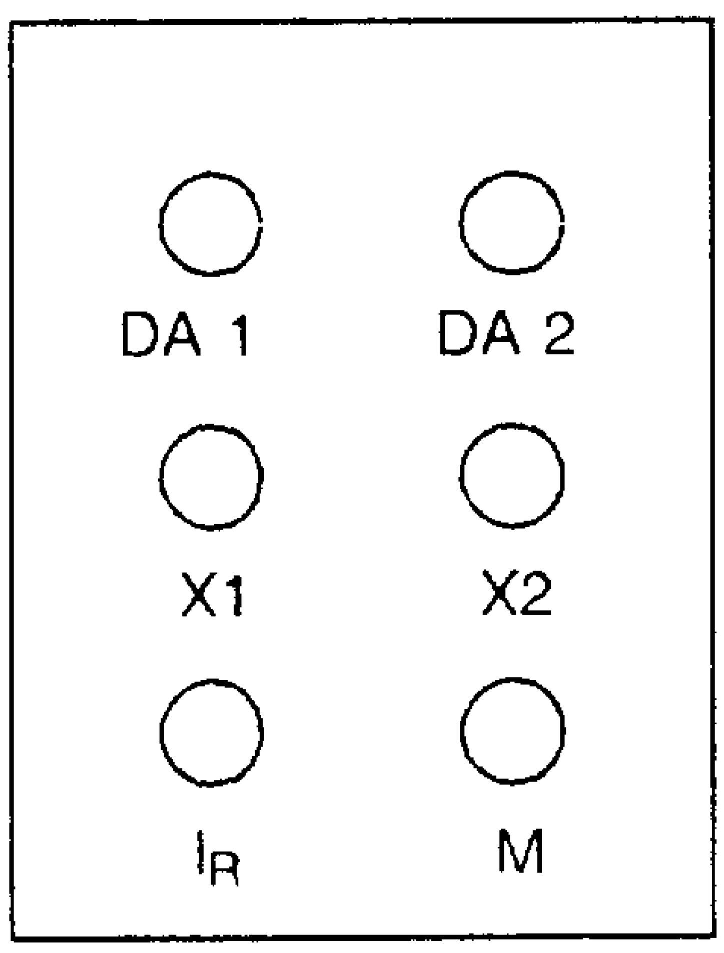
Display position	Bit	Executed self-tuned function
5th from left 	0 1 2 3	Phase current controller (P-115, P-116) Power offset adjustment No-load current (P-166) Main field inductance (P-171)
4th from left 	4 5	Moment of inertia (P-159) Rotor resistance (P-168)

4.1.5 Software release, P-099

Parameter P-099 indicates the software release. This Description assumes that software release 3.00 is available.

4.2 Handling the D/A converters, test sockets P-012, P-013, P-066 to P-069

The induction motor module has 5 test sockets, which can be used during start-up, as diagnostic aid, or for display purposes. Three of these test sockets are permanently wired (X1, X2, I_R), and the other two (DA 1, DA 2) are D/A converter outputs, which can be assigned with any of the digital closed-loop control signals. The reference potential is M.



DA 1	: Test socket D/A converter 1
DA 2	: Test socket D/A converter 2
X1	: Test socket, current actual value, phase S
X2	: Test socket, voltage setpoint, phase R (pulse width modulated signal)
I_R	: Test socket, current actual value, phase R
M	: Reference ground for test sockets

Location of the test sockets on the front of the module

4.2.1 Test sockets, current actual values I_R, X1

The normalization of the current test sockets for phase R (I_R) and phase S (X1) is dependent on the current rating of the module used, as listed in the following table:

Module current rating	1 A in phase R/S corresponds to ... mV at test socket I_R/X1
5/7	721 mV/A
15/20	250 mV/A
24/32	166 mV/A
30/40	126 mV/A
45/60	85.1 mV/A
60/80	63.2 mV/A

Example: A peak value of 5.0 V is measured at the I_R socket on the 15/20 A module, which corresponds to a peak current of: 5.0 V : 250 mV/A = 20 A. (for a sinusoidal current that is 20 $A/\sqrt{2}$ = 14.1 A_{RMS})

4.2.2 Test socket, voltage setpoint X2

Test socket X2 provides the voltage setpoint, phase R , which is available pulse width modulated. The signal level is 0 V or 5 V (logical signal). In this case, 5 V (H) means that phase R is at the DC link potential and 0 V (L), that phase R is at 0 V.
It should be noted, that the potential of the other phases also influences phase current R.

4.2.3 D/A converters DAU 1 and DAU 2 (P-012, P-013, P-066 to P-069, P-078, P-079)

The two test sockets DA1 and DA2 are outputs from two independent 8-bit D/A converters. The maximum signal level is ± 10 V. The converters can output any of the digital closed-loop control signals (assigned using P-066, P-068) as analog voltage. The range of the output value can be adapted in small (P-012, P-013) and rough (P-067, P-069) steps. The following table specifies the addresses and the internal normalization of the most important digital closed-loop control quantities, which must be entered into P-066 or P-068 if the appropriate signal is to be output at the D/A converter. The internal normalization is decisive, if quantitative information is required. The conversion is made later. Further, offsets (P-078, P-079) can be specified.

		Internal normalization	
Calculated speed actual value (absolute value)	11B6H	7FFFH	n_{max} (P-174/P-029)
Utilization	11B8H	7FFFH	Act. torque limit
Calculated speed actual value	1110H	7FFFH	29296/min
Torque setpoint	10ECH	2000H	$M_{d,\ rated}$
Absolute current value (act. value)	10C6H	2000H	$I_{mot.\ rated}$
Absolute current value (setpoint)	10C4H	2000H	$I_{mot.\ rated}$
Torque-generating current (setpoint)	10D2H	2000H	$I_{mot.\ rated}$
Field-generating current (setpoint)	10CAH	2000H	$I_{mot.\ rated}$
Speed setpoint (after the ramp-function gen.	0E02H	7FFFH	29296/min
Field angle (setpoint)	1140H	10000H	2π
Field angle (actual value)	1142H	10000H	2π
Active power (actual value)	1148H	2000H	$P_{S.\ rated}$
Reactive power (actual value)	114AH	2000H	$P_{S.\ rated}$
Integral comp. closed-loop speed controller	117CH	2000H	$M_{d,\ rated}$
Integral comp. closed-loop field controller	116AH	2000H	$I_{mot.\ rated}$
Magnetization current (calc.)	10E6H	2000H	$I_{mot.\ rated}$
Speed setpoint from the serial interface	112CH	7FFFH	29296/min

Addresses and internal normalization of the digital closed-loop control

P-066 Address for output at DAU 1 (D/A converter 1)
Default value: 11B6H (calculated absolute speed actual value)
Range: 0...FFFFH

P-068 Address for output at DAU 2 (D/A converter 2)
Default value: 11B8H (utilization)
Range: 0...FFFFH

P-012 Fine normalization for DAU 1 (D/A converter 1)
Default value: 100.0 Unit: %
Range: -1000.0... + 1000.0 %

P-013 Fine normalization for DAU 2 (D/A converter 2)
Default value: 100.0 Unit: %
Range: -1000.0... + 1000.0 %

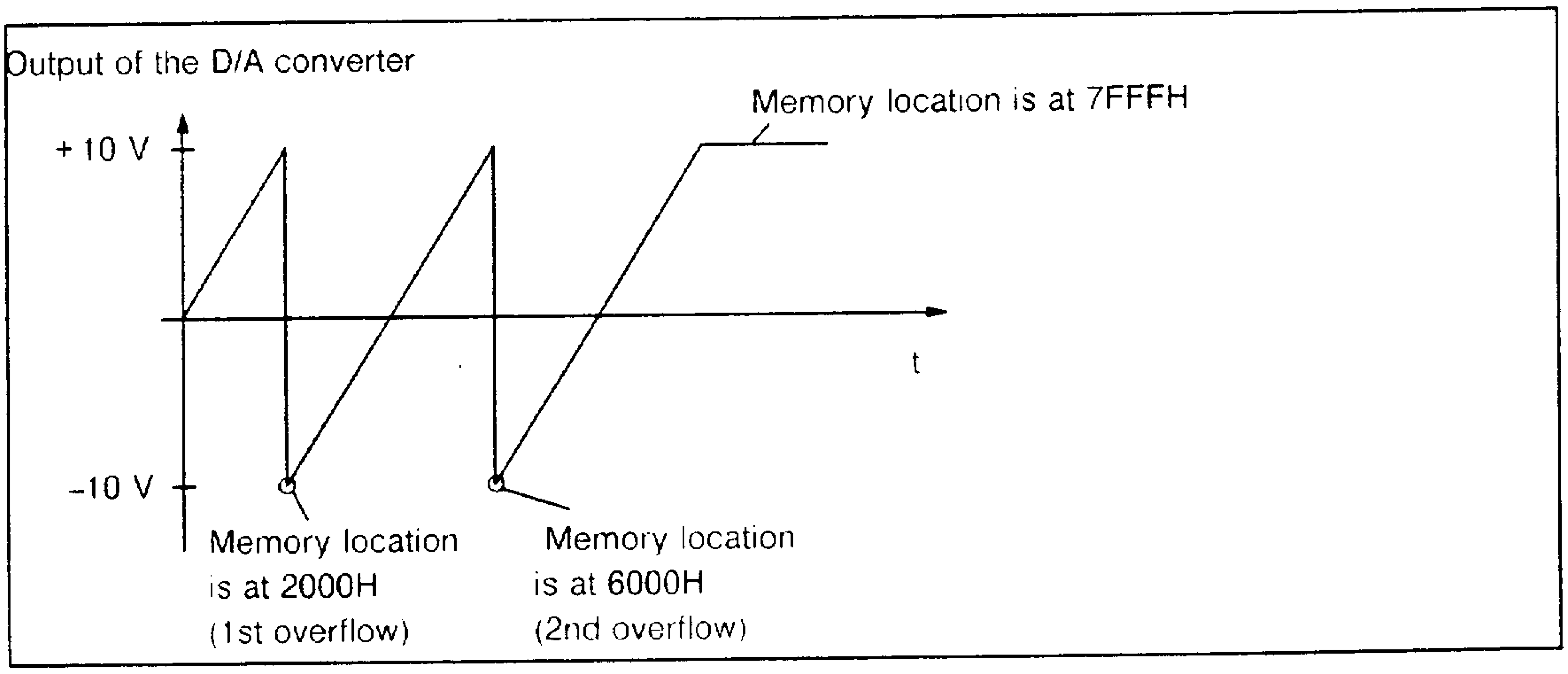
P-067 Shift factor for DAU 1 (D/A converter 1)
Default value: 0H
Range: 0...FH

P-069 Shift factor for DAU 2 (D/A converter 2)
Default value: 0H
Range: 0...FH

Shift factors P-067 and P-069 result in a rough normalization for output at the D/A converter. A shift by 1 corresponds to a multiplication by 2, i.e. the shift factor permits a multiplication by $2^{\text{shift factor}}$. The thus achievable gain is a maximum of 32768 (thus, only the last bit is evaluated), and the increments are quite coarse. An adaption in 0.1% increments can be achieved using P-012 and P-013 and the sign can also be inverted, however, the maximum gain is only 10. The result of the adaption by shifting and fine normalization is then as follows.

[Output value] = [address contents] $\cdot$ $2^{\text{shift factor}}$ $\cdot$ fine normalization (in %)/100

The result is output so that 7FFFH (= 32767) results in 10 V at the D/A converter. The output is bipolar, i.e. 8000H (= -32768) resulting in -10 V. Generally, an overflow which is created by shifting, fine normalization or offset, is ignored (the numerical format is 16-bits wide). Thus, if a memory location was recorded, which is linearly increased from 0 to 7FFFH, and a shift factor of 2 is applied, then the following display is obtained as a result of the overflows.



The actual characteristic is obtained by positioning the curves for each overflow next to one another. The two "calculated speed actual value (absolute value)" and "utilization" signals are specially treated here. They are conceived for output on a unipolar analog measuring instrument so that in this case overflows would be disturbing. If an overflow would occur with these signals, then it is limited to +10 V or −10 V, so that the polarity of the output voltage is not changed. These signals are internally normalized, so that for shift factor 0 and 100.0% fine normalization, exactly the maximum range (10 V) is used without an overflow occurring. The following is an example for the quantitative evaluation of the D/A converter signals.

Example

D/A converter 1 was parameterized as follows:

P-066 = 10ECH	(torque setpoint)
P-067 = 2	(shift factor)
P-012 = 110.0	(fine normalization)

8.0 V is measured at D/A converter 1; that corresponds to:

Measured value (8.0 V)

$$\frac{7FFFH \cdot 8.0\ V \cdot 100.0}{10.0\ V \cdot 2^2 \cdot 110.0\ \% \cdot 2000H} \cdot \text{Rated torque} =$$

P-067 (2^2), P-012 (110.0 %), Internal normalization (2000H)

$$= \frac{32767 \cdot 0.8}{2^2 \cdot 1.1 \cdot 8192} \cdot \text{Rated torque}$$

$$= 0.727 \cdot \text{Rated torque}$$

P-078 Offset for D/A converter 1
Default value: 0 Units: D/A converter increments
Range: −127... +127

P-079 Offset for D/A converter 2
Default value: 0 Units: D/A converter increments
Range: −127... +127

An offset for D/A converter 1 and D/A converter 2 can be set in P-078 and P-079. A setting of +127 generates a voltage offset of 10 V at the D/A converter. The ±10 V output voltage range is not changed by the offset.

4.3 Speed setpoints

4.3.1 General information

The speed setpoint can be specified in the following ways:

- Analog speed setpoint from terminal 56/terminal 14 and/or terminal 24/terminal 8 (differential input), can be parameterized (P-014, P-015, P-019, P-024, P-025)
- Fixed setpoints (P-114.1 to P-114.7), selectable via freely-programmable terminal functions (P-081 to P-089)
- Setpoint from the electronic motorized potentiometer (P-114.8), adjusted using freely-programmable terminal functions (P-081 to P-089)
- Digital setpoint from the serial interface
- Oscillation setpoint (P-154 to P-157)

Further, there are enable terminals (terminals 64, 65, 81) and freely-programmable terminal functions (setpoint enable, clockwise/counter-clockwise, oscillation, fixed setpoints, motorized potentiometer), which influence the setpoint input. Using two different ramp-function generators which can be parameterized (P-016, P-017, P-042, P-043), the ramp-up and ramp-down times, as well as an initial rounding-off (P-018) can be used to specify the speed setpoint change. The standard setpoint is effective if no other setpoint is selected using the input terminals (terminals 64, 81, E1 to E9). The standard setpoint is selected using P-113. If several input terminals, which influence the setpoint, are simultaneously energized, the priority is as follows:

Lowest priority ↓

- Standard setpoint
- Fixed setpoint from the freely-programmable terminal
- Oscillation from the freely-programmable terminal
- Motorized potentiometer
- Clockwise/counter-clockwise from the freely-programmable terminal

Highest priority

- Setpoint enable from the freely-programmable terminal, ramp-function generator fast stop (terminal 81), controller enable (terminals 64, 65).

If the clockwise/counter-clockwise function is assigned to a freely-programmable terminal (P-081 to P-089), only uni-polar, positive setpoints are permitted, and negative setpoints are limited to zero. The setpoint sign is then specified with the clockwise/counter-clockwise terminal.

The speed setpoint is limited so that it does not exceed the absolute value of the speed limiting (P-029) and the maximum speed (P-174). Please note, that the speed limit (P-029) is machining-specific, but the maximum speed (P-174) is a function of the motor.

It is possible to specify a steady-state minimum speed (P-030), the absolute value of which is not fallen below by a standard setpoint input. Zero setpoint can then only be forced with the enable terminals, ramp-function generator enable (terminal 81), controller enable (terminal 64, 6) or setpoint enable (freely-programmable). The measures can be of practical value, for example for self-ventilated motors, in order to prevent overheating when operated continuously at low speeds.

A freely-selectable speed range can be inhibited for the setpoint (absolute value) using the speed range inhibit function (P-054, P-055). The drive cannot operate continuously at these speeds, although it can run through this range. Thus, it is possible to prevent excitation of mechanical resonances in the resonant frequency range. The speed setpoint is indicated in P-001 and P-101.

4.3.2 Standard setpoint selection, P-113

The standard setpoint is selected by entering a number into P-113. The assignment between possible numbers and the associated standard setpoints is illustrated in the following table.

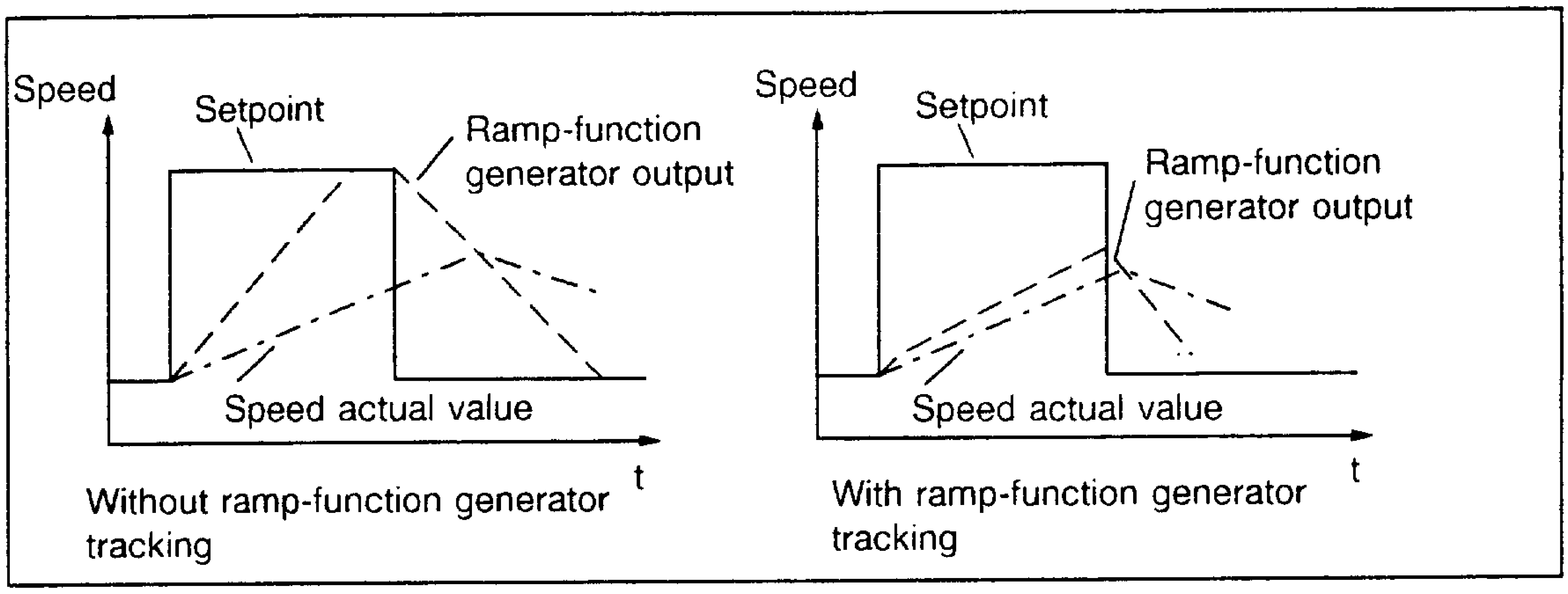
P-113 Standard setpoint selection
Default value: 1
Range: 0...9

Number in P-113	Standard setpoint
0	Setpoint 0, fixed
1	Analog setpoint from channel 1 (terminal 56/terminal 14)
2	Analog setpoint from channel 2 (terminal 24/terminal 8)
3	Analog setpoint sum from channel 1 (terminal 56/terminal 14) and channel 2 (terminal 24/terminal 8)
4	Setpoint from the oscillation generator (P154 to P-157)
5	Digital setpoint from the serial interface
6	Setpoint from the electronic motorized potentiometer
7	Reserved
8	Reserved
9	Summed setpoint, analog channel 1 (term. 56/term. 14) and the fixed setpoint from the freely-programmable terminal
10	Setpoint is input from the post-optimization software

4.3.3 Ramp-function generator (P-016, P-017, P-018, P-042, P-043)

The speed setpoint can be adjusted using the ramp-function generator with adjustable ramp-up and ramp-down times. The times are always specified, within which the setpoint must be changed from zero up to maximum speed (P-174) or vice versa. A changeover is made to the parameter set of the 2nd ramp-function generator by activating the freely-programmable terminal function ("ramp-function generator 2"). If the freely-programmable terminal function "zero ramp-up time" is selected, the ramp-function generator is disabled. The drive is also braked without ramp-function generator for a ramp-function generator fast stop (terminal 81). The ramp-function generator parameter sets are changed depending on the motor. The initial rounding-off smoothes the torque control characteristics. Thus, the torque is smoothly built-up after a setpoint step, and not suddenly. As deep-bar, squirrel-cage rotors cannot instantaneously build-up torque, for these types of induction motors, the initial rounding-off must be set to an appropriately higher value (10 to 30 ms). The initial rounding-off also remains effective at "zero ramp-up time" and for the ramp-function generator fast stop.

If bit 3 is set for control parameter P-053, the ramp-function generator is corrected (tracks) according to the calculated actual speed. Differences manifest themselves if ramp-up times are input but the actual speed cannot follow the specified ramp-up time, and a setpoint is demanded with a different torque direction.



A response to the setpoint change occurs immediately with ramp-function generator tracking.

P-016 Ramp-up time (from zero up to max. speed (P-174)), ramp-function generator 1
P-017 Ramp-down time (from max. speed (P-174) down to zero), ramp-function generator 1
P-042 Ramp-up time (from zero up to max. speed (P-174)), ramp-function generator 2
P-043 Ramp-down time (from max. speed (P-174) down to zero), ramp-function generator 2
Default value: 0.00 s Units: Seconds
Range: 0.00...32.00 s
Sub-parameter: 1...4 (motor-specific)

P-018 Initial rounding-off
Default value: 4.00 ms Units: ms (smoothing time constant)
Range: 0.00...100.00 ms

4.3.4 Parameterization of the analog setpoint channels P-014, P-015, P-019, P-024, P-025

Using P-014, a speed can be set, for each motor, to which the voltage data in P-024 and P-025 is referred. If the voltage from P-024 or from P-025 is applied to the associated analog setpoint input (terminal 56/terminal 14 or terminal 24/terminal 8), the speed, set in P-014 is realized as setpoint, if the appropriate channel was selected. The weighting of the two analog channels can be different and e.g. with the summed setpoint, channel 1 + channel 2, a channel can be used for rough adjustment and the other channel for fine adjustment. The polarity of the analog setpoint input can also be inverted with the sign of P-014.

P-014 Reference speed, analog setpoint channels
Default value: 0 Units: RPM (speed)
Range: –29000... +29000 RPM
Sub-parameters: 1...4 (motor-specific)

Note: is changed by P-153 = –1 (calculate closed-loop control parameters)

P-024 Normalization, speed setpoint, channel 1
P-025 normalization, speed setpoint, channel 2
Default value: 10.0 V Units: Volt
Range: 2.0...10.0 V

P-015 Offset of analog setpoint channel 1
P-019 offset of the analog setpoint channel 2
Default value: 0H Units: Hex (A/D converter increments)
Range: D000H...2000H

In order to achieve the full fine increments for the offset adjustment, the offsets are specified as increments of the A/D converter. Negative offsets are specified as a two's-complement (-1 ≙ FFFFH, -2 ≙ FFFEH, -2000H ≙ D000H).

If an analog setpoint input has been selected, disturbances and noise on the analog setpoint channels result in fluctuating speed setpoints, and thus to uneven running characteristics. The higher the moment of inertia (P-159), then the greater is the effect due to the speed-torque pre-control. A counter-measure is to select another setpoint (fixed setpoint, digital setpoint). If this is not possible, the grounding and screening of the setpoint cables should be checked. If this is also unsuccessful, the speed setpoint can be digitally smoothed, or the setpoint change only permitted when it exceeds a specific threshold. With the latter, the analog setpoint input cannot be adjusted in very small increments as before. The associated values cannot be adjusted per operator control parameter, but must be changed using the functions for writing into the memory (P-250 to P-253) (refer to Section 4.7.3). Here, only the address and the normalization are specified:

- Smoothing time constant for digital speed setpoint smoothing
  Address: 10BAH
  1000 (decimal) ≙ 3E8H ≙ 10 ms smoothing time constant (= default value)
- Analog speed setpoint hysteresis
  Address: 10ACH
  3 ≙ 14.6 mV analog voltage (= default value)

These values can be changed as for the other parameter changes with P-052 = 1 and then stored in the EEPROM by depressing the write protection button.

4.3.5. Fixed setpoints P-114.1 to P-114.7

With the induction motor module, seven fixed setpoints can be entered (with P-114.1 to P-114.7), which can be called-up via freely-programable terminal functions (refer to P-081 to P-089) "fixed setpoint bit 0, fixed setpoint bit 1" and "fixed setpoint bit 2". The standard setpoint is output if all fixed setpoint terminals are inactive. The number of the selected fixed setpoint is coded using the binary number of the active fixed setpoint terminal bit, as can be seen in the subsequent table.

Freely-programmable terminals: Fixed setpoint			Selected setpoint	
Bit 2	Bit 1	Bit 0		
0	0	0	Standard setpoint	P-113
0	0	1	Fixed setpoint 1	P-114.1
0	1	0	Fixed setpoint 2	P-114.2
0	1	1	Fixed setpoint 3	P-114.3
1	0	0	Fixed setpoint 4	P-114.4
1	0	1	Fixed setpoint 5	P-114.5
1	1	0	Fixed setpoint 6	P-114.6
1	1	1	Fixed setpoint 7	P-114.7

1 ≙ Freely-programmable terminal is active
0 ≙ Freely-programmable terminal is inactive

If only three or fewer fixed setpoints are required, it is sufficient to apply "fixed setpoint, bit 0" and "fixed setpoint, bit 1" to freely-programmable terminals. When 9 is entered into P-113, the sum of the analog setpoint from channel 1 (terminal 54/terminal 18) and the selected fixed setpoint are specified as speed setpoint. If a fixed setpoint is not selected, then in this case, only the analog setpoint channel 1 is effective.

Parameter P-114.8 is the motorized potentiometer setpoint. It is not selected via the fixed setpoint terminals.

P-114 Fixed setpoints, motorized potentiometer setpoint
Default value: 0 Units: RPM
Range: -29000... +29000 RPM
Sub-parameters: 1...7 Fixed setpoints (selected with freely-programmable terminals "fixed setpoint bit")
8 Motorized potentiometer setpoint (selected using P-113 = 6: Changed via the freely-programmable "motorized potentiometer" terminals).

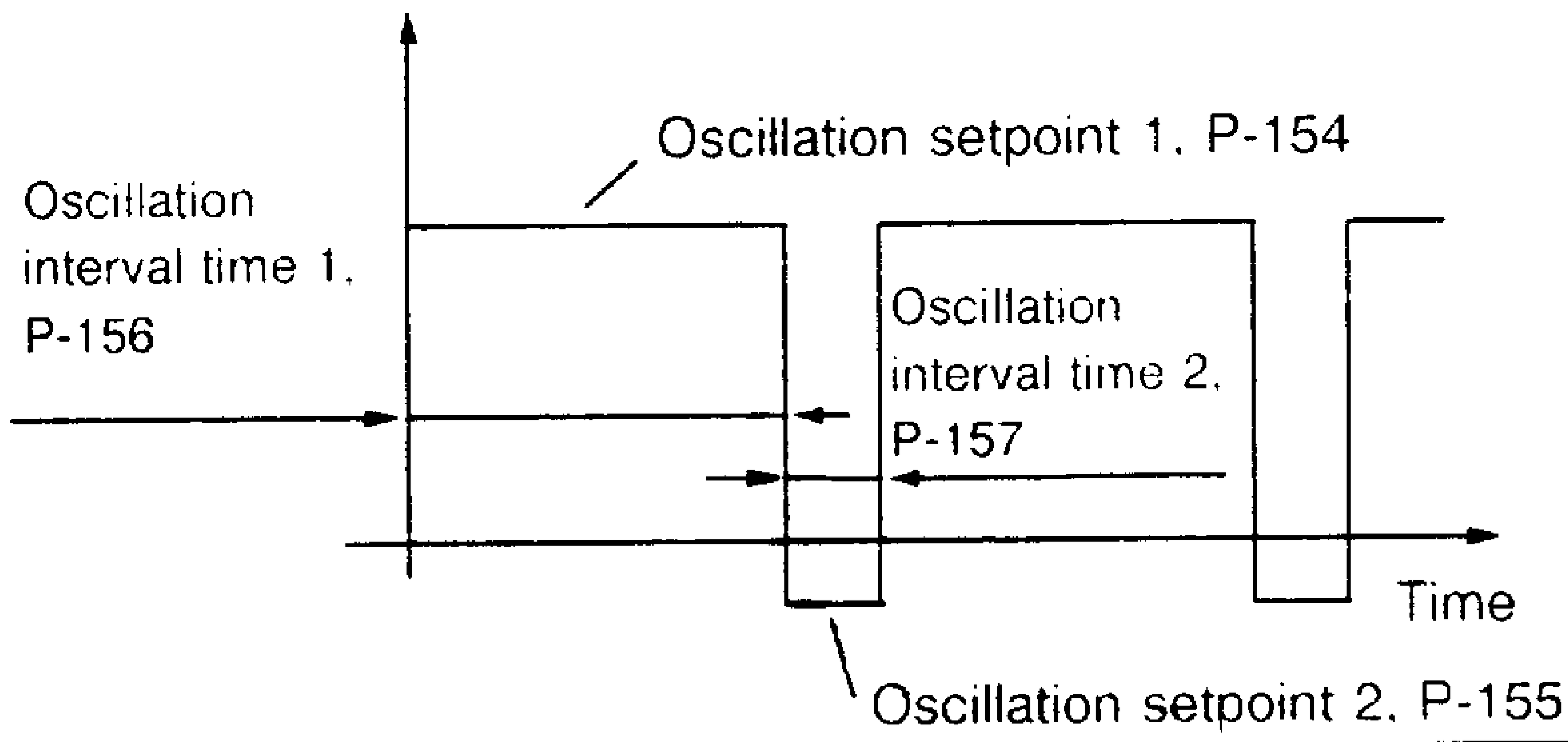
4.3.6 Motorized potentiometer function, P-114.8

The motorized potentiometer function permits a setpoint to be changed via freely-programmable terminal functions: "Increase setpoint" and "decrease setpoint". The rate of change is the same as the ramp-up and ramp-down time of the selected ramp-function generator (P-016, P-017, P-042, P-043). The freely-programmable terminal "zero ramp-up time" does not influence the rate of change of the motorized potentiometer function. Refer to Section 4.3.5 for the parameter description.

4.3.7. Speed setpoint from the oscillation generator, P-154 to P-157

In the oscillation mode, two setpoints are alternately effective. The setpoints as well as the time intervals can be adjusted. The oscillation mode can be activated via a freely-programmable terminal function (P-081 to P-089) or by setting P-113 to 4.

Speed setpoint from the oscillation generator

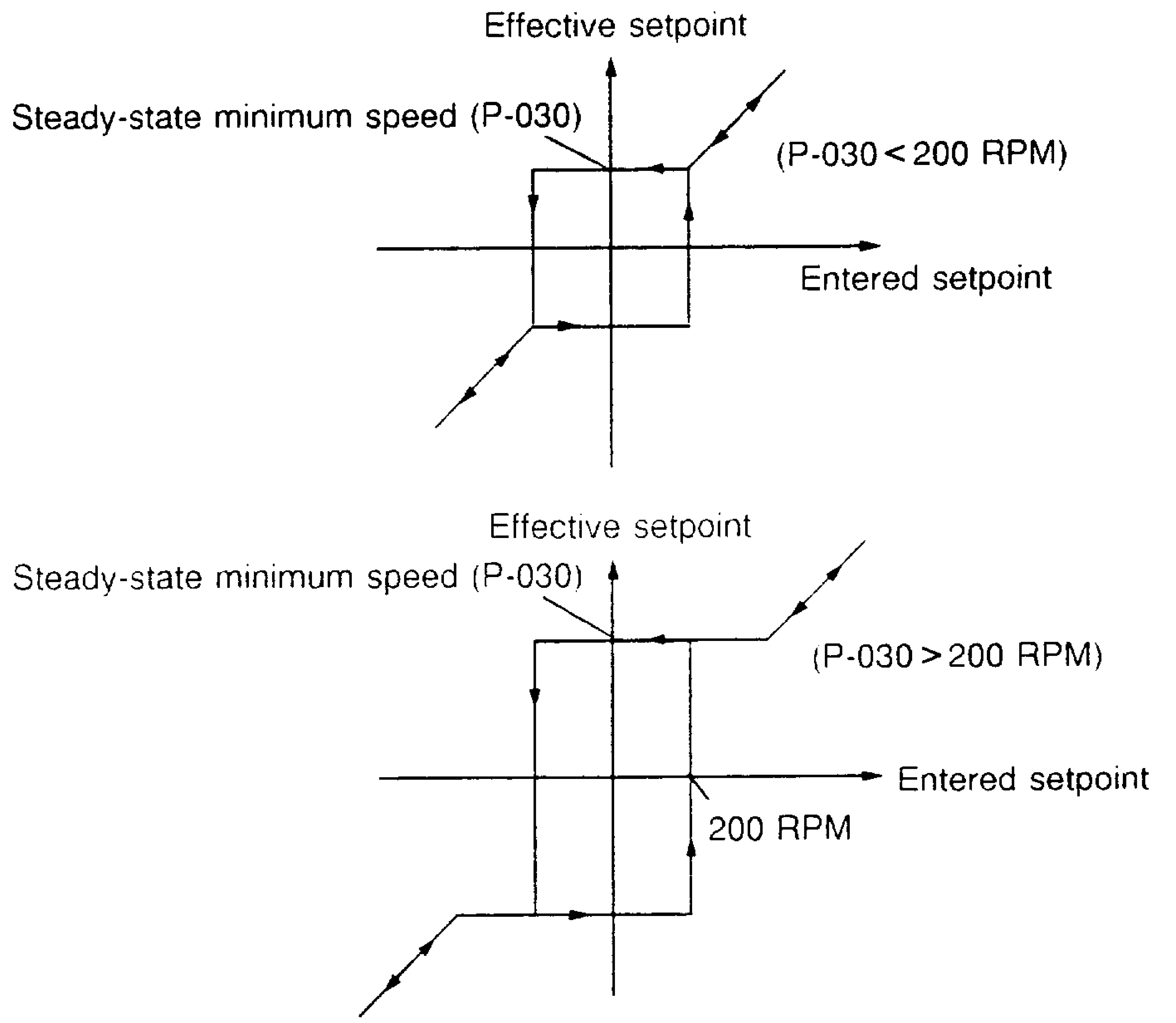


P-154 Oscillation setpoint 1
P-155 Oscillation setpoint 2
Default value: 0 Units: RPM (speed)
Range: -29000... +29000 RPM

P-156 Oscillation interval time 1
P-157 Oscillation interval time 2
Default value: 1.000 s Units: Seconds
Range: 0.002... +60.000 s

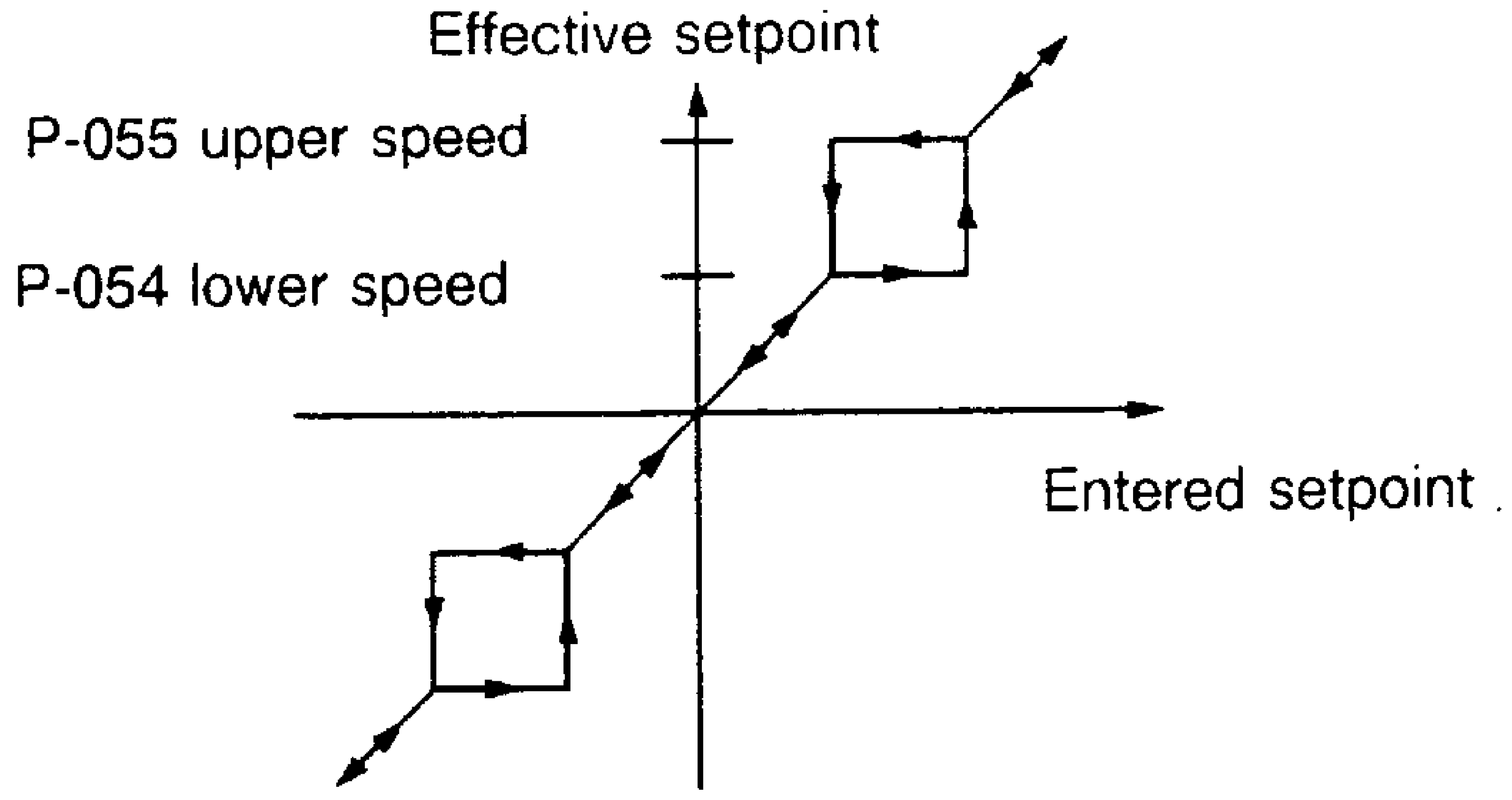
4.3.8 Steady-state minimum speed and speed range inhibit

A minimum speed can be specified in P-030. If the absolute value of the speed setpoint is less than the minimum speed, then the minimum speed with the sign of the speed setpoint is specified as setpoint. For a speed setpoint in the vicinity of zero, hysteresis prevents the polarity oscillating. The hysteresis width is equal to the minimum speed, however, a maximum of 200 RPM. Zero setpoint can only be forced when the speed is different than zero, via the ramp-function generator fast stop (terminal 81) or by removing the controller enable signal (terminals 64, 65) or via the freely-programmable "zero setpoint" terminal function. The setpoint is changed with the ramp-function generator time (P-016, P-042) between setpoint 0 and the specified minimum speed. The following diagram is used to explain the mode of operation in the vicinity of minimum speed.



P-030 Steady-state minimum speed
Default value: 0 RPM Units: RPM
Range: 0...29000 RPM
Sub-parameters: 1...4 (motor specific)

The speed range inhibit function permits the drive to be inhibited from operating under steady-state conditions at speeds in a range which can be parameterized. This range can only be run through, whereby the selected ramp-up and ramp-down times of the ramp-function generator (P-016, P-017, P-042, P-043) are effective. If the speed setpoint, increasing in absolute terms, is between the lower speed (P-054) and the upper speed (P-055) of the speed range inhibit, then the lower speed remains effective as setpoint, until the specified setpoint has reached the upper speed. For a decreasing speed setpoint, the upper speed (P-055) is first retained, until the setpoint has reached the lower speed (P-054). The following diagram illustrates the mode of operation of the speed range inhibit function.



P-054 Speed range inhibit, lower speed
P-055 Speed range inhibit, upper speed

Default value:	0 RPM	Units: RPM
Range:	0...29000 RPM	
Sub-parameters:	1...4 (motor-specific)	

4.4 Motor data

General information regarding the motor data is provided in Section 3.3.2 (start-up, motor data). Here, only individual motor data parameters are listed.

P-158 Inductance of the series reactor

Default value:	0.000 mH	Units: Millihenry
Range:	0.000...65.000 mH	
Sub-parameters:	1...4 (motor-specific)	

For special high-speed motors ($f_{max} \geq 150$ Hz), it is recommended that a series reactor is connected between the motor and converter to smooth the current. A zero is entered if a series reactor is not connected (for more detailed information refer to start-up, closed-loop control data Section 3.3.3).

P-159 Moment of inertia

Default value:	0.0 gm^2	Units: $gm^2 = 10^{-3}\ kgm^2$
Range:	0.0...6500.0 gm^2	
Sub-parameters:	1...4 (motor-specific)	
Note:	is changed using P-153 = +1, possibly with P-153 = -1 and with (P-204 = 5 and P-205 = 1)	

The total drive moment of inertia is entered using P-159 which is used to adjust the speed-torque pre-control. With P-153 = +1, a moment of inertia is always calculated, which approximately corresponds to the motor moment of inertia. The same calculation is executed with P-153 = -1, if P-159 was previously at zero. The total moment of inertia is adjusted using self-tuning P-204 = 5 and P-205 = 1 (refer to Section 3.3).

P-160 Rated motor output (rating plate data)

Default value:	Depending on P-096 at P-096 = 0: 0.00 kW	Units: kW
Range:	0.00...650.00 kW	
Sub-parameters:	1...4 (motor-specific)	

P-161 Rated motor current (rating plate data)
Default value: Depending on P-096 Units: A (RMS current)
at P-096 = 0: 0.00 A
Range: 0.00...650.00 A
Sub-parameters: 1...4 (motor-specific)

P-162 Rated motor voltage (rating plate data)
Default value: Depending on P-096 Units: V (phase-to-phase, RMS)
at P-096 = 0: 380.00 V
Range: 0...650 V
Sub-parameters: 1...4 (motor-specific)

P-163 Rated motor speed (rating plate data)
Default value: Depending on P-096 Units: RPM
at P-096 = 0: 1500 RPM
Range: 0...65000 RPM
Sub-parameters: 1...4 (motor-specific)

P-164 Rated motor frequency (rating plate data)
Default value: Depending on P-096 Units: Hz
at P-096 = 0: 50.00 Hz
Range: 0.00...650.00 Hz
Sub-parameters: 1...4 (motor-specific)

P-166 No-load motor current
Default value: Depending on P-096 Units: A (RMS current)
at P-096 = 0: 0.00 A
Range: 0.00...(max. converter current)
Sub-parameters: 1...4 (motor-specific)

Note: is changed by P-153 = +1 or (P-204 = 3 and P-205 = 1)

The no-load current is the current which flows at rated voltage, rated frequency and under no-load conditions (i.e. no load torque). It corresponds to the magnetizing current in the base speed range.

P-167 Stator resistance
Default value: Depending on P-096 Units: Ω
at P-096 = 0: 0.000 Ω
Range: 0.000...65.000 Ω
Sub-parameters: 1...4 (motor-specific)

Note: is changed by P-153 = +1

The stator resistance represents the induction motor winding resistance in one phase. The stator resistance can be determined by making a resistance measurement:
The resistance between two motor phases is 2 x the stator resistance.

P-168 Rotor resistance
Default value: Depending on P-096 Units: Ω
at P-096 = 0: 0.000 Ω
Range: 0.000...65.000 Ω
Sub-parameters: 1...4 (motor-specific)

Note: is changed by P-153 = +1 or (P-204 = 6 and P-205 = 1)

The rotor resistance is included in the slip calculation. For deep-bar, squirrel-cage rotors (refer to Section 3.3.4, post-optimization), the rotor resistance itself is a function of the slip, and cannot be identified without a position or speed encoder (P-204, P-205). A rotor resistance which is far too high can result in self-excited speed oscillations.

P-169 Stator leakage reactance

Default value:	Depending on P-096	Units: Ω
	at P-096 = 0: 0.000 Ω	
Range:	0.000...65.000 Ω	
Sub-parameters:	1...4 (motor specific)	
Note:	is changed by P-153 = + 1	

P-170 Rotor leakage reactance

Default value:	Depending on P-096	Units: Ω
	at P-096 = 0: 0.000 Ω	
Range:	0.000...65.000 Ω	
Sub-parameters:	1...4 (motor specific)	
Note:	is changed by P-153 = + 1	

The rotor leakage reactance is included in the pre-control for compensating the armature reaction (field weakening due to the torque-generating current). Incorrect values, within specific limits, are compensated by the field controller.

P-171 Main field reactance

Default value:	Depending on P-096	Units: Ω
	at P-096 = 0: 0.000 Ω	
Range:	0.000...650.00 Ω	
Sub-parameters:	1...4 (motor specific)	
Note:	is changed by P-153 = + 1 or (P-204 = 4 and P-205 = 1)	

The field setpoint is determined from the main field reactance and the no-load current. Grossly incorrect values can result in bad motor utilization or even stalling (F11). Self tuning (refer to Section 3.3.4) optimally sets both the no-load current and the main field reactance.

P-174 Maximum motor speed

Default value:	Depending on P-096	Units: RPM
	at P-096 = 0: 1500 RPM	
Range:	0...29000 RPM	
Sub-parameters:	1...4 (motor specific)	

P-174 is used, among other things to limit the speed setpoint and to inhibit the motor from running at excessive speeds. An additional, machining-specific speed limit is possible with P-029.

P-178 cos ϕ (rating plate)

Default value:	0.800	Units: Free
Range:	0.000...1.000	
Sub-parameters:	1...4 (motor specific)	

cos ϕ is used to calculate the no-load current (P-166) with P-153 = + 1. If cos ϕ is unknown, the no-load current can first be calculated using the default value (0.800). Self tuning (P-204, P-205, refer to Section 3.3.4) precisely determines the no-load current and thus compensates for any possible errors in cos ϕ.

4.5 Controller data

General information regarding the controller settings are provided in Section 3.3.4, Post-optimization. Here, all closed-loop control parameters are listed and their function described.

4.5.1 Current controller

P-036 Converter switching frequency
Default value: 0H Units: Hex
Range: 0...1H
Sub-parameters: 1...4 (motor-specific)

The converter switching frequency can be changed over using P-036; 0≙3.3 kHz and 1≙4 kHz switching frequency. By increasing the switching frequency, the current controller dynamic performance is increased, however, the continuous current load capability is reduced to approx. 80% of the rated converter current due to the higher switching losses (temperature rise!). It is recommended that P-036 is set to 1H for special, high-speed motors (f ≥ 150 Hz). The current controller should be re-adjusted after P-036 is changed (refer to Section 3.3.4, Post-optimization).

P-115 P gain of the phase current controller, base speed range
Default value: 2H Units: Hex (gain in the arithmetic format)
Range: 0 ...FH
Sub-parameters: 1...4 (motor-specific)

Note: is changed by P-153 = -1 or (P-204 = 1 and P-205 = 1)

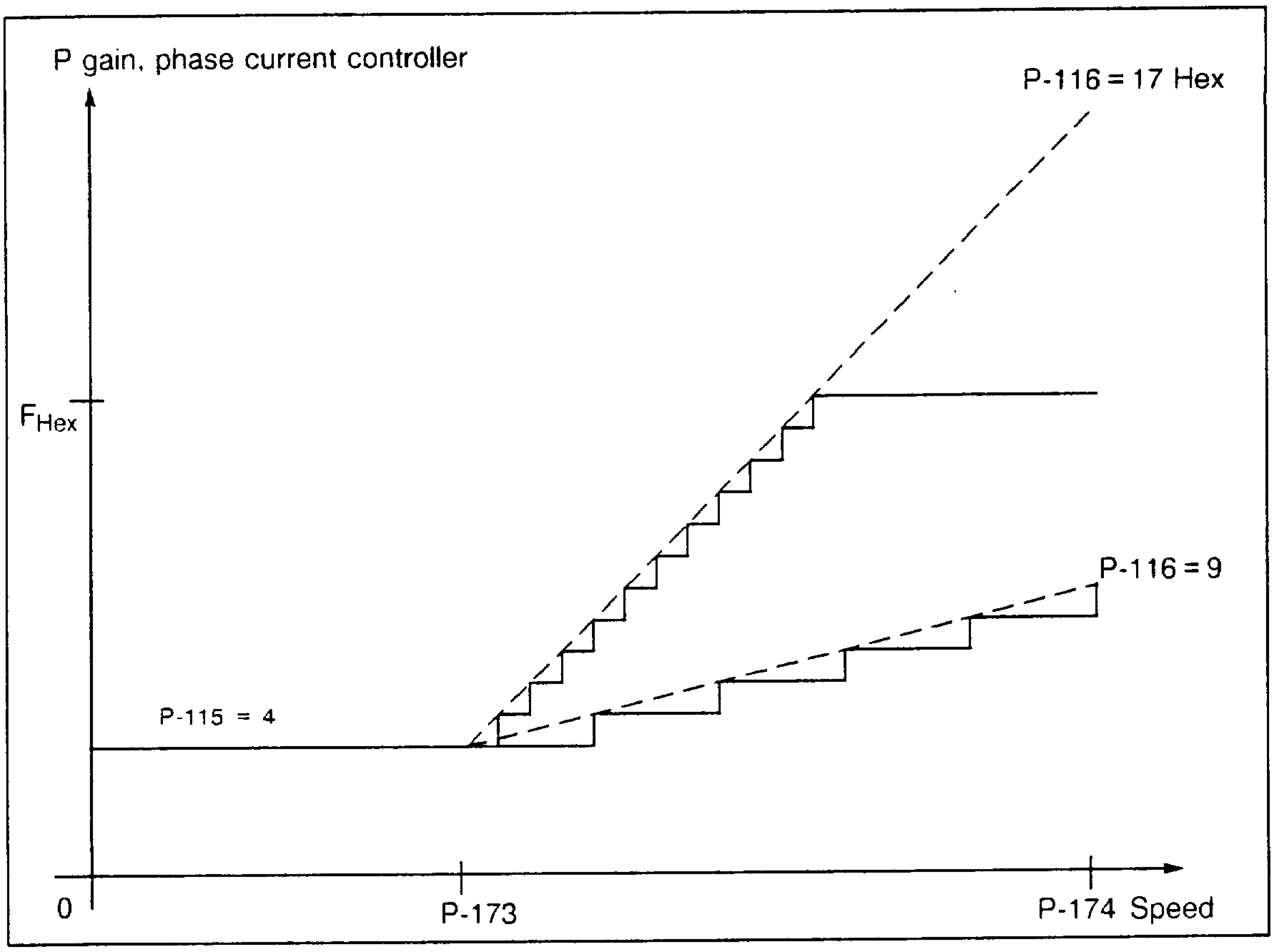
The correct phase current controller setting is decisive for the complete closed-loop control. Values which are too low can lead, under certain circumstances, to problems at high frequencies, and values which are too high, can lead to stalling in the closed-loop controlled mode (speed ≥ P-172 + 200 RPM). The motor noise also changes with the phase current controller setting. The whistling becomes louder (converter switching frequency) the higher P-115. If the motor emits crackling noises at standstill, with motor pulses enabled, then P-115 is far too high. 2H is always entered into P-115 when calculating the controller data with P-153 = -1. With P-204 = 1 and P-205 = 1, the current controller can be automatically set by the converter. The required setting is dependent on the motor, series reactor and the converter switching frequency. If a module with a different current rating is used, then other settings of P-115 are obtained (re-initialization is required anyway).

P-116 Phase current controller P gain in the field weakening range
Default value: 2H Units: Hex (gain in the arithmetic format)
Range: 0 ...FFH
Sub-parameters: 1...4 (motor-specific)

Note: is changed by P-153 = -1 or (P-204 = 1 and P-205 = 1)

The higher the counter EMF of the induction motor, then the lower is the effective loop gain of the current controller. Thus, it is recommended that the current controller gain is adapted at high speeds (in the field weakening range). The current controller gain is linearly increased above the field weakening speed (P-173), so that at maximum speed (P-174), the value of P-116 is reached. The maximum value of the current controller gain is FH. If a value greater than FH is set in P-116, then the maximum gain FH is already reached before maximum speed (refer to the following diagram).

 6SC6111-6AD76
SIMODRIVE 611 (BE)



Example of two different settings for P-116.

When calculating the controller data (P-153 = –1) and when self-tuning the phase current controller (P-204 = 1, P-205 = 1), P-116 is changed according to the following emperical formula:

$$(P\text{-}116) = \frac{(P\text{-}115) \cdot (P\text{-}174)}{(P\text{-}173)}$$

Possibly, somewhat higher values are both possible and more favorable in P-116. Values which are too large will lead to a tendency to stall in this case (F-11).

4.5.2. Speed controller

Speed controller settings are only effective in the closed-loop control range (speeds > P-172 + 200 RPM hysteresis). If speed controller gain adaption is selected (P-195 to P-203), P-031 settings have no effect. Instructions for setting the speed controller are provided in Section 3.3.4, Post-optimization.

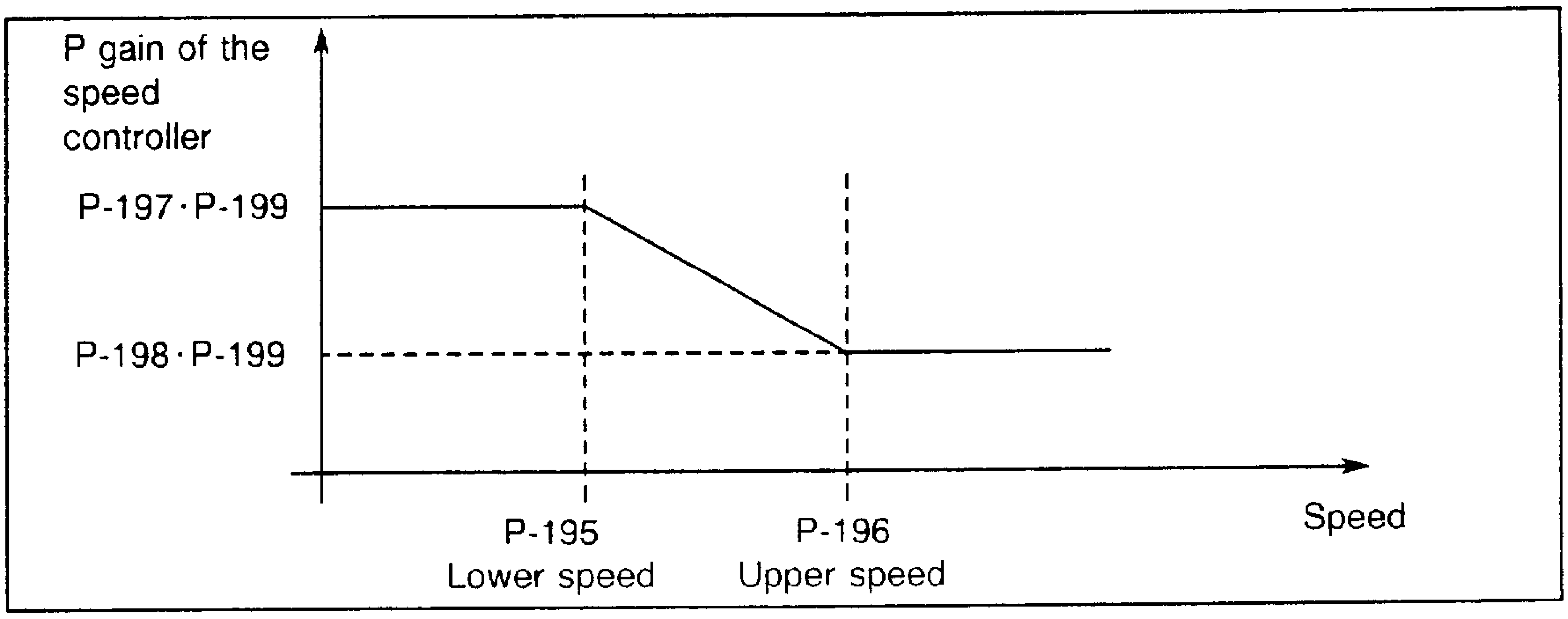
P-031 P gain, speed controller

Default value:	50.0	Units: Arithmetic format
Range:	0.0...327.6	
Sub-parameters:	1...4 (motor-specific)	
Note:	is changed by P-153 = –1	

P-032 Speed controller integral-action time
Default value: 140.0 Units: ms
Range: 10.0...600.0 ms
Sub-parameters: 1...4 (motor-specific)

Note: is changed by P-153 = –1

The speed controller adaption can be parameterized and switched-in using P-195 to P-199, P-203. The speed controller can only have a low P gain as the dynamic performance of the current controller decreases at higher frequencies. P-031 (P gain of the speed controller without adaption) must be set at maximum speed, so that the speed controller is stable over the complete speed range. However, in the lower speed range, the maximum possible dynamic performance is not attained. Using speed controller adaption, which increases the P gain in the lower speed range, optimum dynamic performance can be achieved over the complete speed range. The following diagram indicates the mode of operation.



P-195 Speed controller adaption, lower speed
P-196 Speed controller adaption, upper speed
Default value: 0 RPM Units: RPM
Range: 0...29000 RPM
Sub-parameters: 1...4 (motor-specific)

P-197 Speed controller adaption, P gain at the lower speed
Default value: 50.0 Units: Arithmetic format
Range: 0.0...327.6
Sub-parameters: 1...4 (motor-specific)

P-198 Speed controller adaption, P gain at the upper speed
Default value: 10.0 Units: Arithmetic format
Range: 0.0...327.6
Sub-parameters: 1...4 (motor-specific)

P-199 Speed controller adaption, factor for the P gain
Default value: 100 % Units: %
Range: 1...150 %
Sub-parameters: 1...4 (motor-specific)

The P gain of the speed controller adaption is reduced or increased over the complete range using factor P-199.

P-203 Activate speed controller adaption
Default value: 0 Units: (Logical changeover)
Range: 0...1
Sub-parameters: 1...4 (motor-specific)
0: No speed controller adaption → P gain from P-031 is valid
1: Speed controller adaption active → P gain from P-195 to P-199 is valid

4.5.3 Field controller

The field controller settings are only effective in the closed-loop control mode (speeds >P-172 + 200 RPM hysteresis). Field controller setting instructions are provided in Section 3.3.4, Post-optimization.

P-034 Field controller P gain
Default value: 40.0 A/Vs Units: A/Vs
Range: 0.0...600.0 A/Vs
Sub-parameters: 1...4 (motor-specific)
Note: is changed by P-153 = -1

P-035 Field controller integral-action time
Default value: 30.0 ms Units: ms
Range: 5.0...600.0 ms
Sub-parameters: 1...4 (motor-specific)
Note: is changed by P-153 = -1

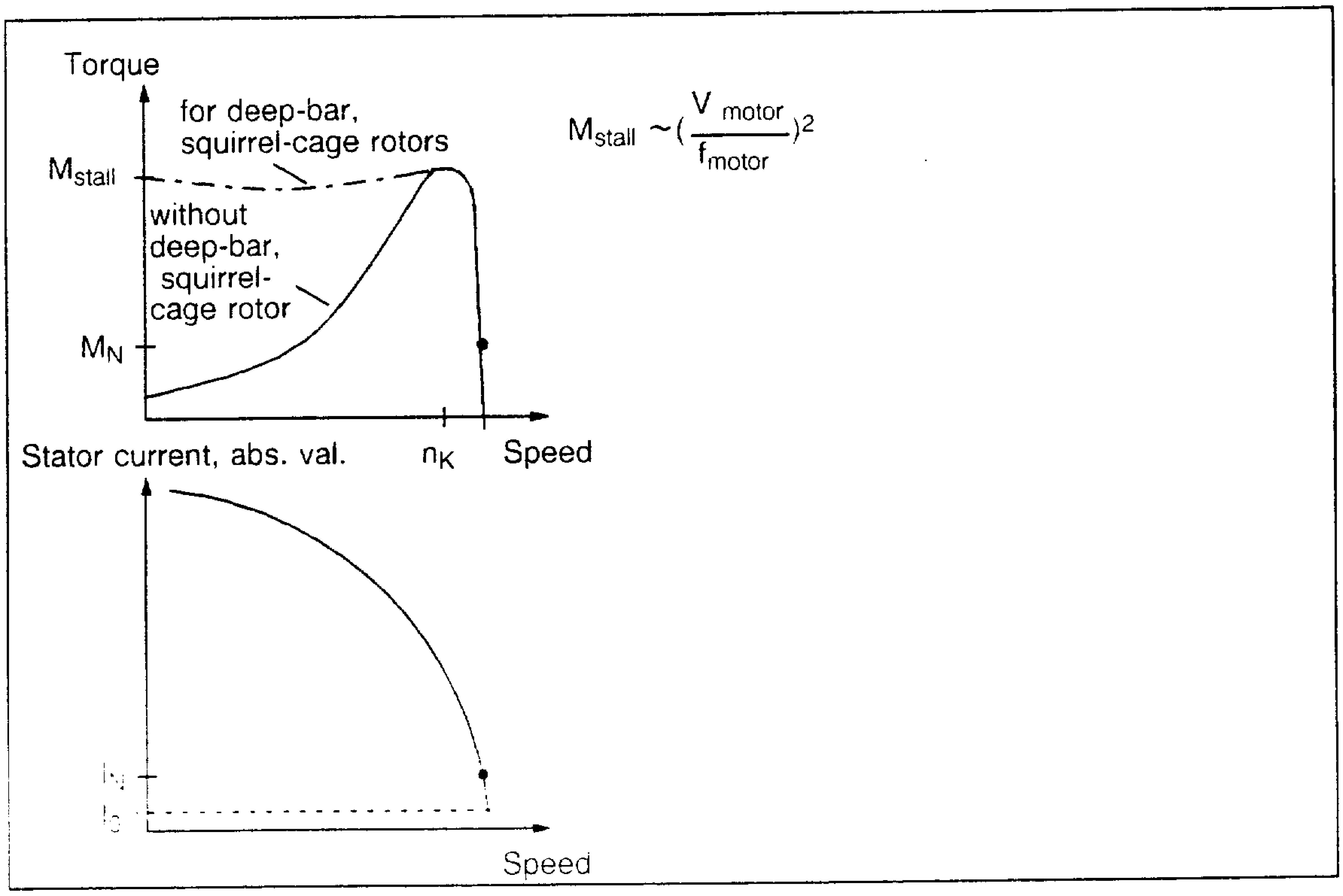
4.5.4 Other controllers

The moment of inertia (P-159) is used to adjust the speed-torque pre-control. If P-159 is correctly set, the setpoint is optimally adjusted (taking into account the set limits), without overshoot. Thus, the adjusted moment of inertia influences the transient response of the speed controller after a setpoint step. The parameter description is provided in Section 3.3.2, Motor data. The moment of inertia can be automatically adjusted (refer to Section 3.3.4, Post-optimization).

It is possible to operate induction motors in the field-weakening mode using field-oriented vector control. This is used to extend the motor speed range upwards, without increasing the motor voltage (which is in any case limited by the value of the DC link voltage). The optimum motor-converter utilization is obtained when the field is only weakened after the maximum converter voltage has been reached (minus the control reserve). A value for the field-weakening speed (P-173) is calculated by setting P-153 to -1. In order to prevent voltage limiting, the calculated value is generally lower than the optimum value. Instructions for setting the field weakening speed are provided in Section 3.3.4, Post-optimization. The field weakening speed and the constant power range are not linked (refer to Section 4.6, Limits).

P-173 Field weakening speed
Default value: 1500 RPM Units: 1500 RPM
Range: 0...29000 RPM
Sub-parameters: 1...4 (motor-specific)
Note: is changed by P-153 = -1

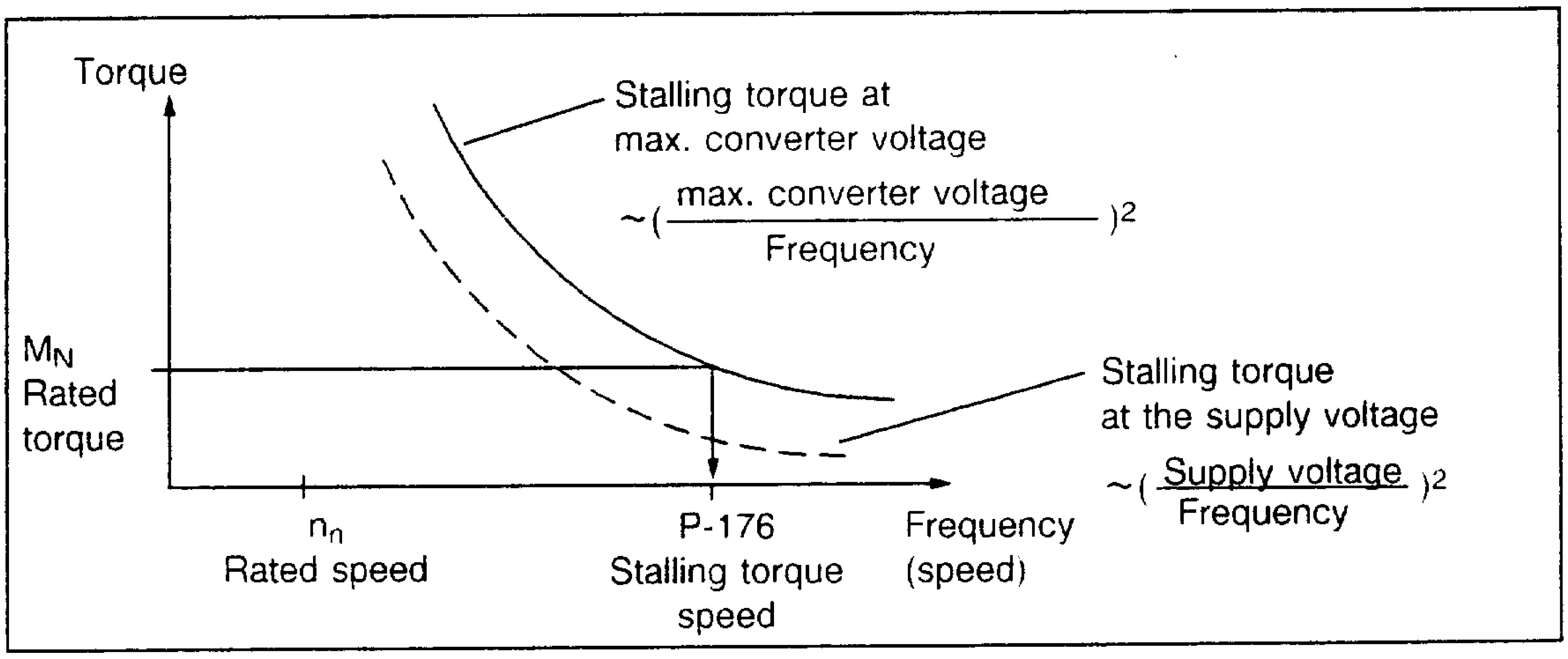
The following diagram indicates the general characteristics of the steady-state speed-torque characteristic of an induction motor connected to a stiff network as well as the associated absolute value of the stator current.



It can be seen, that there is the specific maximum torque M_{stall}, the so-called stalling torque. If the load torque is greater than the stalling torque and the stall speed n_K is fallen below, the induction motor torque rapidly decreases as the speed drops, although the current drawn increases significantly. For deep-bar, squirrel-cage rotors, the torque hardly decreases, but the current drawn still increases over-proportionally.

When the motor is operated from the induction motor module, the characteristics are completely different than when operated from a stiff network. In this case, the induction motor is operated with field vector control, and there is no stalling torque as is the case when connected to stiff networks, as long as the converter voltage is sufficient to impress the current setpoints. However, the stalling torque cannot be exceeded continually at the maximum converter voltage due to the available converter voltage. As the stalling torque increases as a square function of the voltage, and decreases as a square function with the frequency, the maximum possible torque of the induction motor module is greater than the stalling torque of the motor on a stiff network (as long as the supply voltage is < 420 V_{RMS}).

However, in the field-weakening mode, the torque must be appropriately limited, in order that the current controller doesn't go into voltage limiting, which would significantly reduce the controller performance. The stalling torque speed is set in P-176, which additionally limits the torque, in order to prevent the **voltage being limited due to the torque being established** (P-173, field weakening speed prevents voltage limiting due to the field!). The following diagram should clarify this:



P-176 is calculated by setting P-153 to -1. It is practical to check the calculated value if the motor is operated in the field weakening range and or overload conditions are permitted. P-176 can be increased as long as voltage limiting does not occur when accelerating from 0 to max. speed along the set torque limit (limiting only occurs when the torque is being established). Voltage limiting means that the current deviates significantly from a sinusoidal waveform and the motor torque surges. Fault F-11 (stall) can occur at voltage limiting.

P-176 Stalling torque speed

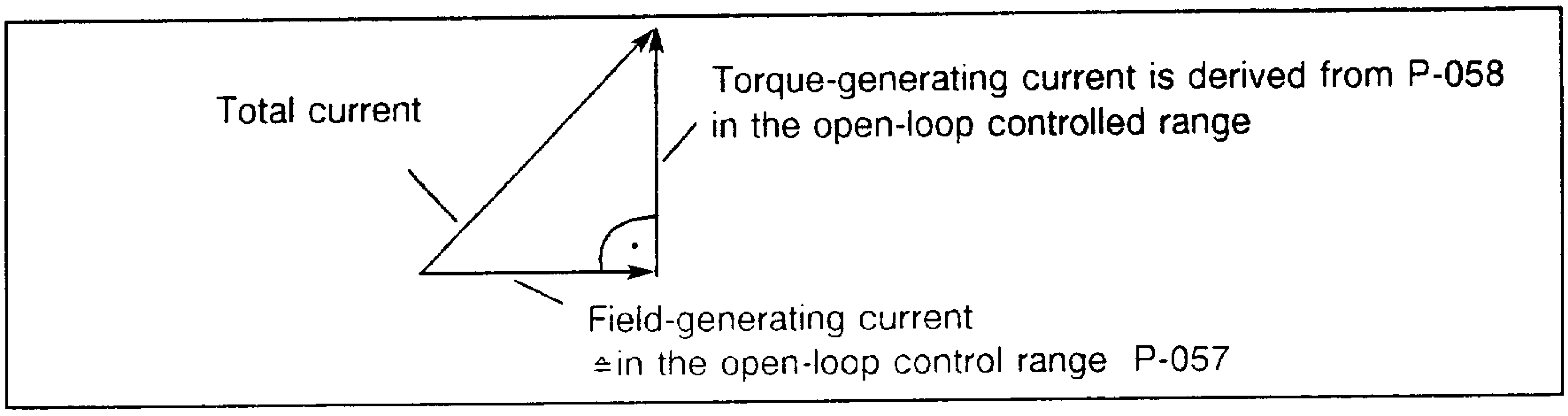
Default value:	32767 RPM	Units: RPM (speed)
Range:	0...65535 RPM	
Sub-parameters:	1...4 (motor-specific)	
Note:	is changed by P-153 = –1	

4.5.5 Open-loop control range

In Section 3.3.5 (setting the limits, open-loop control mode), it was explained, that in the lower speed range (P-172) open-loop current-frequency control is used. The reason is that at low speeds, the measured power values are so low and inaccurate, that field-oriented vector control based on these measured values is no longer possible.

The steady-state current in the open-loop controlled mode is parameterized with P-057. P-057 specifies the current which is input in the open-loop control range when the setpoint is reached. If rated torque is to be provided in the open-loop control range, then at least 100% (= rated motor current) must be entered in P-057. If no load torque is demanded in the open-loop control range, then a lower value can be entered into P-157, but at least the no-load current (approx. 60%) plus 20% reserve (= 80%).

Using the accelerating torque in the open-loop control range (P-058), and the moment of inertia (P-159), it is calculated how fast the frequency must be adjusted after a setpoint step in the open-loop control range. If the drive has to accelerate with a load torque, then less than 100% (≙rated motor torque) should be set in P-058, as the total torque is not available for accelerating. If the drive is to accelerate without load and if short accelerating times are required (due to overload during acceleration) P-058 can be increased up to the maximum of 399%. Please note that the torque limit (P-039 and P-041) are valid globally and an increase of P-058 is only effective, when the torque limit is also increased (P-039 and P-041). Both are true for the current limit. An increase in P-057 and/or P-058 are only effective, if the current limit is not activated. In this case, both components of the torque-generating current (~P-058) and the field-generating current (P-057) must be vectorially added in the open-loop control range, as shown in the following diagram (refer to Section 3.3.5). When the current limit becomes active, the torque-generating current is reduced. and the drive accelerates at a slower rate.



A transition is made into the closed-loop control range at speeds higher than P-172 (+200 RPM hysteresis). P-172 is calculated with P-153 = -1 (transition speed, closed-loop/open-loop control). Generally, the calculated value should not be changed.

P-057 Steady-state current in the open-loop control range

Default value:	100 %	Units: % of the rated motor current
Range:	0...150 %	
Sub-parameters:	1...4 (motor-specific)	
Note:	P-059 (current limiting) has higher priority than P-057	

P-058 Accelerating torque in the open-loop control range

Default value:	50 %	Units: % of the rated motor torque
Range:	0...399 %	
Sub-parameters:	1...4 (motor-specific)	
Note:	The torque limit (P-039 and P-041) and the current limit (P-059) have higher priority than P-058	

P-172 Transition speed, closed-loop/open-loop control

Default value:	300 RPM	Units: RPM (speed)
Range:	0...29000 RPM	
Sub-parameters:	1...4 (motor-specific)	
Note:	is changed by P-153 = -1	

4.6 Limits

Various limits can be set on the induction motor module, which are always simultaneously taken into account. If a motor overload is permitted for accelerating, generally speaking, more than one limit must be changed in order to have significant benefits. Please note, that the limits are partially motor-specific and partially machining-specific and are selected with the appropriate data set numbers.

P-029 Speed limits
Default value: 6000 RPM — Units: RPM
Range: 0...29000 RPM
Sub-parameters: 1...4 (motor-specific)

P-174 Maximum speed
Default value: Dependent on P-096 — Units: RPM
for P-096 = 0: 1500 RPM
Range: 0...29000 RPM
Sub-parameters: 1...4 (motor-specific)

P-029 and P-174 have the same effect, only that P-029 is selected with the machining-specific data set numbers and P-174 with the motor-specific data set numbers.

P-059 Current limit
Default value: 100 % — Units: % of the rated motor current
Range: 0...399 %
Sub-parameters: 1...4 (motor-specific)
Note: is automatically limited to the maximum converter current (caution when adjusting P-61, as under certain circumstances P-059 is changed)

P-039 1st torque limit
Default value: 100 % — Units: % of the rated motor current of the selected motor
Range: 0...399
Sub-parameters: 1...8 (machining-specific)

Using the freely-programmable terminals, it is possible to select the 2nd torque limit (P-041) instead of the 1st torque limit. The 2nd torque limit is effective, when the freely-programmable terminal "2nd torque limit" is active and the calculated actual speed exceeds the absolute value of P-050 (transition speed for the 2nd torque limit).

P-041 2nd torque limit
Default value: 50 % — Units: % of the rated motor torque of the selected motor
Range: 0...399
Sub-parameters: 1...8 (machining-specific)

P-050 Transition speed for the 2nd torque limit
Default value: 6000 RPM — Units: RPM
Range: 0...29000 RPM
Sub-parameters: 1...8 (machining-specific)

The motor active power can also be limited. This means, that above a specific transition speed, the torque limit must be reduced with a 1/n characteristic. For DC drives, for reasons of simplicity, the described transition speed is selected as the field-weakening speed (and this again the same as the rated speed). Thus, in the field-weakening range, the drive is automatically operated at constant power. However, this leads to inadequate voltage utilization of the motor which which must be achieved with an appropriately higher current and thus a higher rotor temperature rise. With the induction motor module, the field weakening (P-173) can be set independently of a power limit (P-060) and both independently of the rated speed (P-163), so that the maximum converter voltage (approx. 420 V_{RMS}) can be used.

P-060 Power limit

Default value:	100 %	Units: % of the rated motor output
Range:	0...399 %	
Sub-parameters:	1...4 (motor-specific)	

Please note, that when increasing the limits to shorten accelerating times, it is also practical to change the open-loop control range. A possible setting could for example look like this:

P-039 = 399 %	(torque limit)
P-057 = 100 %	(steady-state current, open-loop control)
P-058 = 399 %	(accelerating torque, open-loop control)
P-059 = (max. converter current)	(current limit)
P-060 = 399 %	(power limits)

With the limit settings indicated in the example, the drive is accelerated along the current limit (if the torque or power limit does not respond). With a lower current, significantly shorter accelerating times are obtained contrary to starting on a stiff network or for voltage-frequency converters, as the torque is established very fast. Please note, that the stalling torque transition speed (P-176) can additionally reduce the torque. However, P-176 can be generally increased, without voltage limiting occuring during torque build-up in the field-weakening range (refer to controller data, P-176), which permits even shorter accelerating times.

4.7 Key and control words

4.7.1 Braking to standstill without overshoot

The functions of the enable terminals are listed in Section 4.8. When the controller enable terminal (terminal 64 or terminal 65) is opened, the drive is braked with the set deceleration time (P-017, P-043), and when the internal minimum speed is fallen below (P-022), the motor pulses are cancelled. If bit 2 is set in P-053, the motor pulses are also cancelled with a ramp-function generator fast stop after the speed in P-022 is fallen below (internal minimum speed). The advanced cancellation of the motor pulses suppresses a direction of rotation reversal due to an overshoot when approaching zero speed.

P-022 Response value of the internal minimum speed for shutdown without overshoot
Default value: 8 RPM Units: RPM
Range: 0...16000 RPM
Sub-parameters: 1...4 (motor-specific)

P-022 should not be mistaken for P-021 (response value, minimum speed for the relay signal $|n_{act}| < n_{min}$).

4.7.2 Initialization

Initialization was already described under start-up (Section 3.3.1). Initialization is only possible when P-095 is displayed immediately after the converter has been switched-on. This is the case, if a new software module is used, or if an already initialized software module is appropriately prepared (refer to the following table). Before initialization, a number for the current rating of the converter (converter number) is entered into P-095. Further, the motor data can be loaded from a stored list, by entering the associated numbers in P-096 (motor loading can first be used in software releases later than 3.0 as at the present time the list only has a few motor types). If the motor to be used is not included in the list, zero should be left in P-096, and the motor data manually entered. Initialization is started by entering a 1 into P-097 (the display then indicates "INITIAL"), and the write protection key of the software module is then depressed. At initialization, defined values (default values) are written into the EEPROM (non-volatile memory). The software module LED is lit during writing. The LED goes dark and P-000 is displayed once writing has been completed.
With an already initialized software module, the initializing mode can be selected by re-setting P-097 to 0 (if necessary, disable the write protection with P-051 = 4H), and this change is stored in the EEPROM by setting P-052 to 1 and depressing the write protection button of the software module. Please note, that all previous settings are lost. After the software module LED goes dark, the initializing mode is selected by switching the unit off and on again. Please note, that changes in P-095 and P-096, are only effective in the initializing mode. Both of these parameters cannot be changed in the normal mode.

P-095 Converter code number
Pre-initialization: 7 (significance of the number, refer to the table)
Range: 4...9

Note: Can only be adjusted in the initializing mode

Module	Current	Number
6SC6110-5DA00	5/7 A	4
6SC6111-5DA00	15/20 A	5
6SC6112-4DA00	24/32 A	6
6SC6113-0DA00	30/40 A	7
6SC6114-5DA00	45/60 A	8
6SC6116-0DA00	60/80 A	9

P-096 Motor code number
Pre-initialization: 0
Range: 0...6 (software release 3.0)
Sub-parameters: 1...4 (motor-specific)

Note: Can only be changed in the initializing mode

(for software release 3.0. is only installed for test purposes)

P-097 Start initialization
Pre-initialization: 0
Range: 0...1
Significance in the initializing mode: Initialization is started by changing from 0 to 1 and depressing the write protection button
Significance in the normal mode: Initializing mode is generated by changing from 1 to 0, saving (P-052) and switching off and on. In this case, all previous settings are lost.

The converter goes into the initializing mode after the software or EEPROM has been replaced.

4.7.3 Memory functions

WARNING

The RAM memory area cannot be protected from a write access. Thus, when certain memory locations are changed, this can, under certain circumstances, result in considerable damage. The functions for writing into the memory should therefore be carefully handled by trained personnel.

After switch-on, the contents of the EPROMs and EEPROMs (non-volatile memories) are loaded into the converter RAM memory. All parameter changes are first realized in the RAM and are immediately effective, but however are lost after switch-off, if they haven't been stored in the EEPROM (P-052). The contents of each individual 16-bit memory location can be viewed and (in case they can be written into) can be changed using P-249 to P-253. Memory operations are also possible via the serial interface (refer to Section 4.3.8).
The RAM area cannot be protected from a write access. Thus, when specific memory locations are changed this can lead, under certain circumstances, to considerable damage. The functions for writing into the memory should therefore be handled carefully by trained personnel. Parameters P-249 to P-253 are thus provided with a special write protection 10H in P-051/P-151. The segment address of the applicable segment area is entered into P-249 (data segment address: 0H). The (offset) address of the required memory location is changed using P-250. The existing contents of the memory location are displayed in P-251. The desired new contents are entered into P-252 but are only transferred when the transfer is started with P-253. A +1 in P-253 results in the value being transferred once into P-252, and then P-253 is automatically reset to 0. If −1 is entered into P-253, the value of P-252 is continually written into the memory location of the selected address. If the write sequence is to be terminated, P-253 must be manually reset to 0. It is also possible to set P-253 to −1, and the value to be written-in, changed using P-252; this change is then immediately effective.

P-249 Segment address of the memory location
Default value: 0H Units: Hexadecimal (segment address 0≙data segment)
Range: 0...FFFFH

P-250 Address (offset) of the memory location
Default value: 0H Units: Hexadecimal (address)
Range: 0...FFFFH

P-251 Memory contents display of the memory location addressed with P-249, P-250 (16 bit)
Display parameter Units: Hexadecimal (arithmetic format)
Range: 0...FFFFH

P-252 Value to be transferred with the memory location addressed using P-249, P-250 (16 bit)
Default value: 0H Units: Hexadecimal (arithmetic format)
Range: 0...FFFFH

P-253 Transfer control for writing into memory locations
Default value: 0 Significance:
0: Inactive
+1: Written into once (is automatically reset to 0)
−1: Is continually written into (must be manually reset)
Range: −1... +1

4.7.4 Other control parameters

P-051/P-151	Write protection		
	Value after switch-on:	0H	Significance: 4H, write protection cancelled 10H, special write protection cancelled
	Range:	0...7FFFH	

The parameters can only be changed if the write protection in P-051 or P-151 has been disabled. Several safety-relevant parameters can only be changed with special write protection. The changed parameters are immediately effective, however are lost at switch-off, if they are not first stored in the EEPROM (P-052). To store in the EEPROM, among other things, the hardware write protection must be disabled by depressing the write protection button on the software module. The hardware write protection button protects the EEPROM (non-volatile memory), P-051/P-151 protects the RAM.

P-052/P-152	Store the parameterization in the EEPROM		
	Value after switch-on:	0H	Significance: 0 inactive Store 1 parameter
	Range:	0...1H	

Changed parameters are immediately effective, but are however lost at switch-off, if they were not stored in the EEPROM prior to this. To realize this, a 1 must be entered into P-052 or P-152 and the software module write protection button depressed. If the write protection button is not depressed, fault message F-26 appears, which is acknowledged by depressing the write protection button. During writing, the software module LED is lit, and the unit cannot be switched-off while it is lit, as otherwise the initialization mode is entered after the unit is switched-on again. The LED goes dark when writing is completed.

P-053	Control bits		
	Default value:	1H	Units: Hexadecimal (logical switch)
	Range:	0...FFFFH	

Various control functions can be selected by setting the individual bits of P-053. Naturally, all control functions can be combined. Please note, that four bits are combined to a hexadecimal position.

Significance of the individual bits:

Bit 0: If the least-significant bit is set to 1, the ready relay is activated as long as there is no fault condition. If bit 0 is 0, the ready relay only pulls-in if a fault condition is not present and the converter pulses are enabled.

Bit 1: If bit 1 is set, the motor parameter set is changed over immediately after a request for a motor changeover via freely-programamble terminals ("motor selection") or P-056. Otherwise, a motor changeover after a request is only effective, when the motor pulses were cancelled. The user can select the enable terminals for pulse cancellation (terminals 63, 64, 663, 65, and possibly 81) (refer to enable terminals, Section 3.2, refer to motor data, Section 3.3.2).

Please note that the motor feeders must not be disconnected when the motor pulses are enabled. When bit 1 is set, the functions for motor changeover are only used for parameter adaption **of a** motor.

Bit 2: If bit 2 is set, and the ramp-function generator fast stop (terminal 81) is activated, the motor pulses are cancelled when the absolute value of the internal minimum speed is fallen below (P-022). In the other case (bit 2 deleted), the motor pulses are never cancelled for a ramp-function generator fast stop.

Bit 3: If bit 3 is set, the ramp-function generator is corrected (tracking), otherwise not. The ramp-function generator tracking function is explained in Section 4.3.3.

(Bit 4: Not assigned)

Bit 5: If bit 5 is set, a fault signal can be acknowledged by opening and closing the controller enable terminal (terminal 65).

(Bit 6: Not assigned)

Bit 7: Bit 7 defines from which speed, the actual speed is searched for, if pulse enable has been issued (terminals 663 and 63 closed) and all other remaining enable signals are available prior to this (terminals 64, 65, 81, "setpoint enable"). If bit 7 is set, the actual speed is searched for starting from zero. This means, that a pulse enable causes the motor to be first braked and the open-loop control range run through. If bit 7 is deleted, the actual speed is searched for starting from the specified setpoint. The open-loop control range is in this case generally no longer run through. Thus, problems can occur when the pulse enable is issued with either the motor stationary, or with the motor rotating in the opposite direction of rotation than that specified by the setpoint. Generally however, these problems are normally handled so that accelerating times are significantly shorter than if the motor would first be braked. Many users, when changing over the motor only remove the pulse enable, let the motor coast down, and then switch to an already rotating motor. In this case, the user should check as to whether reliable acceleration is realized with bit 7 cancelled after a renewed pulse enable, otherwise bit 7 should be set.
Independent of bit 7, the actual speed is always searched for starting from zero, if pulse enable (terminals 63, 663) is provided before controller enable (terminals 64, 65) or before withdrawing the ramp-function generator fast stop (terminal 81) or the "setpoint enable".

(Bit 8: If bit 8 is deleted, the field controller integral action time is deleted, if voltage limiting occurs. Thus, voltage limiting can be possibly exited again. If bit 8 is set, the field controller integral action time is not influenced by the voltage limiting. However, in this case voltage limiting leads to a continuous increase of the field-generating current, so that voltage limiting can no longer be automatically exited.)

P-056 Motor selection
Default value: 0 Significance:
0≙Motor selection using the freely-programmable terminals (P-081...P-089)
1...4: Motor selection with entered number
Range: 0...4

P-056 can be used for changing over the motor during start-up, if the terminals are not used for changeover . The calculations with P-153 are only effective for the currently selected motor, so that a motor changeover is necessary when commissioning several motors on an induction motor module.

P-061 Fixed DC link voltage
Default value: 0 Significance:
0≙DC link voltage is initiated via the equipment bus (X151)
1...700: Permanently input DC link voltage in volts when operated from the monitoring module
Range: 0...700

If the induction motor module is connected to the equipment bus (X151) of an infeed/regenerative feedback module, the instantaneous value of the DC link voltage can be read-in and conditioned. The value of the DC link voltage is displayed using P-006 (DC link voltage display) if there is a zero in P-061. The monitoring module does not provide any information regarding the DC link voltage via the converter bus, so that when operating the induction motor module on the equipment bus of a monitoring module, the DC link voltage value must be entered as constant in P-061. If P-061 is not equal to zero, then the value of P-061 is displayed in P-006 (DC link voltage display).

P-090 Display format - control parameters

Default value:	1H	Significance: 0 ≙ Display in hexadecimal, range limits are ineffective 1 ≙ Display as described, decimal or hexadecimal
Range:	0...1	

All parameters are displayed in hexadecimal and the range limits can be exceeded by deleting bit 0 of P-090. This function should only be used by trained personnel as damage can be caused when the range limits are exceeded.

P-153 Calculate motor data/controller data

Default value:	0	Significance: 0 ≙ Inactive 1 ≙ Calculate motor data –1 ≙ Calculate controller data
Range:	–1... + 1	
Note:	Parameters for the motor and for the controller data of the selected motor data set are changed using P-153 = + 1 or P-153 = –1.	

If only the rating plate data (P-160, P-161, P-162, P-163, P-164, P-178) is known for the motors, then the additionally required motor data (P-159, P-166, P-167, P-168, P-169, P-170, P-171) are roughly calculated by setting P-153 = + 1. P-153 is then automatically reset to 0.
The calculation is only effective for the currently selected motor data set.
Additional information can be entered after the calculation. If all of the motor data (with the exception of the moment of inertia and cos ϕ) are known, the motor data calculation is unnecessary and it should be entered manually (refer to Section 3.3.2, motor data). The controller data (P-159 if previously 0, P-031, P-032, P-034, P-035, P-115, P-116, P-172, P-173, P-176) are roughly calculated from part of the motor data and P-174 (max. speed) and P-158 (series reactor) and internal quantities, and P-014 (setpoint reference speed) is assigned the value from P-174 (max. speed). Also in this case, the calculation is only made for the currently valid motor data set. P-153 is automatically reset to 0 after the calculation. Automatic or manual post-optimization can bring improvements and should thus be subsequently made (refer to Section 3.3.3, Controller data, and the following section).
The procedure is as follows when starting-up a motor, where only the rating plate data is known:

- Initialization
- Cancel write protection
- Enter rating plate data (P-160, P-161, P-162, P-163, P-164, P-178)
- Enter additional data (P-174, P-158)
- P-153 = + 1
- P-153 = –1
- Post-optimization

P-204 Function selection, post optimization

Default value: 0		Significance: 0: Inactive 1: Setting the current controller, P-115, P-116 2: Compensating the offset of the power sensing 3: Identification of the no-load current, P-166 4: Identification of the main field reactance, P-171 5: Identification of the moment of inertia, P-159 6: Identification of the rotor resistance, P-168
Range:	0...6	
Note:	The applicable parameters are changed with a post-optimization run.	

P-205 Starting post-optimization

Default value:	0	Significance: 0: Inactive 1: Start
Range:	0...1	
Note:	The parameters involved are changed using post-optimization.	

P-204 and P-205 are used for handling the post-optimization functions. In order to prevent the self-tuning values being accidently selected, both of these parameters are provided with a special write protection 10H in P-051/P-151. A number for the required function is entered into P-204, which is started by setting P-205 to 1. A prerequisite is that all enable signals are available, and the motor has no opposing load torque.

The speed or current setpoints are specified from the optimization software, whereby speeds up to the maximum speed are used, if no limits are made with P-029. All of the other limits and the ramp-function generator remain active (exception: current limiting when identifying the no-load current). During self-tuning, the parameter involved - if available - is displayed and the actual tuning procedure can be monitored. It is changed until the desired setting has been found, or the search sequence is terminated with a fault message (F-60). During self-tuning " □ " is displayed as setpoint source at the fifth position from the left of the operating display (P-000, P-100), and P-113 (setpoint selection) is at 10 (setpoint from the post-optimization).

When the enable terminals (terminals 63, 64, 65, 663, 81) are opened, the drive is braked to standstill and the motor pulses cancelled. As soon as the motor pulses are cancelled, the search sequence is terminated with the fault message F-60. A search sequence, which is not successful or is not completed, can be terminated by opening the pulse enable terminal (terminal 63, terminal 663). P-205 is automatically reset to 0 when the search sequence has been completed, the setpoint selection (P-113), and the operating display are restored. The duration of a search sequence is generally less than one minute. For motors with deep-bar, squirrel-cage induction rotors (standard motors), the rotor resistance identification must not be selected (P-204 = 6). If self-tuning is aborted with F-60, the start value is re-entered into the parameter. A bit is set in P-020 for every successfully executed self-tuned function, so that later it can be determined which self-tuning values have already been executed. Refer to Section 3.3.4 for more information regarding post-optimization.

4.8 Freely-programmable terminal functions

Terminals E1 to E9 can be assigned per software to various functions via parameters P-081 to P-089. The selected functions are displayed in parameters P-254 and P-255, and the selected terminals in parameter P-011. The table indicates the assignment of the numbers to be entered in P-081 to P-089 and the associated terminal function.

Number in P-081 to P-089	Associated terminal function	Assignment after initialization
1	Torque limit 2	P-081 (E1)
2	Oscillation	-
3	Fault memory reset	P-083 (E3)
4	Reserved	-
5	Reserved	-
6	Reserved	-
7	Zero ramp-up time	P-082 (E2)
8	Reserved	-
9	Gearbox stage/machining-specific parameter bit 0	P-087 (E7)
10	Gearbox stage/machining-specific parameter bit 1	P-088 (E8)
11	Gearbox stage/machining-specific parameter bit 2	P-089 (E9)
12	CW CCW phase sequence	-
13	Ramp-fnct. gen. 2	-
14	Increase setpoint } Motorized pot. fnct.	-
15	Decrease setpoint } Motorized pot. fnct.	-
16	Setpoint enable	-
17	Fixed setpoint, bit 0	P-084 (E4)
18	Fixed setpoint, bit 1	P-085 (E5)
19	Fixed setpoint, bit 2	P-086 (E6)
20	Motor selection, bit 0	-
21	Motor selection, bit 1	-

A terminal (terminal E1 to terminal E9) is considered closed, if it is connected to the enable voltage (terminal 9), or if a voltage from +13 V to +33 V, with respect to the enable signal ground (terminal 19) of the infeed/regenerative feedback module is connected at its input. A freely-programmable terminal function is active when it is connected to one of the freely-programmable terminals, and this terminal is closed. A freely-programmable terminal is inactive if it is connected to a freely-programmable terminal which is however open, or if it is not assigned to any of the freely-programmable terminals.

P-081 to P-089 Freely-programmable terminal functions
Default value: Refer to Table Significance: Refer to Table
Range: 1...21

Several freely-programmable terminals should not be assigned the same function, as the function will then be executed by the identically assigned terminal due to OR'ing. The functioning of the individual terminal functions is now described.

4.8.1 2nd torque limit

The 2nd torque limit is selected with P-041. If the terminal function is active, the 2nd torque limit is effective, if the absolute value of the speed actual value (calculated value) is greater than the value in P-050 (refer to Section 4.6).

4.8.2 Oscillation

If the oscillation terminal function is active, the speed setpoint from the oscillation generator is effective, if a setpoint with a higher priority is not present (e.g. motorized potentiometer, setpoint-, controller enable or ramp-function generator fast stop). The oscillation generator is parameterized using parameters P-154 to P-157.

P-154 Oscillation setpoint 1
P-155 Oscillation setpoint 2
P-156 Oscillation setpoint time 1
P-157 Oscillation setpoint time 2

4.8.3 Fault acknowledgement

A fault message is displayed when faults occur, and the motor pulses are cancelled. Generally, faults can be acknowledged only after first opening the controller enable terminal (terminal 65). Acknowledgement can be realized by depressing the "P" key, by closing the freely-programmable "fault acknowledge" terminal, by closing the "central reset" terminal (terminal R) of the infeed/regenerative feedback unit and the monitoring module or by switching the equipment off and on again. If bit 5 of P-053 is set, it is sufficient to open and close the controller enable terminal (terminal 65) for acknowledgement. If the fault cause has not been removed, the fault can re-appear after acknowledgement. After successful acknowledgment, the fault message disappears, and the motor pulses can be re-enabled.

4.8.4 0 ramp-up time

If the freely-programmable "0 ramp-up time" terminal is active, the drive is accelerated without ramp-function generator in the shortest time, only taking into account the selected limits; otherwise, the setpoint is entered with the selected ramp-up and ramp-down times (P-017, P-018, P-042, P-043).

4.8.5 Machining-specific parameters, gearbox stage

In order to take into account differences between the various machining procedures, limits (P-029, P-039, P-041) and relay functions (P-021, P-023, P-027, P-047, P-050), can be parameterized for eight different machining sequences (machining-specific data). The currently valid machining-specific data sets are selected - binary coded - using the freely-programmable terminal functions "machining-specific parameters" bit 0 to bit 2. If none of these terminals are active, the machining-specific data set 1 is valid. The 6th position from the left of the operating display (P-000/P-100) indicates the number of the currently selected machining-specific data set. When changing over the motor-specific data, the valid machining-specific data set is not changed, however, changes can occur due to the changed reference quantities (the torque limit is, for example, specified as a percentage of the rated motor torque).

Terminal function, machining-specific parameters			Associated machining-specific data set number
Bit 2	Bit 1	Bit 0	
0	0	0	1
0	0	1	2
0	1	0	3
0	1	1	4
1	0	0	5
1	0	1	6
1	1	0	7
1	1	1	8

1 ≙ Terminal function active
0 ≙ Terminal function inactive

4.8.6 Clockwise/counter-clockwise rotation

For several applications it might be necessary to permit only one direction of rotation. If the "clockwise/counter-clockwise" function is applied to one of the freely-programmable terminals. when the setpoint is input, only values with a positive sign are accepted, negative values are limited to zero. The polarity of the effective setpoint is defined via the "clockwise/counter-clockwise" terminal. If this terminal is active, counter-clockwise direction of rotation is specified, otherwise clockwise direction of rotation. A prerequisite is that the U, V, W motor terminals are connected to the appropriate U, V, W terminals of the induction motor module. If two motor terminals are interchanged, this also leads to a direction of rotation reversal, so that the "clockwise/counter-clockwise" terminal function is inverted. For motor changeover with pulse enable cancellation (terminals 63, 663) and when the "clockwise/counter-clockwise" terminal is simultaneously actuated (other direction of rotation), bit 7 of P-053 should be set, in order to prevent the drive accelerating with the false direction of rotation
(refer to Section 4.7.4).

4.8.7 Ramp-function generator 2

The speed setpoint can be set with ramp-up and ramp-down times which can be specified (P-016, P-017, P-042, P-043). Two parameter sets for ramp-up and ramp-down times are provided, which can be changed over with the freely-programmable "ramp-function generator 2" terminal function. If this terminal is energized, the ramp-up and ramp-down times of the 2nd ramp-function generator (P-042, P-043) are effective.

4.8.8 Motorized potentiometer function

The motorized potentiometer function can be used to enter a setpoint. The setpoint can then be adjusted via the freely-programmable terminal functions "increase setpoint" and "decrease setpoint" the rate of change is specified by the currently valid ramp-up and ramp-down times (P-016, P-017 or P-042, P-043), which are even effective, if the "0 ramp-up time" terminal function is selected. If both motorized potentiometer terminal functions are simultaneously active, the setpoint is adjusted towards zero. 6 must be entered into P-113 to select the motorized potentiometer setpoint. The motorized potentiometer setpoint can be displayed and adjusted in P-114.8. When writing into the EEPROM, the motorized potentiometer setpoint is stored.

4.8.9 Setpoint enable

If one of the freely-programmable terminals is assigned the "setpoint enable" terminal function and is opened, zero setpoint is input with the highest priority. The drive brakes with the selected ramp-down time (P-017, P-043), and comes to a standstill with the pulses still enabled. If the "setpoint enable" function is active, the entered setpoint is effective, if all other remaining enable signals are provided (terminals 63, 64, 663, 65, 81).

4.8.10 Fixed setpoints

Using the freely-programmable terminal functions "fixed setpoints", bit 0 to bit 2, seven stored fixed setpoints (P-114.1 to P-114.7) can be selected. If all fixed setpoint terminal functions are inactive, the standard setpoint is effective (if a setpoint with a higher priority has not been selected). In the other case, one of the fixed setpoints - binary coded - is used (if no setpoint with a higher priority is available), as is indicated in the following table (refer to Section 4.3.1, Section 4.3.5).

Terminal function, fixed setpoint			Selected setpoint (if no higher-priority setpoints are available)	Parameter
Bit 2	Bit 1	Bit 0		
0	0	0	Standard setpoint	P-113
0	0	1	1	P-114.1
0	1	0	2	P-114.2
0	1	1	3	P-114.3
1	0	0	4	P-114.4
1	0	1	5	P-114.5
1	1	0	6	P-114.6
1	1	1	7	P-114.7

1 ≙ Terminal function active
0 ≙ Terminal function inactive

4.8.11 Motor selection

With the induction motor module, the complete data sets from four motors can be simultaneously parameterized (motor-specific data). The required motor data set is selected - binary coded - via the terminal functions "motor selection" bit 0 and bit 1, if 0 is entered into P-056, otherwise selection is realized via P-056. As it is generally not practical to changeover a motor under current, the associated motor data set is normally only valid after a changeover request, when the motor pulses have been cancelled. The user himself can decide which of the enable terminals is used for pulse cancellation. While the motor data is being changed-over (approx. 20 ms), pulse cancellation is interlocked. The interlock can then be cancelled, and the freely-programmable relay "motor <No.> active" of the associated motor pulls-in if it has been programmed. This relay signal can be used to control a contactor for the motor terminal changeover. The currently valid motor data set is displayed in the first position from the left of the operating display (P-000/P-100). If bit 1 is set in control parameter P-053, motor data sets are also changed over even with the pulses enabled.

Terminal function Motor selection		Motor data set No. if P-056 = 0
Bit 1	Bit 0	
0	0	1
0	1	2
1	0	3
1	1	4

1 ≙ Terminal function active
0 ≙ Terminal function inactive

4.9 Freely-programmable relay functions

The induction motor module has six freely-programmable relays (terminals A11 to A61). If a relay function is active, the associated relay output (terminals A11 to 61) is connected to the common center contact (terminal 289). The individual relays can be assigned to various signaling functions by entering a number via parameters P-241 to P-246. Using P-247, the mode of operation of the six freely-programmable relays can be individually inverted. Each segment is assigned to a relay in the second position from the left of the operating display (P-000/P-100), which is lit when the associated relay has pulled-in. The following table indicates the assignment of the numbers to be entered into P-241 to P-246, and their signaling functions as well as the initialized value.

Number in P-241...P-246	Associated signaling function of the appropriate relay	Assignment after initialization
1	$\lvert n_{act}\rvert < n_{min}$	P-243 (term. A31)
2	Ramp-up completed	P-246 (term. A61)
3	$\lvert M_d\rvert < M_{dx}$	P-242 (term. A21)
4	$\lvert n_{act}\rvert < n_x$	P-244 (term. A41)
5	I^2t pre-alarm	P-245 (term. A51)
6	Heatsink overtemperature	–
7	Variable relay function 1 (P-185 ... P-189)	–
8	Variable relay function 2 (P-190 ... P-194)	–
9	Reserved	–
10	Reserved	–
11	Motor 1. active	–
12	Motor 2. active	–
13	Motor 3. active	–
14	Motor 4. active	–
15	Reserved	–
16	Reserved	–
17	Reserved	–
18	Reserved	–
19	Reserved	–
20	$n_{act} = n_{set}$	P-241 (term. A11)

P-241...P-246 Freely-programmable relay functions
Default value: Refer to Table   Significance: Refer to Table
Range: 1...20

WARNING
When the motor pulses are cancelled, there is no motor speed data. The calculated speed actual value is then set to 0. Thus, all relay signals, which monitor the speed ($\|n_{act}\| < n_{min}$, acceleration completed, $\|n_{act}\| < n_x$, $n_{act} = n_{set}$) provide no useful information when the motor pulses are cancelled. The motor pulses can be cancelled by withdrawing enable signals or as a result of fault signals.

4.9.1 Relay function, $|n_{act}| < n_{min}$

Machining-specific speed thresholds can be entered using P-021. If a relay is assigned this signal, it pulls-in when the absolute value of the calculated speed falls below the currently selected n_{min} threshold of P-021. In this case, a hysteresis of 2 RPM is effective (it can be changed and stored in the EEPROM: Address EA4H, entered in the arithmetic format 29296 RPM≙7FFFH). The n_{min} threshold should not be confused with the internal minimum speed (P-022) for smooth shutdown without overshoot.

P-021 Threshold for relay function $|n_{act}| < n_{min}$
Default value: 10 RPM Units: RPM (speed)
Range: 0...16000 RPM
Sub-parameters: 1...8 (machining-specific)

4.9.2 Acceleration completed, $n_{act} = n_{set}$, $|M_d| < M_{dx}$

The relay function, acceleration completed, $n_{act} = n_{set}$ and $|M_d| < M_{dx}$ are logically combined and therefore will be discussed together. The speed tolerance bandwidth from $n_{act} = n_{set}$ and acceleration completed is set in P-027, and the torque threshold for $|M_d| < M_{dx}$, in P-047, whereby the valid data set is changed over with the machining-specific data.

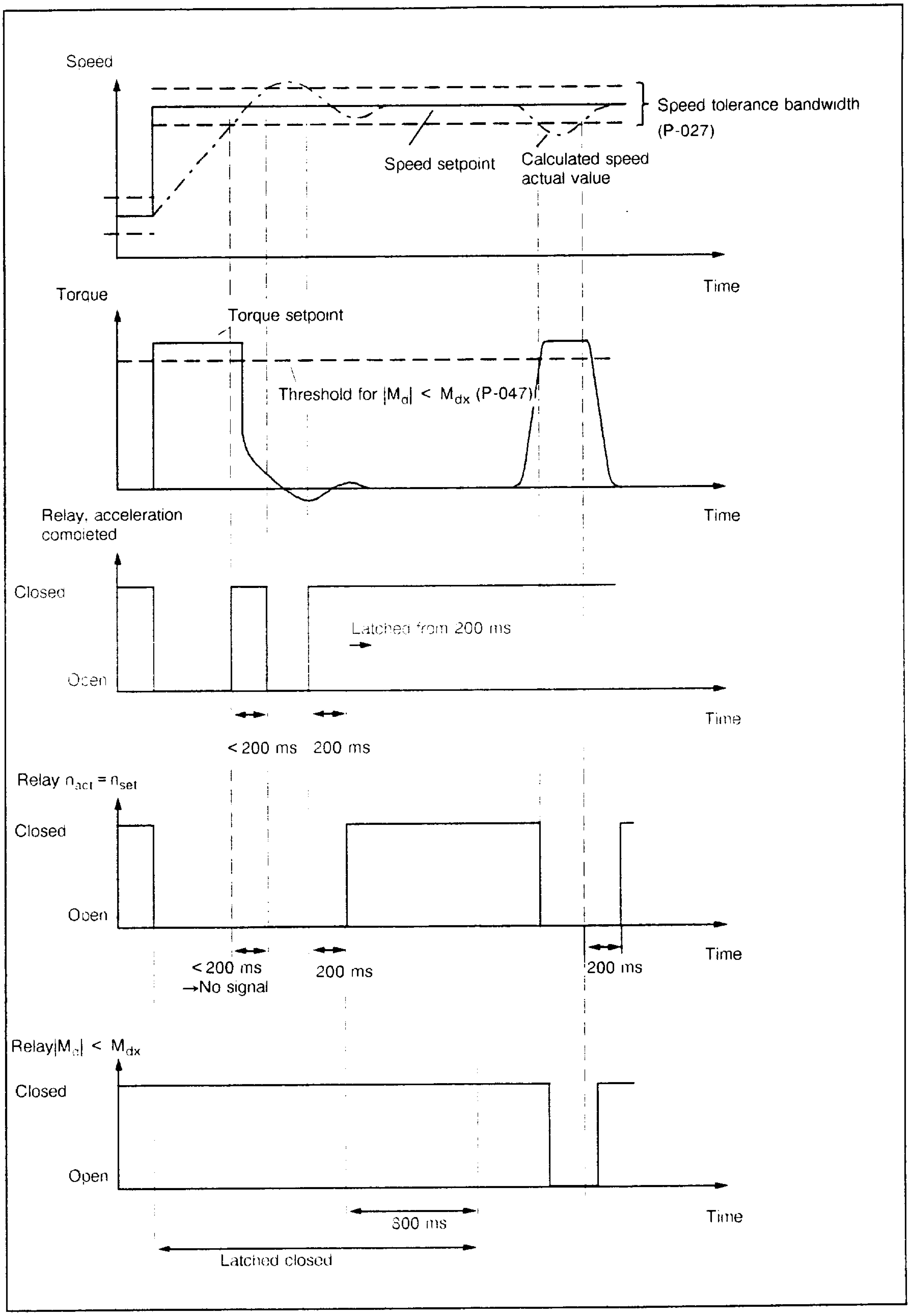
P-027 Speed tolerance bandwidth for the relay function $n_{act} = n_{set}$ and "acceleration completed"
Default value: 100 RPM Units: RPM (speed)
Range: 0...29000
Sub-parameters: 1...8 (machining-specific)

P-047 Relay function threshold, $|M_d| < M_{dx}$
Default value: 90.0 % Units: % of the effective torque limit
Range: 0.0...100.0 %
Sub-parameters: 1...8 (machining-specific)

- Acceleration completed
  The freely-programmable relay signal "acceleration completed" is active (the associated relay closes), if, after a setpoint step, the calculated actual speed lies in the speed tolerance bandwidth of the new setpoint. The width of the tolerance bandwidth is set using P-027. If the calculated actual speed lies in the tolerance bandwidth for longer than 200 ms, the "acceleration completed" relay signal is interlocked in the active setting, i.e. even when the calculated actual speed leaves the tolerance bandwidth again after 200 ms, the signal remains active unless of course the setpoint has in the meantime changed. If the tolerance bandwidth is left again before the 200 ms has expired, or after it has been left due to a setpoint step, the "acceleration completed" relay opens. Please note, that in the open-loop controlled range, a speed dip due to a load torque cannot be identified.

- Relay signal, $n_{act} = n_{set}$
  The freely-programmable relay signal "$n_{act} = n_{set}$" is active (the associated relay closes) after the speed actual value lies within the speed tolerance bandwidth of the setpoint, and remains in the tolerance bandwidth for at least 200 ms. If the tolerance bandwidth is left, the "$n_{act} = n_{set}$" relay immediately opens. Please note, that in the open-loop controlled range, the calculated speed actual value is the same as the setpoint, and a speed dip due to a load torque cannot be identified.

- Relay signal, $|M_d| < M_{dx}$
  The freely-programmable relay signal "$|M_d| < M_{dx}$" is active up to 800 ms after the interlocking "acceleration completed" after a setpoint step. Only then can the associated relay drop-out. if the torque setpoint is greater than the threshold set in P-047. The threshold is set as a percentage of the effective torque limit. Please note, that the current limit also influences the torque limit, and that a load torque is not identified in the open-loop control range.


Speed
Speed tolerance bandwidth (P-027)
Speed setpoint
Calculated speed actual value
Time
Torque
Torque setpoint
Threshold for $|M_d| < M_{dx}$ (P-047)
Time
Relay, acceleration completed
Closed
Latched from 200 ms
Open
Time
< 200 ms
200 ms
Relay $n_{act} = n_{set}$
Closed
Open
Time
< 200 ms
→No signal
200 ms
200 ms
Relay $|M_d| < M_{dx}$
Closed
Open
Time
300 ms
Latched closed

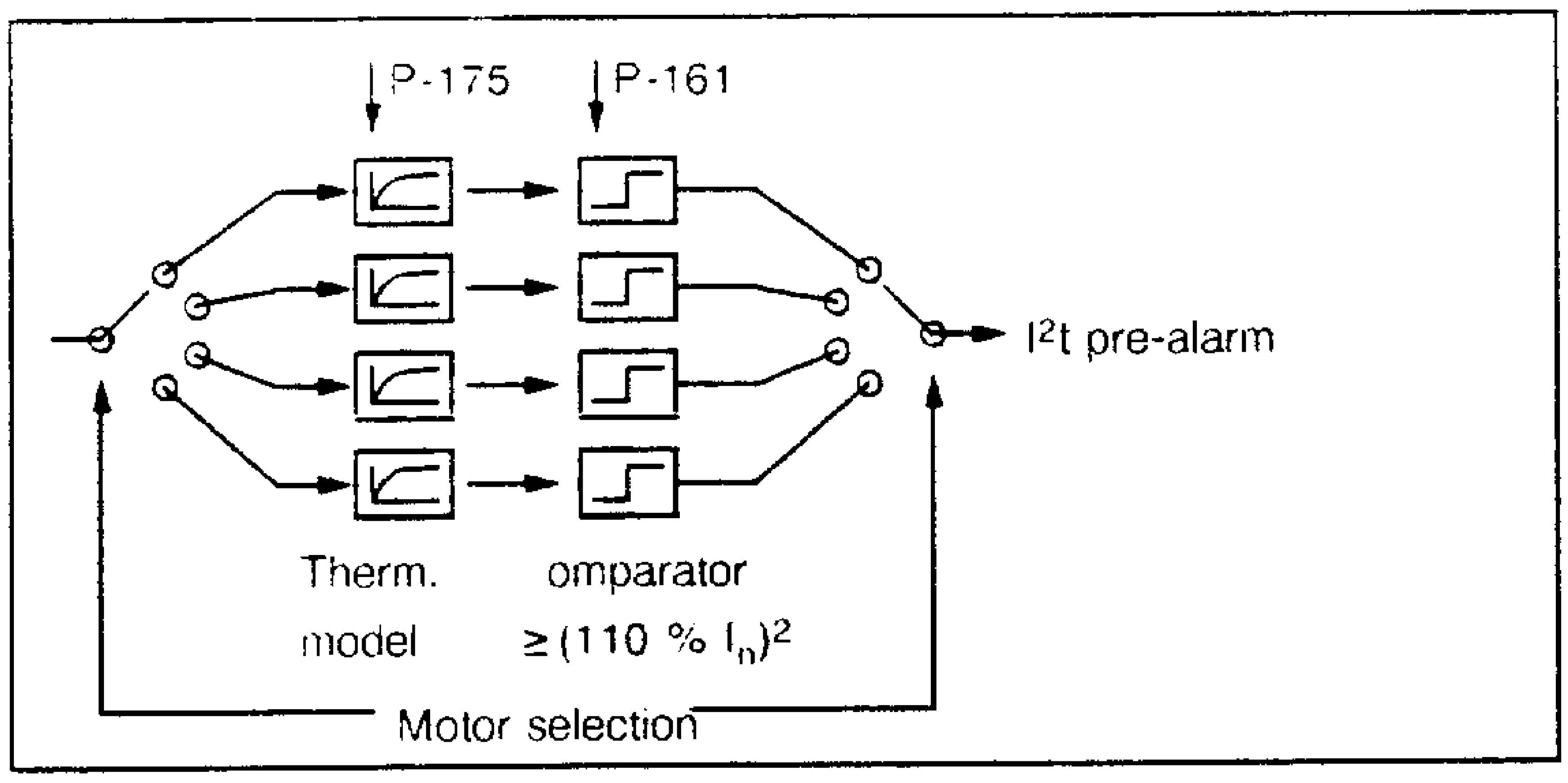
4.9.3 Relay function $|n_{act}| < n_x$

Machining-specific speed thresholds can be entered in P-023 for the "$|n_{act}| < n_x$"relay function. The "$|n_{act}| < n_x$" relay is closed if the absolute value of the calculated speed actual value falls below the threshold of P-023 selected with the machining-specific data. In this case, a hysteresis of 17 RPM is effective (can be adjusted and stored in the EEPROM: Address E6CH, entered in the arithmetic format 29296 RPM ≙ 7FFFH).

P-023 Threshold for the relay function $|n_{act}| < n_x$
Default value: 3000 RPM Units: RPM (speed)
Range: 0...29000 RPM
Sub-parameters: 1...8 (machining-specific)

4.9.4 Relay function, I²t pre-alarm

The freely-programmable I²t pre-alarm relay function is used to protect the connected motor(s). A simple thermal model (PT_1 element = smoothing, 1st order) is calculated for each of the four possible motors, which receives as input the square of the absolute current actual value (I^2) of the appropriate motor. The thermal time constants of the motors used are set in P-175. The I²t pre-alarm becomes active if a value is available at the output of the thermal model of the selected motor, which is greater than the square of 110% of the rated motor current. The user is responsible for responding to this pre-alarm. Please note, that important quantities, which influence the motor temperature rise (fan, external temperature) are not taken into account in the I²t model. It would be preferable to evaluate, if available an NTC or PTC thermistor incorporated in the motor.



P-175 Thermal motor time constant for the I²t pre-alarm
Default value: 1.0 min Units: min (time constant)
Range: 0.0...500.0 min
Sub-parameters: 1...4 (motor-specific)

4.9.5 Relay function, heatsink overtemperature

A temperature sensor is attached to the heatsink of the power transistors to protect the induction motor module from thermal overload. At overtemperature, the sensor activates the relay function "heatsink overtemperature" (the relay closes). The motor pulses are cancelled and fault F-15 is output two minutes after the relay signal, if the heatsink still has an overtemperature condition. The "heatsink overtemperature" relay function provides the user with the possibility of making appropriate measures to terminate the machining sequence or to reduce the converter overload condition before fault message F-15 trips the drive.

4.9.6 Variable relay functions

The variable relay functions permit practically every memory location of the digital open-loop and closed-loop control to be monitored and to generate a relay signal. Two, independent, variable relay functions are available, whose function is set in parameters P-185 to P-194. The address of the memory location to be monitored, the threshold, hysteresis and a pull-in and drop-out delay time are set. The hysteresis prevents the relay from continuously switching in and out if the contents of the memory location change by less than the hysteresis around the threshold. The relay function becomes active. if the value of the selected memory location is greater than the threshold, and the pull-in delay has expired. If bit 8 or bit 9 of P-247 is set, the absolute value of the memory location to be monitored is generated before comparison with the variable relay functions 1 and 2. otherwise the sign is taken into account. If the threshold is fallen below, the associated relay opens after the drop-out delay has expired. The addresses and the internal normalization of the most important memory locations are provided in Section 4.2, Handling the D/A converters.

P-185 Memory location address, variable relay function 1
P-190 Memory location address, variable relay function 2
Default value: 1110H Significance: Address in hexadecimal (≙calculated speed actual value)
Range: 0...FFFFH

P-186 Threshold for variable relay function 1
P-191 Threshold for variable relay function 2
Default value: 0H Units: Arithmetic format, negative numbers in the two's complement if P-247. bit 8 or bit 9 deleted
Range: 0...FFFFH

P-187 Pull-in delay, variable relay function 1
P-192 Pull-in delay, variable relay function 2
Default value: 0.00 s Units: s (time)
Range: 0.00...10.00 s

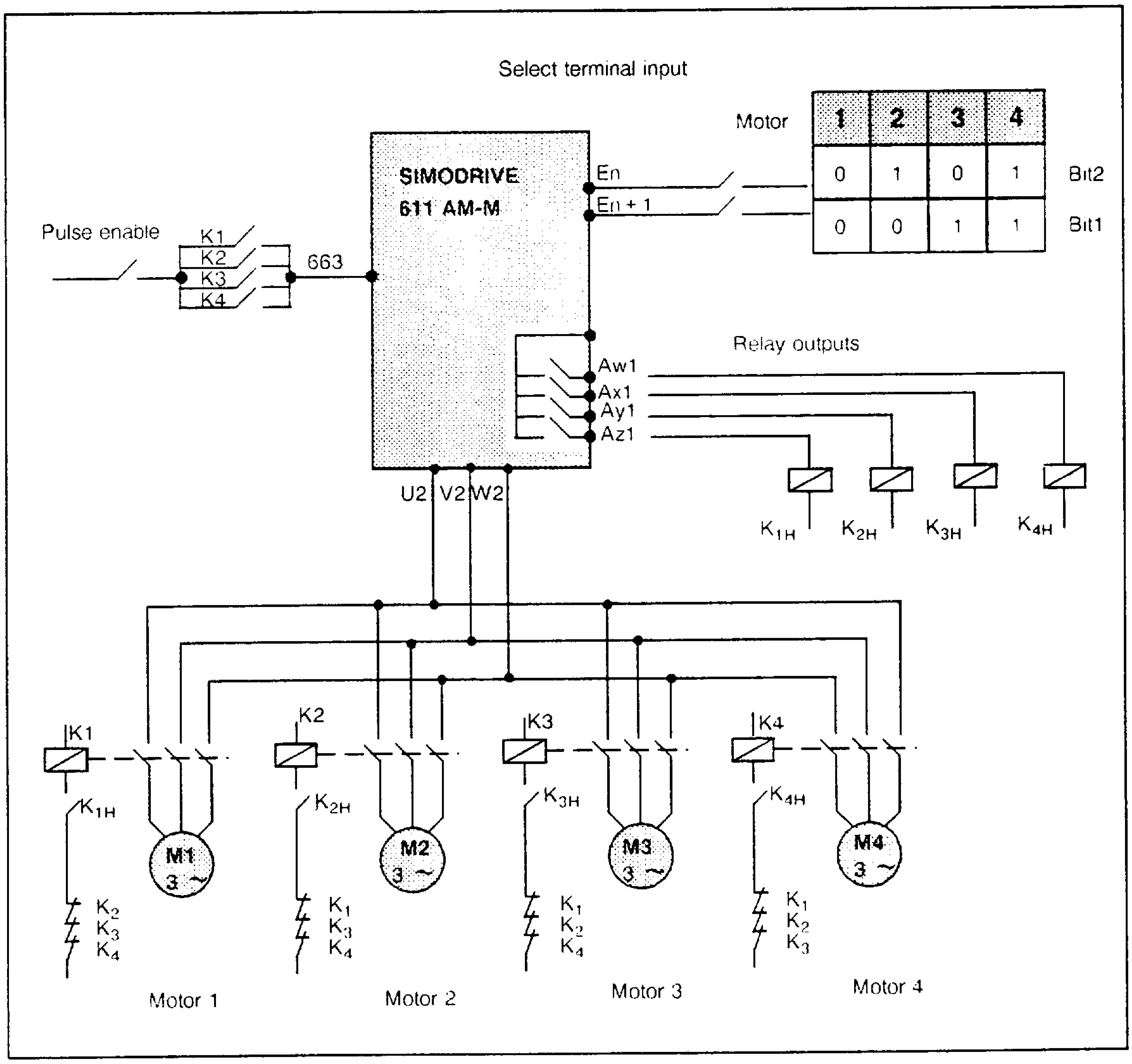
P-188 Drop-out delay, variable relay function 1
P-193 Drop-out delay, variable relay function 2
Default value: 0.00 s Units: s (time)
Range: 0.00...10.00 s

P-189 Hysteresis, variable relay function 1
P-194 Hysteresis, variable relay function 2
Default value: 1H Units: Arithmetic format, hexadecimal
Range: 0...FFFFH

4.9.7 Relay functions, motor ... active

There is a freely-programmable relay signal which is active for each of the four selectable motor data sets, if the associated motor data set is the currently valid one. This signal is of use, as generally after a switchover request, the motor data set is not immediately changed, but only after the motor pulses have been cancelled. During reloading, all "motor ... active" relays are open. Thus, these relay functions can be used for controlling motor contactors for motor changeover. Additional information regarding motor changeover is provided in Section 4.4, Motor data and Section 4.8.11, Motor selection.

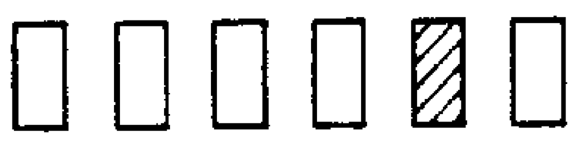
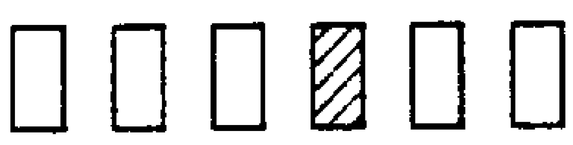
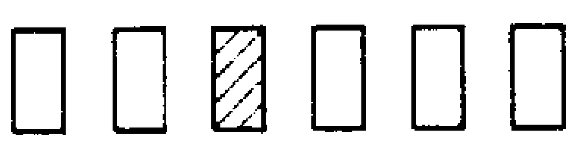
The following diagram shows a recommended circuit for contactor control for motor changeover. In this case, freely-programmable terminals E_n and E_{n+1} are assigned with "motor selection", bit 0 and bit 1" and freely-programmable relays Aw1, Ax1, Ay1, Az1 assigned with "motor 1, 2, 3, 4 active. The mutual relay interlocking is already realized using the induction motor module software. but the recommended contactor interlocking guarantees, that even with parameterizing errors, only one motor is connected to the converter and that the motor pulses are cancelled before the motor contactor is opened.



4.9.8 Relay function control word P-247

If bits 0 to 5 of P-247 are set, the mode of operation of the individual freely-programmable relay functions A11 to A61 is inverted. The "variable relay functions 1 and 2" are evaluated with sign, if bit 8 or bit 9 of P-247 is deleted, otherwise, the absolute value of the monitored memory locations is used for evaluation.

P-247 Relay function control word
Default value: 0 Units: Hexadecimal (logical switch)
Range: 0...FFFFH

Display location	Bit	Significance at 0	Significance at 1
	0 1 2 3	– – – –	Function of A11 inverted Function of A21 inverted Function of A31 inverted Function of A41 inverted
	4 5	– –	Function of A51 inverted Function of A61 inverted
	8	Evaluation with sign of the variable relay function 1	Absolute value evaluation of variable relay function 1
	9	Evaluation with sign of the variable relay function 2	Absolute value evaluation of variable relay function 2

5 Faults and diagnostic aids

5.1 Faults after power-up

The following faults/errors can be present when the operating display LEDs are not lit after power-up:

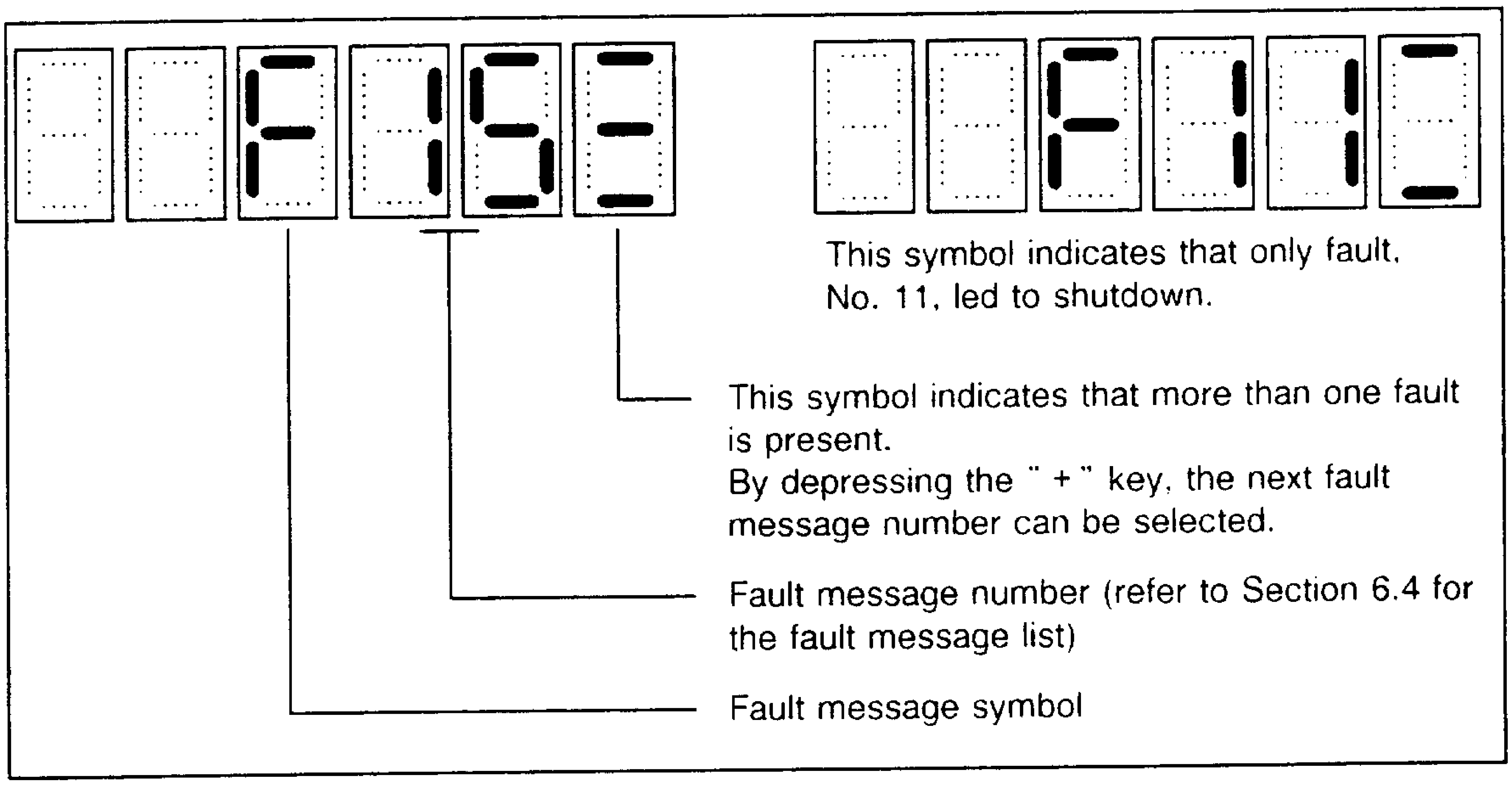
- Circuit-breaker not switched-in
- At least two phases missing (infeed/regenerative feedback module)
- At least two input fuses have blown (infeed/regenerative feedback module)
- Electronics power supply (60 V AC/17 kHz) defective in the I/R feedback module
- Equipment bus connection I/R feedback module ↔ induction motor module (ribbon cable) defective or not inserted
- Connection between the display board and the control board defective
- 5 volt power supply on the control board defective
- Control board defective

The following faults can be present if all display LEDs (8.8.8.8.8.8.), are lit after power-up:

- Control board defective
- Software module or EPROMs defective

5.2 Fault messages and fault mode

Fault messages are displayed for several of the possible faults. The motor pulses are cancelled when a fault message occurs with the exception of fault F-26. The operator control is then in the fault mode which is indicated when the following symbols flash:



If parameters have to be viewed or changed in the fault mode, the operator control mode can be selected for approx. one minute by depressing the "–" key. The fault number is then displayed again.

The significance of the individual fault messages and their possible causes is provided in the following list:

Fault message	Designation	Possible causes
F-05	Motor current = 0	• All enable signals available, but motor not connected • All enable signals provided, but at least one of the parameters P-160, P-166, P-057, P-059 is equal to zero.
F-08	EEPROM check sum incorrect	• Defective EEPROM • Defective software module
F-11	Frequency setpoint > max. frequency	• Ribbon cable between the control board → gating board defective, or not connected • Motor is not connected or phase missing • Gating board power supply defective • DC link fuse defective • Motor stalled, as the motor or controller parameters grossly incorrect • Induction motor module connected to a monitoring module but no DC link voltage was entered in P-061 • When changing-over the machining-specific data set, the speed limit (P-029) was reduced, although the motor was running at a speed above this limit.
F-13	Field controller is at its limit	• Motor or controller data grossly incorrect • Entered motor data and motor circuit configuration (star/delta) do not coincide. • Motor has stalled, as the motor or controller parameters are grossly incorrect
F-15	Converter overtemperature	• Converter overloaded (incorrect duty cycle) • Ambient temperature too high • Fan has failed • Defective temperature sensor
F-17	Motor no-load current > max. converter current	• No-load current too high • Converter current rating too low
F-60	Self-tuning fault	• Self-tuning was interrupted • Self-tuning resulted in unreasonable values • Other causes, refer to Section 3.3.4
F-26 Alarm (motor pulses not cancelled)	EEPROM write protection not cancelled	• An attempt was made to write into the EEPROM, without first depressing the write protection button on the front side of the software module. Acknowledgement is realized by depressing the write protection button.

5.3 Fault acknowledgement

The fault must be acknowledged so that the fault display disappears and the motor pulses are enabled. If the cause is not removed, under certain circumstances, the fault re-appears immediately after acknowledgement. For fault acknowledgement, the "controller enable" enable terminal (terminal 65) must be open. Faults can be acknowledged as follows:

- Depress the "P" key with the controller inhibited (terminal 65 open)
- Activate the freely-programmable terminal function "acknowledge fault" with the controller inhibited (terminal 65 open)
- Open and close the "controller enable" terminal (terminal 65) if bit 5 of P-053 is set.
- Close terminal "R" (central reset) of the infeed/regenerative feedback unit or monitoring module. (In this case, terminal 65 (controller enable) can also be opened after terminal R has closed).
- Switch the converter off and on again.

5.4 Diagnostic aids

5.4.1 Test sockets

The test sockets are extremely helpful for diagnostics and can be used for solving various problems as the D/A converters can be appropriately parameterized. The test sockets are described in Section 4.2, Handling the D/A converters, test sockets.

5.4.2 Transistor diagnostics

A hardware monitoring function is provided for the induction motor module power transistors, which trips at overcurrent (short-circuit proof) and checks whether a switch-on command also actually switches the appropriate transistor. Thus, faults regarding implementation of gating commands can be identified. If the parameter contents of P-070 are 0H, then such a fault has not occured, otherwise, a bit is set for each individual gating and transistor path:

Bits set from P-070	Faulty transistor for 60/80 A module	Faulty transistor for the remaining modules	Involves phase...
Bit 0 Bit 1	A 11 A 12	V 1 V 1	U 2 U 2
Bit 2 Bit 3	A 13 A 14	V 2 V 2	V 2 V 2
Bit 4 Bit 5	A 15 A 16	V 3 V 3	W 2 W 2

The transistor designations refer to the module circuit diagrams in Section 9; if the parameter contents are not equal to 0H, the causes can be as follows:

- Defective gating board
- Defective transistor in the power section
- Defective control board
- Terminals U2, V2, W2 short-circuited

The contents of P-070 are reset to 0 by setting P-075 to 1. Thus, in P-070, it can be checked as to whether a fault was only sporadic, or continuously re-occurs.

P-070 Transistor diagnostics
Display parameter in hex 0H: No fault occurred
otherwise: Fault, refer to table
Range: 0...2FH
Note: Is reset using P-075

P-075 Resetting the transistor diagnostics
Default value: 0H Significance: 0H≙Inactive
1H≙Resetting the transistor diagnostic parameter, P-070.

5.4.3 Minimum and maximum value monitoring

The minimum and maximum value of a memory location can be determined within the activated time frame using this function. 16-bit numbers and 16-bit numbers with sign can be evaluated (two's complement notation for negative numbers), depending on the value in P-179. The evaluation is started and stopped with P-179. The address of the memory location to be monitored is entered into P-181. P-182 displays the minimum, and P-183 the maximum value. The previous minimum and maximum values are deleted, if the address (P-181) is changed. Several important addresses and their internal normalization (arithmetic format) are provided in Section 4.2, Handling the D/A converters.

P-179 Minimum/maximum value monitoring control
Default value: 0H Significance:
0H ≙ No evaluation (same function with 3)
1H ≙ Evaluation for 16-bit numbers without sign
2H ≙ Evaluation for 16-bit numbers with sign
3H ≙ No evaluation (same function with 0)
Range: 0...3H
Note: P-182 and P-183 are influenced by P-179

P-181 Address for minimum/maximum value monitoring
Default value: 1110H (calculated speed actual value) Units: Hex (address)
Range: 0...FFFFH
Note: P-182 and P-183 are initialized when P-181 is changed (minimum/maximum values).

P-182 Minimum value display
Display: Hex in arithmetic format

P-183 Maximum value display
Display: Hex in arithmetic format

5.4.4 Transient recorder function

The induction motor module has a signal memory for diagnostics where two 640 ms digital signals (16 bit) can be stored (transient recorder). The addresses of the signals to be recorded are entered into P-212 (channel 1) and P-213 (channel 2) (important addresses, refer to Section 4.2, Handling the D/A converters). There are various ways of starting, stopping and triggering to fill the memory when a specific event occurs. The trigger condition is entered into P-207, the trigger addresses and thresholds in P-208 and P-209 (start condition triggering) and in P-210 and P-211 (stop condition triggering). The transient recorder is activated by setting P-206 to 1H. P-206 and P-207 are automatically reset to 0H, when the recording has been completed. When recording, a value pair is stored every millisecond. When recording with stop condition, the recorder memory has a ring-type structure and recording is terminated when the stop condition is fulfilled. The last 640 values are stored in the memory. However, the start generally does not coincide with the memory start. The memory can also be initialized with defined values.
The stored values can be cyclically output via D/A converters, whereby two trigger signals can be set at the start of the output in P-217 and P-218. The output via the D/A converters is started with P-214 whereby shift factors for the output can be specified in P-215 and P-216. The previous assignment of the D/A converters is buffered and is restored after this output function has been completed.

For self-tuning (refer to Section 3.3.4), the transient recorder is used, whereby the previous settings are not restored.

P-206 Activate transient recorder
Default value: 0H Significance:
0H ≙ Inactive
1H ≙ Activated (is automatically reset after recording)
Range: 0...1H

P-207 Trigger condition for the transient recorder
Default value: 0 Significance:
1H ≙ Recording is automatically started via P-206 and stops when the memory is full.
2H ≙ Recording with start condition (P-208, P-209). The recording stops when the memory is full.
4H ≙ The recording memory is preset with the contents of P-217.
5H ≙ Recording in the ring memory starts with P-206 = 1 and stops, when the stop condition (P-210, P-211) is fulfilled.
6H ≙ Recording starts with the start condition and ends with the stop condition.
The start and stop conditions are inverted by setting bit 3
Range: 0...CH

During recording, the appropriate bit is deleted in P-207, when the associated condition is fulfilled. Thus, P-207 provides information regarding the status of the recording. P-206 is deleted when the recording has ended.

P-208 Start condition address, transient recorder
Default value: 0H Units: Hex (address)
Range: 0...FFFFH

P-209 Start condition threshold, transient recorder
Default value: 0H Units: Arithmetic format, hex (negative values in the two's complement notation)
Range: 0...FFFFH

If bit 3 of P-207 is deleted, the start condition is fulfilled if the memory contents with the address from P-208 exceeds the threshold of P-209. If bit 3 of P-207 is set, the threshold must be fallen below in order to activate triggering.

P-210 Stop condition address, transient recorder
Default value: 0H Units: Hex (address)
Range: 0...FFFFH

P-211 Stop condition threshold, transient recorder
Default value: 0H Units: Arithmetic format, hex (negative values in the two's complement notation)
Range: 0...FFFFH

If bit 3 of P-207 is deleted, the stop condition is fulfilled if the memory contents, with the address of P-210, exceeds the threshold of P-211. If bit 3 of P-207 is deleted, the threshold must be fallen below in order to activate triggering.

P-212 Address of record signal 1, transient recorder
Default value: 1110H Units: Hex (address)
(calculated speed actual value)
Range: 0...FFFFH

P-213 Address of record signal 2, transient recorder
Default value: 10D2 Units: Hex (address)
(torque-generating current)
Range: 0...FFFFH

P-214 Activation, transient recorder output at the D/A converters
Default value: 0H Significance:
0 ≙ Inactive
1 ≙ Output active
Record signal 1→D/A converter 1
Record signal 2→D/A converter 2
Range: 0...1H

P-215 Normalization (shift factor) for record signal 1
P-216 Normalization (shift factor) for record signal 2
Default value: 2 Significance:
Amplification of the associated output signal by $2^{\text{shift factor}}$.
Range: 0...15

P-217 Trigger signal amplitude 1 for transient recorder output
Default value: 0H Units: Hex
(≙0 V at the D/A converter)
Range: 0...FFFFH

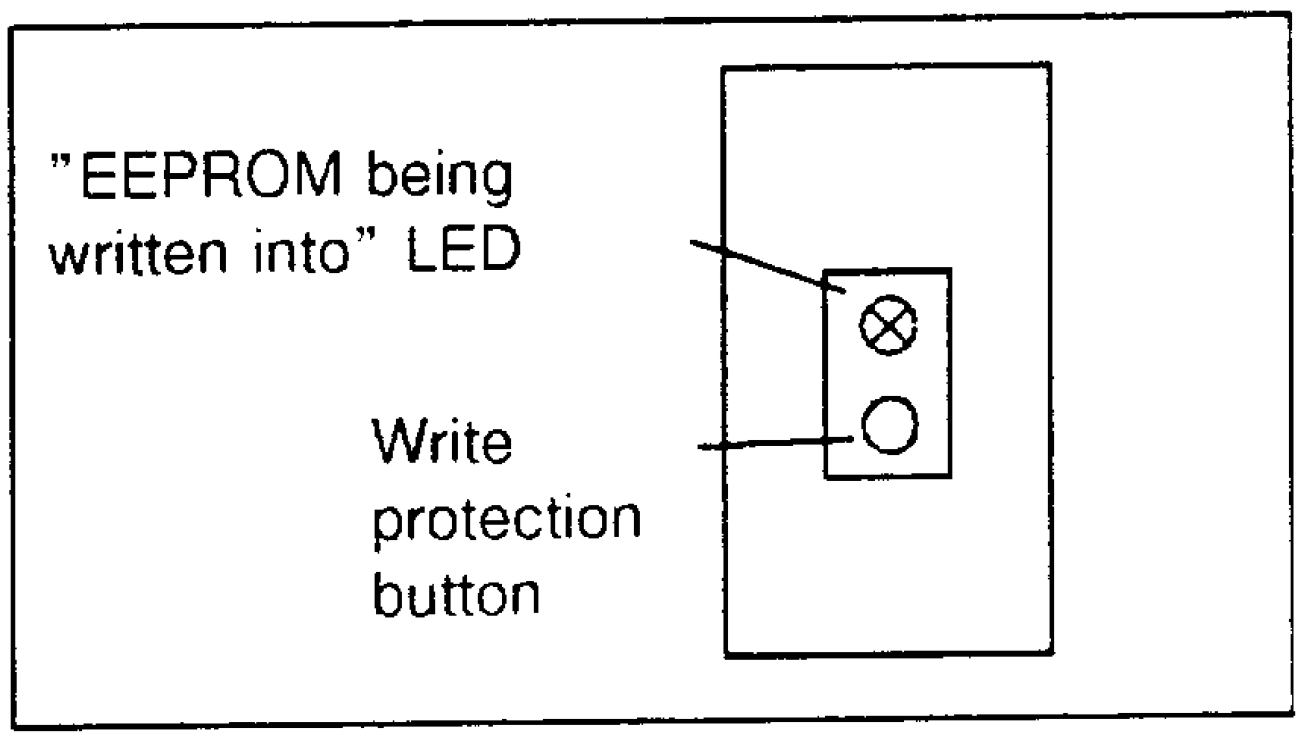
P-218 Trigger signal amplitude 2 for transient recorder output
Default value: 7FFFH Units: Hex
(≙10 V at the D/A converter, if there is no shifting (P-215, P-216) and fine normalization (P-012, P-013) = 100 %)
Range: 0...FFFFH

A trigger signal is output via D/A converter 1 and D/A converter 2 at the start of the output of the recorded signals. At first, trigger signal amplitude "1" appears for 1ms, and then trigger signal amplitude "2" for 1 ms, followed by the output of the recorded signals.

6 Software module

6.1 Application

Two EPROMs and one EEPROM are accomodated on the software module for operating the induction motor module. The software is stored in the two EPROMs and all user settings in the EEPROM. Thus, the complete parameterization is contained in the plug-in software module which is of advantage when servicing. Settings are permanently stored by writing them into the EEPROM. To write into the EEPROM, the hardware write protection must be cancelled by depressing the write protection button on the software module. The software module LED is lit, and the converter must not be switched-off while data is being written into the EEPROM.



Front view, software module

6.2 Software upgrade

When upgrading a software module, or at initialization, the following procedure must be maintained:

1. Note all of the changed setting data for the installation (parameters).
2. Switch-off the unit and replace the software module.
3. Switch-on the unit.
   P-095 must be displayed.
4. Initialize with pulse and controller inhibit.
   P-095 Enter converter code number
   P-096 Enter motor code number. A zero should be entered if there is no motor code number for the motor used.
   P-097 Set to 1H
   Depress the EEPROM write protection button on the front panel of the software module. The LED above the button is lit during initialization. It must then go out again, and the unit must indicate the operating display (P-000).
   Note: If data save is interrupted due to a power failure or the power being disconnected, the EEPROM is reset into the initialized status.
5. Set P-051 to 4H.
   Re-enter the values noted under point 1.
6. It is recommended that the power offset is adjusted (refer to Section 3.3.4). If a module, version C is used, and if a software release < 3.00 is replaced with a software release 3.00 or later, then P-115 and P-116 must also be set again (refer to Section 3.3.4, Post-optimization and Section 3.3.8, Module replacement).
7. Set P-052 to 1H, and depress the EEPROM write protection button.
   The modified values are then transferred into the EEPROM. The induction motor module is ready after the LED goes dark.

If the EEPROM write protection button is not depressed then "F-26" is displayed after approx. 30 s. This alarm is acknowledged by depressing the button. The modified values are then transferred into the EEPROM.
Alarm F-26 can also be acknowledged by writing 0H into parameter P-052. In this case, the modified values are not transferred into the EEPROM. [1]
The following procedure must be maintained if an EEPROM which has already been written into, is to be reset into the initialized status.

1. Set P-051 to 4H
2. Set P-097 to 0H
3. Set P-052 to 1H, and depress the EEPROM write protection button
4. Switch the unit off and on again. P-095 must be displayed

Initialization can now be carried-out.

6.3 Overview of ordering data

- Software module
  6SC6 110-0EDXX — Programmed software module
  XX = Dependent on the software release
  e.g. XX = 03, software release 3.00

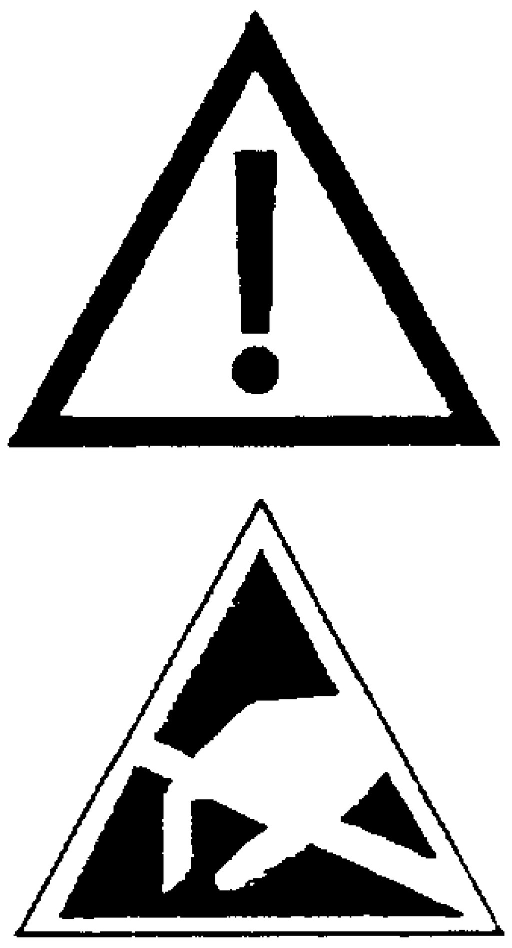
1) The converter must not be switched-off when writing into the EEPROM (LED is lit).

7 Option board

7.1 Application

The functional scope of the SIMODRIVE 611 AM module can be expanded by installing an option board.

7.2 Installation and connection



WARNING

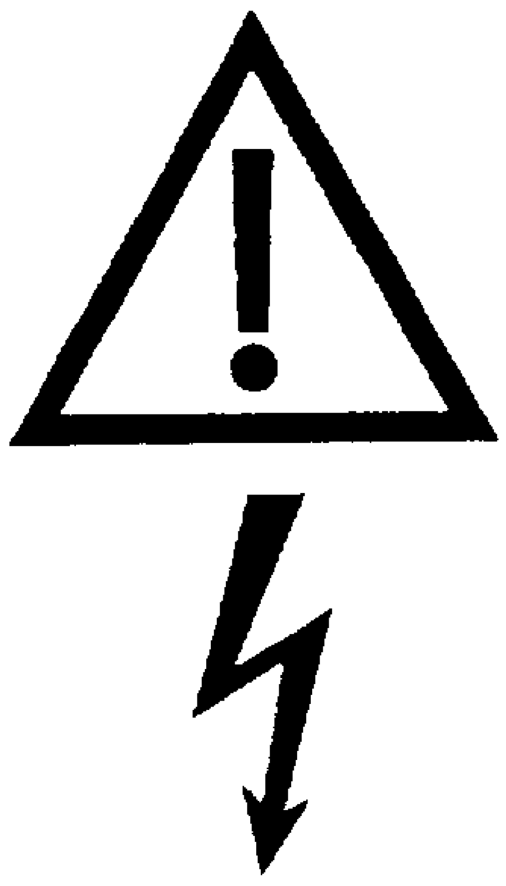
The perfect and safe operation of this converter requires that the unit is professionally transported, installed and mounted as well as careful operator control and maintenance.

If the warning notes are not observed, this can result in severe personal injury or material damage.

The boards contain components which can be destroyed by electrostatic discharge. The human body must be electrically discharged before touching an electronic board. This can be simply realized by touching a conductive, grounded object immediately beforehand (e.g. bare metal cubicle components, outlet socket protective conductor contact).

Option boards can be inserted in the induction motor module by removing the cover from the module front panel inserting the boards and tightening the retaining screws. Installation and withdrawal must only be made when the module is in a no-voltage condition.

8 Maintenance/spare parts



WARNING

This equipment contains hazardous voltages.

If this equipment is incorrectly handled it can lead to death or severe bodily injury as well as significant material damage.

Therefore, when servicing this equipment, please observe all the instructions in this section and on the product labels themselves.

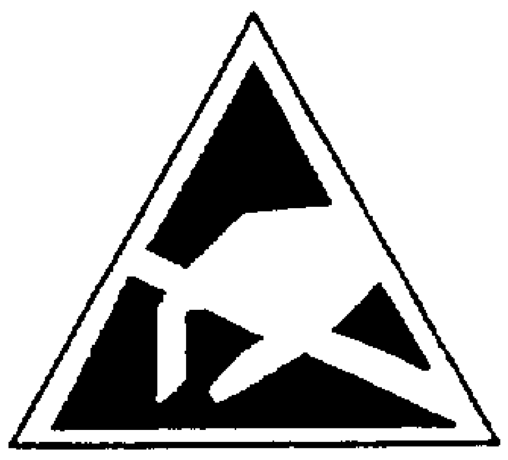
- The unit must only be serviced by appropriately qualified personnel.
- The unit should be disconnected from the supply, grounded and locked-out before any work commences.
  A hazardous voltage is available for approx. 4 minutes after the unit has been shutdown as a result of the DC link capacitors.
  Equipment components can still be live even when the motor is stationary.
- Only use spare parts authorized by the manufacturer.

8.1 Maintenance information

The transistor PWM inverter is maintenance-free.

The unit fan bearings are pre-lubricated for their service life.

8.2 Software upgrade and initialization



WARNING

Perfect and safe operation of the unit is only ensured under the condition that it is professionally transported, stored, mounted and installed as well as careful operator control and maintenance.

Severe bodily injury or material damage can occur if this warning information is not observed.

The boards contain components which can be destroyed by electrostatic discharge. The human body must be electrically discharged before touching an electronic board. This can be simply done by touching a conductive, grounded object immediately beforehand (e.g. bare metal cubicle components, socket outlet protective conductor contact).

The software release is coded in the machine readable product designation on the software module.

6SC6110-0EDXX

Software release

When the software module is upgraded or at initialization, the following procedure should be observed.

1. Note all setting data which has been changed in the system (parameters).
2. Switch-off the unit and replace the software module.
3. Switch-on the unit. P-095 must be displayed.
4. Initialize with pulse and controller inhibit.
   P-095 Enter converter code number
   P-096 Enter motor code number. A zero should be entered if there is no motor code number for the motor used.
   P-097 Set to 1H
   Depress the EEPROM write protection key on the front panel of the software module.
   The LED above the button is lit during initialization. It must then go out again, and the unit must indicate the operating display (P-000).
   Note: If data save is interrupted due to a power failure or the power being disconnected, the EEPROM is reset into the initialized status.
5. Set P-051 to 4H.
   Re-enter the values noted under point 1.
6. It is recommended that the power offset is adjusted (refer to Section 3.3.4). If a module, version C is used, and if a software release < 3.00 is replaced with a software release 3.00 or later, then P-115 and P-116 must also be reset (refer to Section 3.3.4, Post-optimization and Section 3.3.8, Module replacement).
7. Set P-052 to 1H, and depress the EEPROM write protection button.
   The modified values are then transferred into the EEPROM. The induction motor module is ready after the LED goes dark.

If the EEPROM write protection button is not depressed, then "F-26" is displayed after approx. 30 s. This alarm is acknoweldged by depressing the button. The modified values are then transferred into the EEPROM.
Alarm F-26 can also be acknowledged by writing 0H into parameter P-052. In this case, the modified values are not transferred into the EEPROM.

8.3 Overview of ordering data, spare parts

- Induction motor modules

6SC6110-5DA00	5/7 A module
6SC6111-5DA00	15/20 A module
6SC6112-4DA00	24/32 A module
6SC6113-0DA00	30/40 A module
6SC6114-5DA00	45/60 A module
6SC6116-0DA00	60/80 A module

- Software module
  6SC6110-0EDXX — Programmed software module
  XX = Dependent on the software release
  e.g.: XX = 03, actual software release 3.00

- Data cable PG 750/PG 730
  6FC9348-2T □[1)] — Connecting cable between the PWM inverter and the PG 750/PG 730 programming units

1) *B = 5 m* *C = 10 m*

9 Appendix

9.1 Block diagram 9–3

9.2 Connecting diagram 9–4

9.3 Circuit diagrams

- 5/7 A, 15/20 A, 24/32 A, 30/40 A, 45/60 A induction motor modules 9–5
- Main spindle module, 60/80A induction motor module 9–6

9.4 Dimension drawings

- Dimension drawing, 5/7 A, 15/20 A 9–7
- Dimension drawing, 24/32 A 9–8
- Dimension drawing, 30/40 A, 45/60 A 9–9
- Dimension drawing, 60/80 A 9–10

9.5 Locations of terminals and connectors 9–11

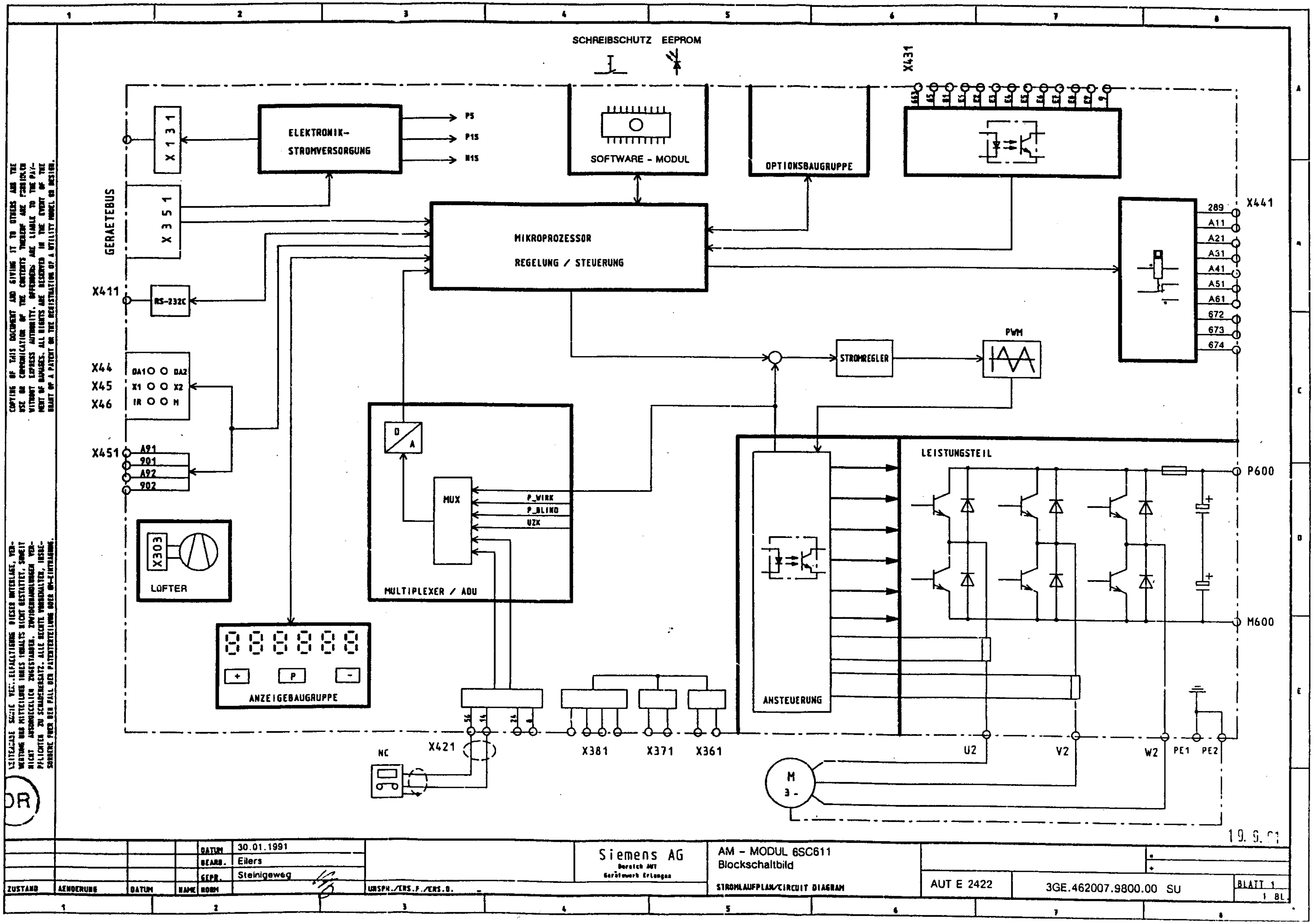
9.6 Manual post-optimization 9–12

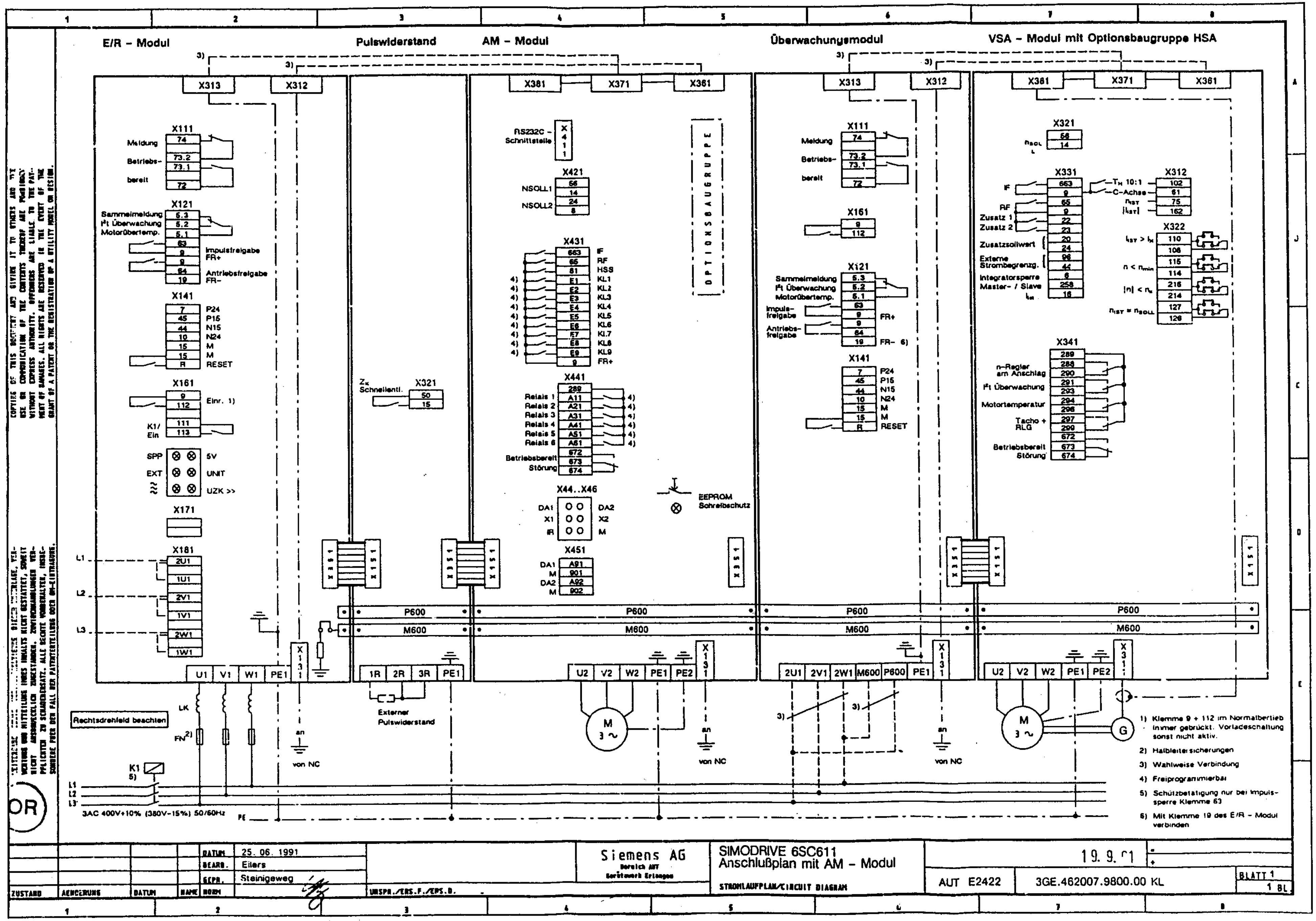
9.7 Parameter list 9–19

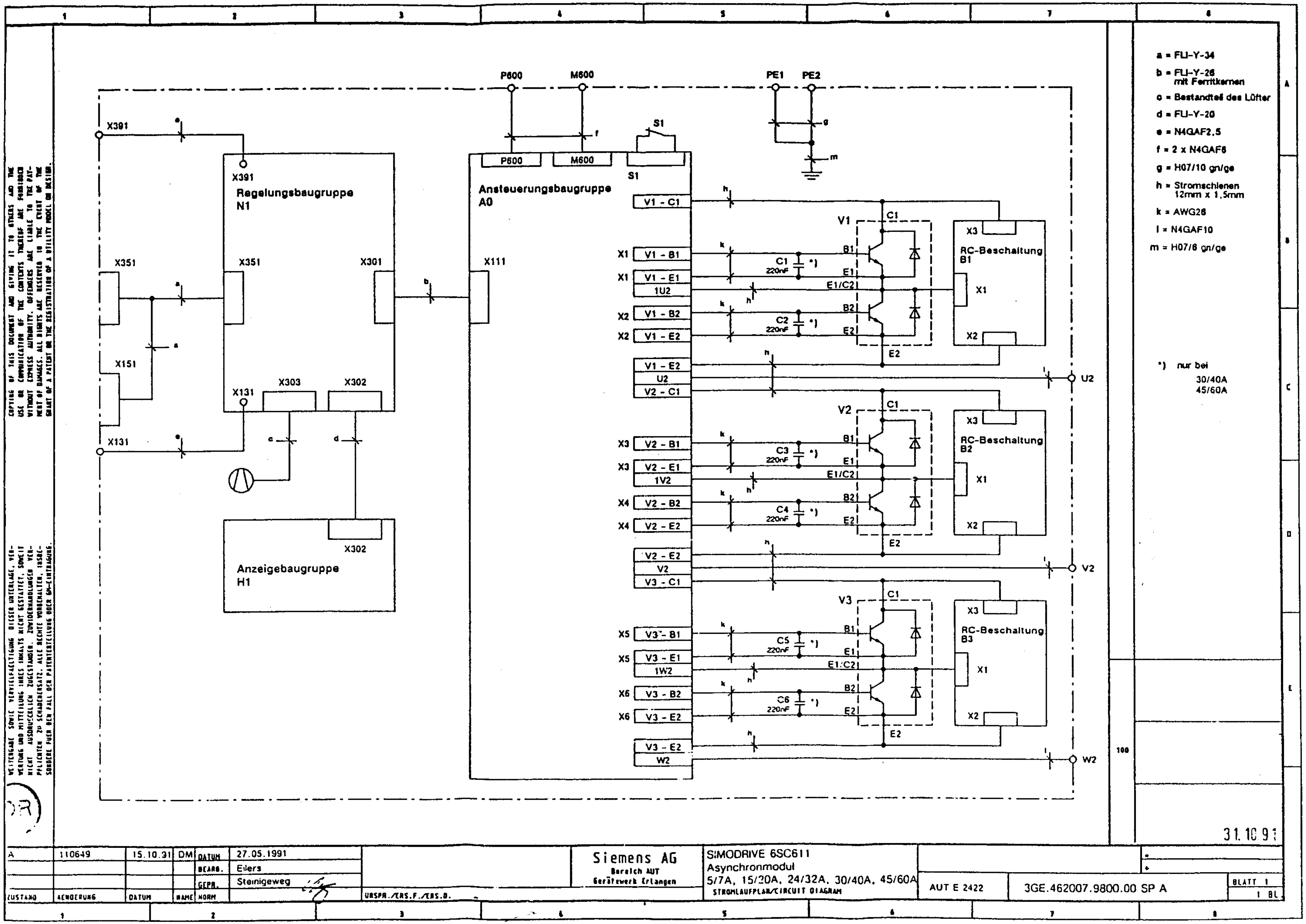
9.8 Setting and check data 9–26

9.9 ECB instructions 9–43

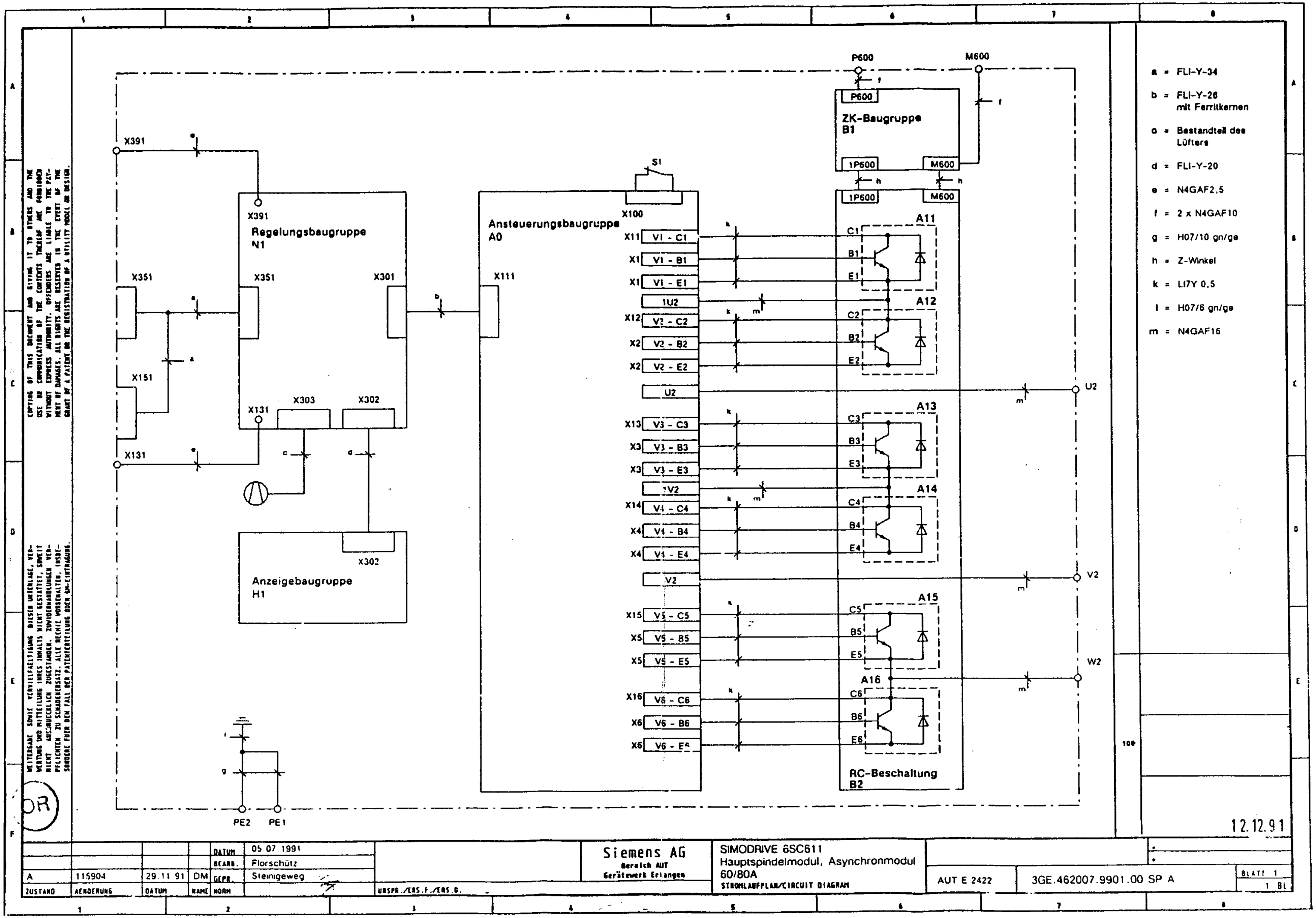
9.10 Standards and specifications 9–44

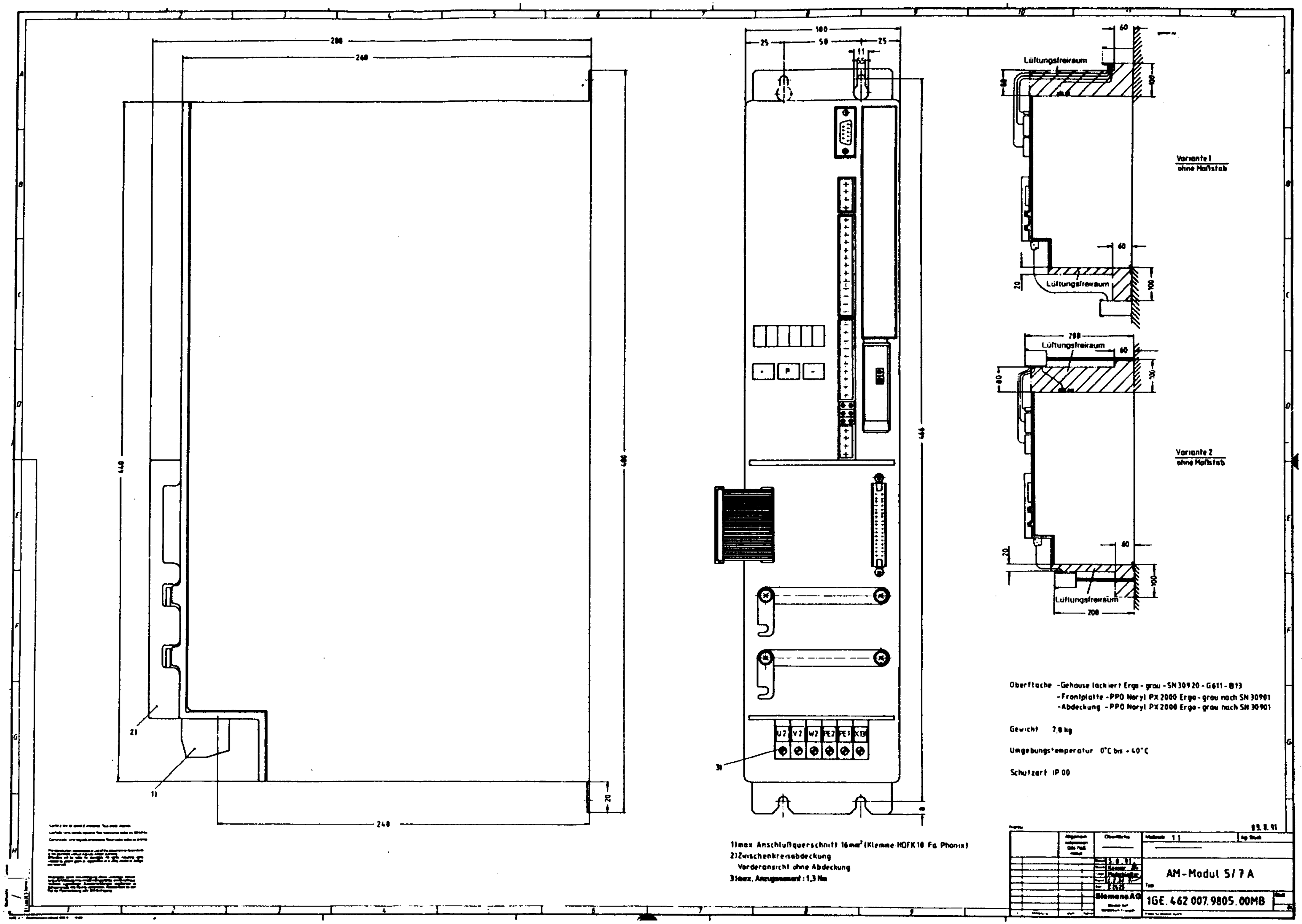

SCHREIBSCHUTZ EEPROM
X431
ELEKTRONIK-STROMVERSORGUNG
P5
P15
N15
SOFTWARE - MODUL
OPTIONSBAUGRUPPE
X131
X351
GERAETEBUS
MIKROPROZESSOR
REGELUNG / STEUERUNG
X441
289
A11
A21
A31
A41
A51
A61
672
673
674
X411
RS-232C
X44
X45
X46
DA1
DA2
X1
X2
IR
M
X451
A91
901
A92
902
PWM
STROMREGLER
D
A
MUX
P_WIRK
P_BLIND
UZK
MULTIPLEXER / ADU
LEISTUNGSTEIL
P600
M600
X303
LÜFTER
ANZEIGEBAUGRUPPE
+
P
-
ANSTEUERUNG
NC
X421
X381
X371
X361
U2
V2
W2
PE1
PE2
M
3 -
DATUM 30.01.1991
BEARB. Eilers
GEPR. Steinigeweg
ZUSTAND
AENDERUNG
DATUM
NAME
NORM
URSPR./ERS.F./ERS.D.
Siemens AG
AM - MODUL 6SC611
Blockschaltbild
STROMLAUFPLAN/CIRCUIT DIAGRAM
AUT E 2422
3GE.462007.9800.00 SU
BLATT 1
1 BL

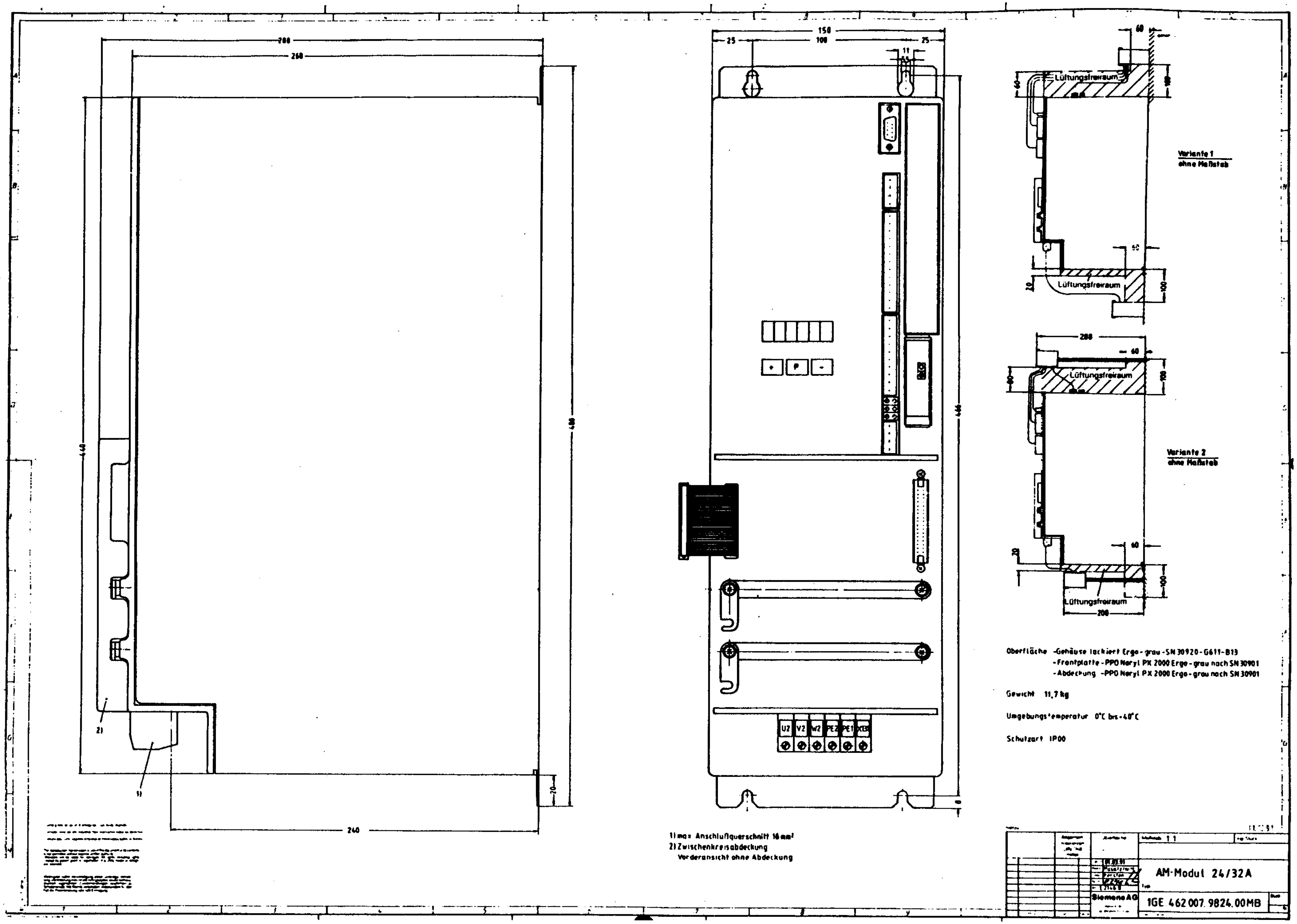

E/R - Modul
Pulswiderstand
AM - Modul
Überwachungsmodul
VSA - Modul mit Optionsbaugruppe HSA
X313
X312
X381
X371
X111
Meldung
Betriebs-
bereit
X121
Sammelmeldung
I²t Überwachung
Motorübertemp.
Impulsfreigabe FR+
Antriebsfreigabe FR-
X141
P24
P15
N15
N24
M
RESET
X161
Einr. 1)
K1/ Ein
SPP
EXT
5V
UNIT
UZK >>
X171
X181
L1
L2
L3
U1
V1
W1
PE1
Rechtsdrehfeld beachten
LK
FN 2)
K1 5)
3AC 400V+10% (380V-15%) 50/60Hz
PE
von NC
Zx Schnellentl.
X321
1R
2R
3R
Externer Pulswiderstand
RS232C - Schnittstelle
X421
NSOLL1
NSOLL2
X431
X441
Relais 1
Relais 2
Relais 3
Relais 4
Relais 5
Relais 6
Betriebsbereit
Störung
X44..X46
X451
OPTIONSBAUGRUPPE
EEPROM Schreibschutz
P600
M600
U2
V2
W2
PE2
M
3 ~
X331
X322
X341
n-Regler am Anschlag
I²t Überwachung
Motortemperatur
Tacho + RLG
Zusatzsollwert
Externe Strombegrenzg.
Integratorsperre
Master- / Slave
G
1) Klemme 9 + 112 im Normalbetrieb immer gebrückt. Vorladeschaltung sonst nicht aktiv.
2) Halbleitersicherungen
3) Wahlweise Verbindung
4) Freiprogrammierbar
5) Schützbetätigung nur bei Impulssperre Klemme 63
6) Mit Klemme 19 des E/R - Modul verbinden
DATUM 25. 06. 1991
BEARB. Eilers
GEPR. Steinigeweg
Siemens AG
SIMODRIVE 6SC611
Anschlußplan mit AM - Modul
STROMLAUFPLAN/CIRCUIT DIAGRAM
AUT E2422
3GE.462007.9800.00 KL
BLATT 1
1 BL

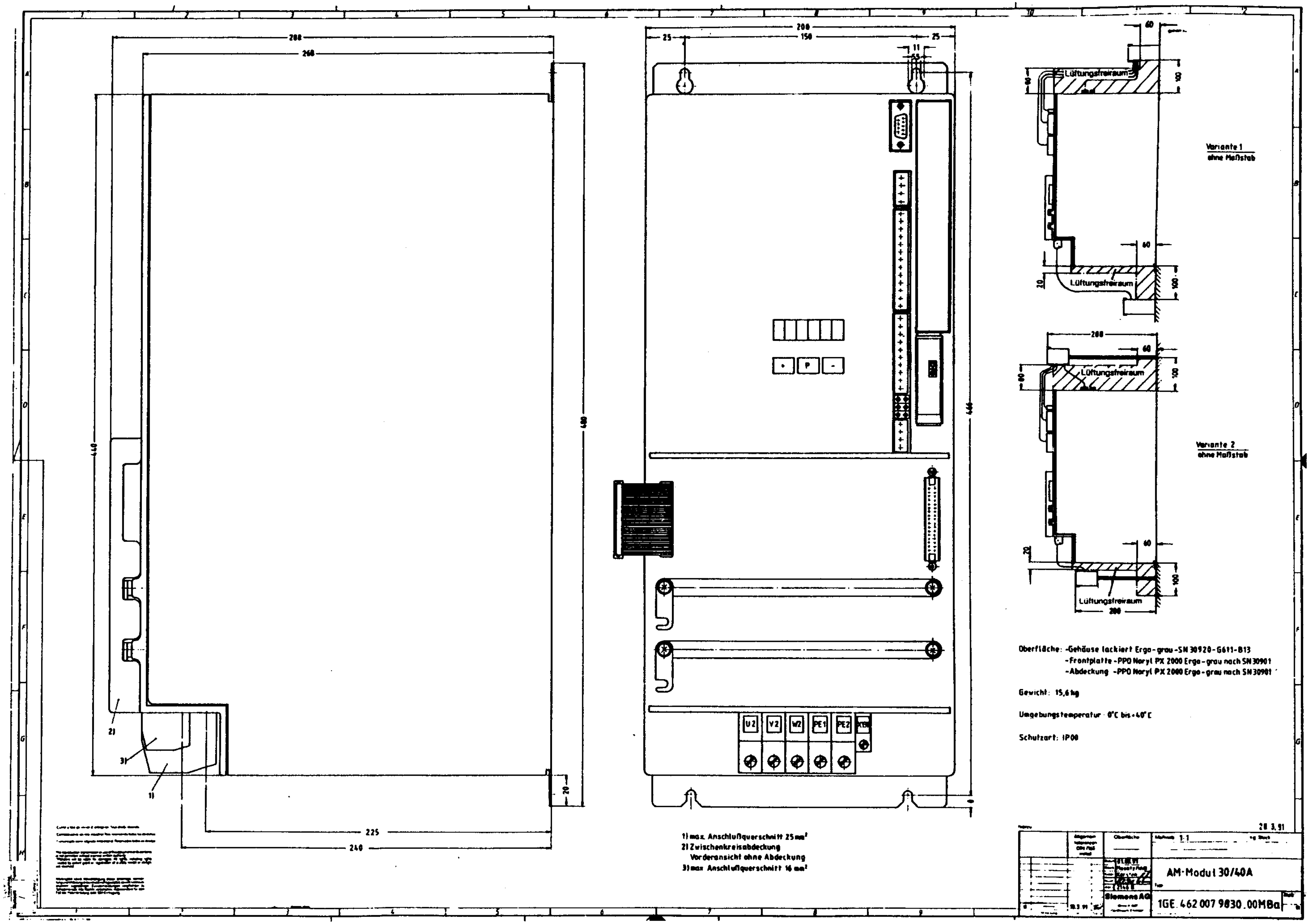


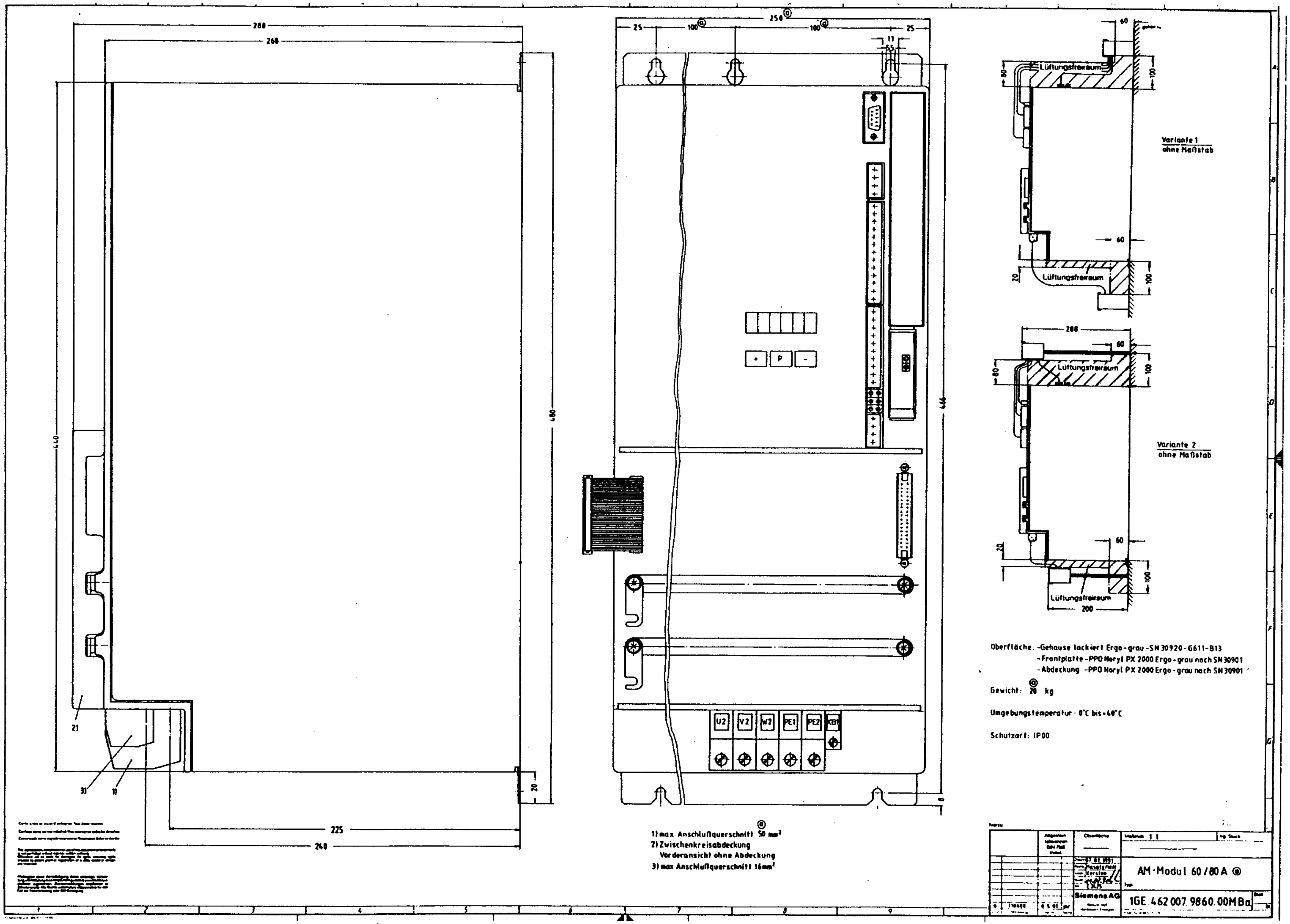
 6SC6111-6AD00
SIMODRIVE 611 (BE)


P600
M600
ZK-Baugruppe
B1
1P600
X391
S1
X100
Regelungsbaugruppe
N1
X351
X301
X111
Ansteuerungsbaugruppe
A0
X151
X131
X303
X302
Anzeigebaugruppe
H1
A11
A12
A13
A14
A15
A16
U2
V2
W2
RC-Beschaltung
B2
PE2
PE1
a = FLI-Y-34
b = FLI-Y-26 mit Ferritkernen
c = Bestandteil des Lüfters
d = FLI-Y-20
e = N4GAF2,5
f = 2 x N4GAF10
g = H07/10 gn/ge
h = Z-Winkel
k = LI7Y 0,5
l = H07/6 gn/ge
m = N4GAF16
12.12.91
DATUM 05 07 1991
BEARB. Florschütz
GEPR. Steinigeweg
A 115904 29.11.91 DM
ZUSTAND ÄNDERUNG DATUM NAME NORM
URSPR./ERS.F./ERS.D.
Siemens AG
Bereich AUT
Gerätewerk Erlangen
SIMODRIVE 6SC611
Hauptspindelmodul, Asynchronmodul
60/80A
STROMLAUFPLAN/CIRCUIT DIAGRAM
AUT E 2422
3GE.462007.9901.00 SP A
BLATT 1
1 BL

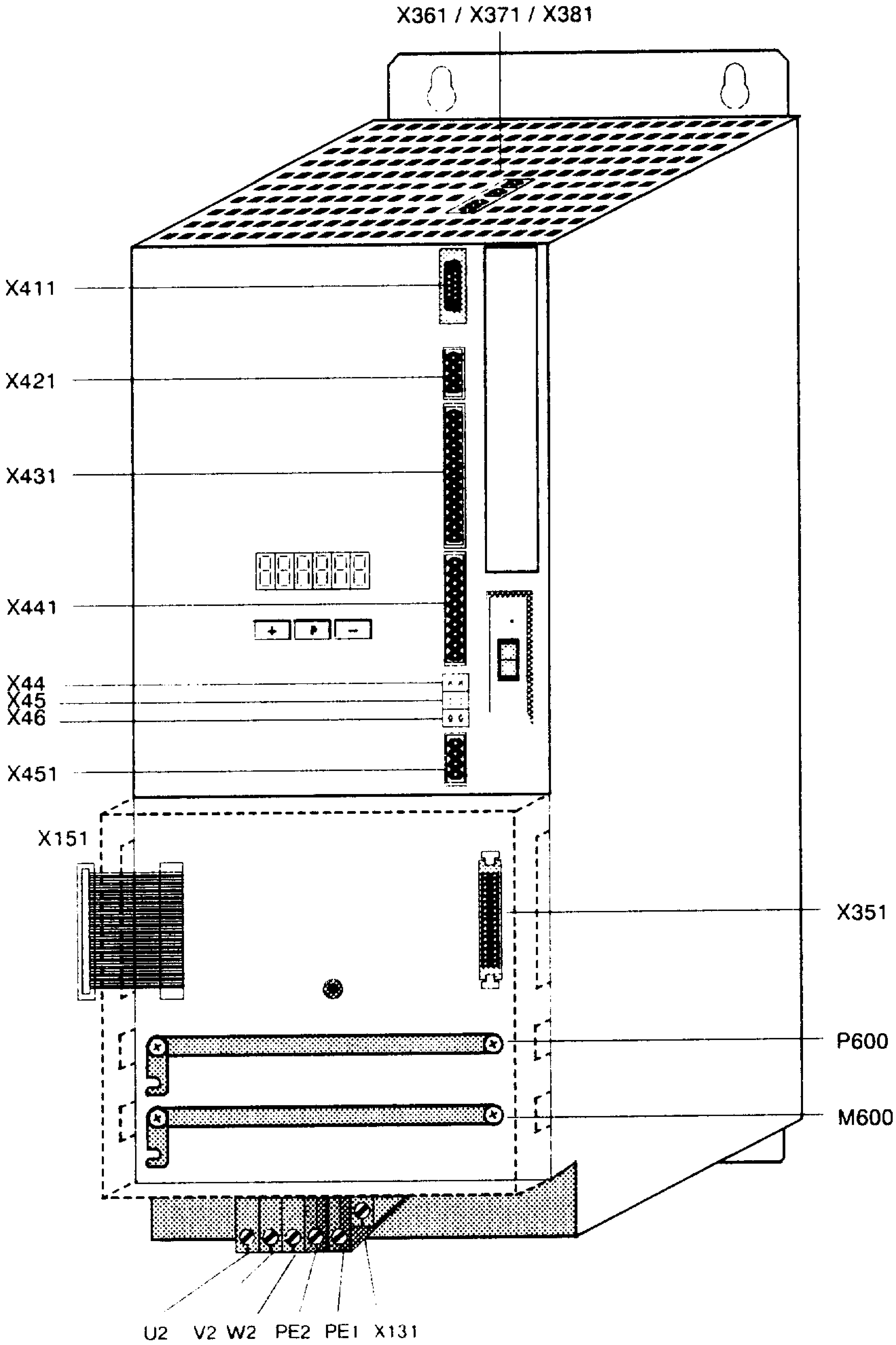

Lüftungsfreiraum
Variante 1
ohne Maßstab
Variante 2
ohne Maßstab
U2 V2 W2 PE2 PE1 X131
Oberflache -Gehause lackiert Ergo-grau-SN 30920-G611-B13
-Frontplatte -PPO Noryl PX 2000 Ergo-grau nach SN 30901
-Abdeckung -PPO Noryl PX 2000 Ergo-grau nach SN 30901
Gewicht 7,8 kg
Umgebungstemperatur 0°C bis +40°C
Schutzart IP 00
1) max Anschlußquerschnitt 16mm² (Klemme HDFK 10 Fa Phonix)
2) Zwischenkreisabdeckung
Vorderansicht ohne Abdeckung
3) max. Anzugsmoment: 1,3 Nm
AM-Modul 5/7 A
Siemens AG
1GE. 462 007.9805.00MB


Lüftungsfreiraum
Variante 1
ohne Maßstab
Variante 2
ohne Maßstab
U2
V2
W2
PE2
PE1
X131
Oberfläche -Gehäuse lackiert Ergo-grau-SN 30920-G611-B13
-Frontplatte-PPO Noryl PX 2000 Ergo-grau nach SN 30901
-Abdeckung -PPO Noryl PX 2000 Ergo-grau nach SN 30901
Gewicht 11,7 kg
Umgebungstemperatur 0°C bis +40°C
Schutzart IP00
1) max Anschlußquerschnitt 16 mm²
2) Zwischenkreisabdeckung
Vorderansicht ohne Abdeckung
AM-Modul 24/32A
Siemens AG
1GE 462 007.9824.00MB


208
260
25
200
150
25
11
5,5
480
440
444
225
240
20
8
1)
2)
3)
U2
V2
W2
PE1
PE2
X131
Lüftungsfreiraum
60
100
80
20
Variante 1
ohne Maßstab
Variante 2
ohne Maßstab
Oberfläche: -Gehäuse lackiert Ergo-grau-SN 30920-G611-B13
-Frontplatte -PPO Noryl PX 2000 Ergo-grau nach SN 30901
-Abdeckung -PPO Noryl PX 2000 Ergo-grau nach SN 30901
Gewicht: 15,6 kg
Umgebungstemperatur 0°C bis +40°C
Schutzart: IP00
1) max. Anschlußquerschnitt 25 mm²
2) Zwischenkreisabdeckung
Vorderansicht ohne Abdeckung
3) max Anschlußquerschnitt 16 mm²
28.3.91
1:1
Siemens AG
AM-Modul 30/40A
1GE.462 007 9830.00MBa


288
268
440
480
225
240
20
250
25
100
466
8
11
5,5
U2
V2
W2
PE1
PE2
KB
P
1) max. Anschlußquerschnitt 50 mm²
2) Zwischenkreisabdeckung
Vorderansicht ohne Abdeckung
3) max Anschlußquerschnitt 16mm²
Lüftungsfreiraum
60
100
80
20
200
Variante 1
ohne Maßstab
Variante 2
ohne Maßstab
Oberfläche: -Gehause lackiert Ergo-grau -SN 30920-G611-B13
-Frontplatte -PPO Noryl PX 2000 Ergo-grau nach SN 30901
-Abdeckung -PPO Noryl PX 2000 Ergo-grau nach SN 30901
Gewicht: 20 kg
Umgebungstemperatur: 0°C bis +40°C
Schutzart: IP00
Maßstab 1:1
07.01.1991
Siemens AG
AM-Modul 60/80 A
1GE 462 007 9860.00MBa

9.5 Locations of terminals and connectors



9.6 Manual post optimization

9.6.1 Current controller

9.6.1.1 Converter switching frequency, P-036

Using P-036, the converter switching frequency can be selected, depending on the motor, between 3.3 kHz and 4 kHz. A higher switching frequency (P-036 = 1) leads to an increase in the possible current controller dynamic performance, but also to increased switching losses. The current load capability is reduced to 80% of the rated value as a result of the switching losses. For high-speed motors (stator frequencies ≥150 Hz, low leakage reactances), P-036 should be set to 1. Further, a series reactor (entered in P-158!) is required.

For all motor types, an increased switching frequency can result in improved current controller characteristics. Criteria for problems with the current controller are: Uneven no-load running characteristics, torque surges. The phase current controller must be re-adjusted after the converter switching frequency has been changed (refer to Sections 9.6.1.2, 9.6.1.3).

9.6.1.2 Phase current controller, base speed range P-115

The pulses must be enabled and speed setpoint 0 present in order to set P-115. The current actual value of phase R is available at the test socket, and should be observed using an oscilloscope. Starting from 0, P-115 is increased by 1 and the current ripple observed. If the current ripple is significantly higher after a step, then the previous setting was the correct one. The increased ripple is also indicated by a significantly louder whistling noise. P-115 is far too large if there is a crackling noise. The correct phase current controller setting is of crucial importance for the complete closed-loop control. Values which are too large result in immediate stalling in the closed-loop control range (F11), and values which are too low, result in problems at high stator frequencies (uneven no-load running characteristics, torque surges).

9.6.1.3 Phase current controller, field-weakening range P-116

At higher speeds, the counter voltage of the induction motor results in a reduction of the effective loop gain of the phase current controller. Thus, it is possible to increase the current controller gain in the field-weakening range. P-116 should be set according to the following empirical formula:

$$(\text{P-116}) = (\text{P-115}) \cdot \underbrace{\frac{(\text{P-174})}{(\text{P-173})}}_{\text{Field weakening factor}}$$

Under certain circumstances, a somewhat higher value will provide better results. Excessive values will however lead to immediate stalling, and values which are too low will result in uneven running characteristics at no load or torque surges.

9.6.2 Adjusting the power offset (addresses 11D0H, 11D2H)

As the range of possible power values is very wide, an offset in the power sensing hardware can, under certain circumstances, become dominant and lead to significant errors. This applies especially at low speeds and/or for motors, which, compared with the converter current, only have a low rated current. This is typically manifested by different no-load currents in the closed-loop control range at the same absolute speed but with different directions of rotation. In the most unfavorable case, the magnetization current can almost be completely reduced to zero as a result of incorrect measurement, so that the motor coasts down. This can be remedied by adjusting the offset of the power sensing. This offset is dependent on the converter. Thus, it only needs to be set once, as long as the software card stays in the same converter. If the software card is inserted in another converter, re-adjustment is recommended. When adjusting, the fact that the power disappears when the current disappears is utilized. Thus, at 0 current setpoint, only the power offset is read, and can be corrected. The procedure is as follows:

- Speed setpoint = 0
- Pulses must be enabled (terminals 663, 65, 63, 64)
- P-057 = 0 (current setpoint = 0), note the old value
  Read-out the values of addresses 906H and 908H using P-250 and P-251
  (P-051 = 10H!) (refer to Section 4.7.3 for handling P-250 to 253)
- Enter the offset using P-250 to P-253:
  Value in address 11D0H must supplement the value in 906H to 10000H
  Value in address 11D2H must supplement the value in 908H to 10000H
  Example: The value in address 906H is FFFBH

  Then, $\frac{\text{0005H}}{\text{10000H}}$ must be entered into address 11D0H.

  The value in address 908 is 0003H.

  Then, $\frac{\text{FFFDH}}{\text{10000H}}$ must be entered into address 11D2H.
- Check, 0 ± 1 must be read-out in 906H and 908H (P-250 to P-251)
  (Caution: -1 = FFFFH)
- Reset P-057 to the old value

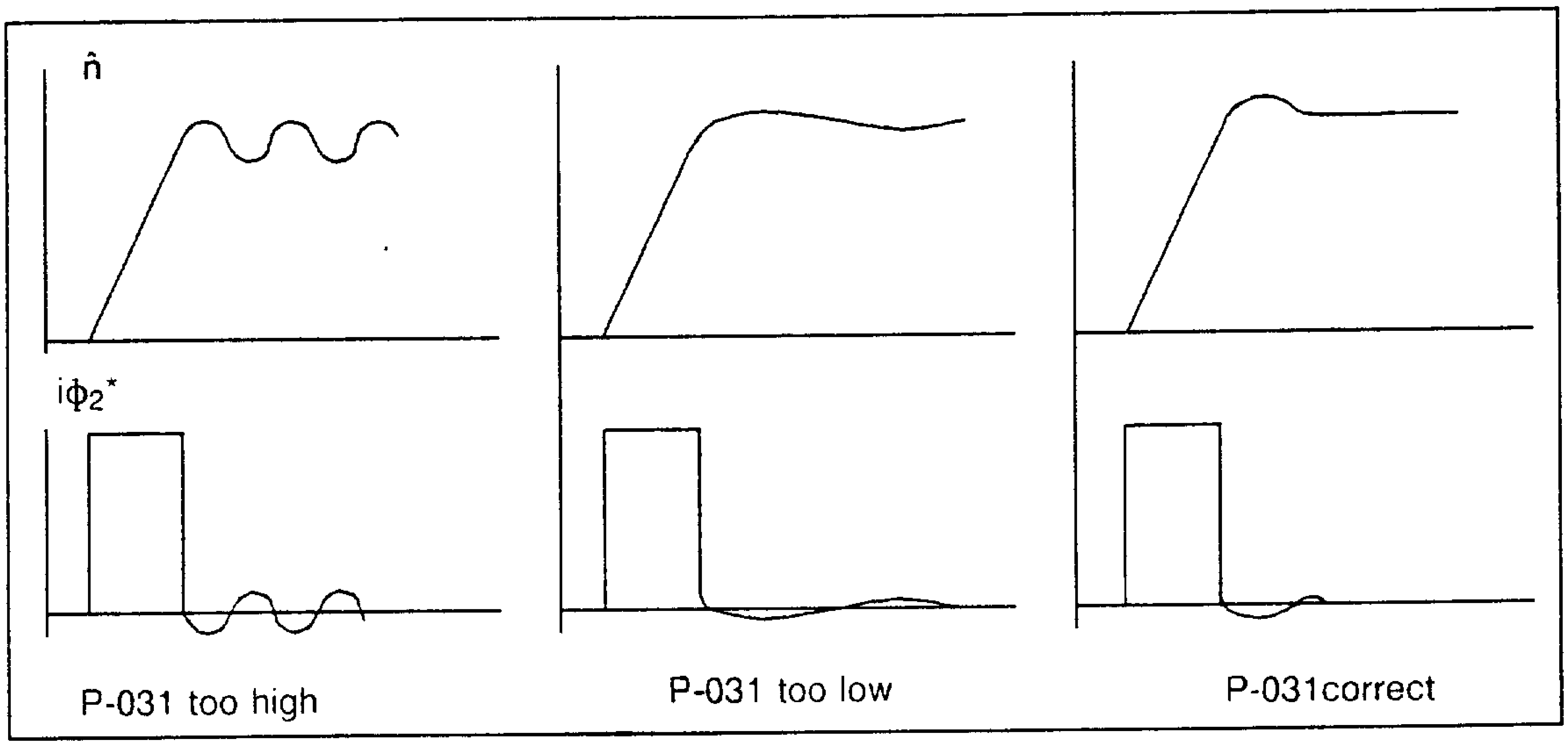
9.6.3 Rounding-off, P-018

For deep-bar, squirrel-cage induction rotors (practically all standard motors), the motor data changes as a function of the slip. Even slip changes lead to current displacement and thus to (temporary) motor parameter fluctuations. Fluctuations such as these especially occur in the field weakening range (the slip is greater there), and can lead to a stall condition, if the slip changes (i.e. when the torque changes). The torque and thus the slip are changed more slowly by increasing the rounding-off, so that the controllers can intervene in time. 30 ms is recommended for P-018 for deep-bar, squirrel-cage rotors, (default value is 4.00 ms).

9.6.4 Speed controller

9.6.4.1 Speed controller, P gain P-031

To adjust the speed controller, the speed (address 1110H or 1186H) and the torque-generating current (address 10D2H) should be connected to the D/A converters (P-066 + P-068), and the transformed quantities observed on an oscilloscope. A speed setpoint step can be used as excitation, and the overshoot observed when the setpoint has been reached. The setting is correct, if a maximum of two overshoots occur (refer to the following diagram). Overshoots with a long period (> 1 s, depending on the moment of inertia) result from a value in P-031 which is too small, and overshoots with a short period (< 500 ms depending on the moment of inertia) from a value in P-031 which is too high (refer to the following diagram).



At higher motor frequencies, the dynamic performance of the speed control loop is reduced, so that P-031 should be set at the maximum speed. If it is not possible to optimize the speed controller at the maximum speed with the specified measures, then it can be concluded, that settings, which were optimized later, are still grossly incorrect. In this case, P-031 should be set to a low value (e.g. 10.0), and adjusted after the other functions have been optimized.

9.6.4.2 Speed controller, integral action time P-032

With a very high external moment of inertia (from approx. 1:10) and elastic coupling, it is further necessary to increase the speed controller integral-action time.

9.6.5 Field controller, P gain P-034

Essentially, the following two problems can occur.

- If P-034 is too small, this leads to a tendency to stall (F-11) in the field weakening range at load or speed setpoint steps.
- If the value in P-034 is too high, disturbances occur in the speed controller loop, even under no-load conditions. This is manifested, depending on the deviation from the optimum value in P-034, in increased speed ripple or in torque surges. If P-034 is far too large, then this can result in stalling (F-11) even under no-load conditions.

9.6.6 No-load current, P-166

If it is not known, the no-load current is roughly calculated from cosΦ (P-178) and I_N (P-161) with P-153 = +1, . However, the no-load current can also be identified. In this case, the converter voltage requirement must be calculated at the rated motor speed:

$$V_{converter} = \underset{\underset{(P\text{-}162)}{\uparrow}}{V_N} + 2\pi\sqrt{3}\,\underset{\underset{(P\text{-}164)}{\uparrow}}{f_N} \cdot \underset{\underset{(P\text{-}158)}{\uparrow}}{L_{vor}} \cdot \underset{\underset{(P\text{-}166)}{\uparrow}}{I_0}$$

The maximum converter voltage, which is possible with closed-loop current control, is approximately 420 V. If the determined converter voltage is greater than 400 V, the frequency should be determined, at which approximately 400 V is available (V~f).

The no-load current is calculated as follows:

- Set P-172 greater than the no-load speed[1], note the old value.
- Set P-057 to approx. 50%, note the old value.
- Set the speed setpoint, so that the frequency determined above is available at no-load (n_{set} must be less than the value in P-172).
- P-010 indicates the associated converter voltage. The required voltage can be selected (V~i) by adjusting P-05. The motor must run under no-load conditions.
  If the current controller demands more than the max. converter voltage, the motor runs unevenly with torque surges and the current deviates significantly from the sinusoidal waveform. The value in P-010 fluctuates significantly. In this case, P-057 must be reduced.
- $[P\text{-}166] = \dfrac{[P\text{-}161] \cdot [P\text{-}057]}{100}$ (if P-057 was adjusted)
- The old values should be written back into P-172 and P-057.

If there are very significant deviations between the identified no-load current and the calculated value, a check should be made as to whether the correct converter was initialized (P-095), and whether the motor data refers to the selected circuit configuration of the motor (star or delta).

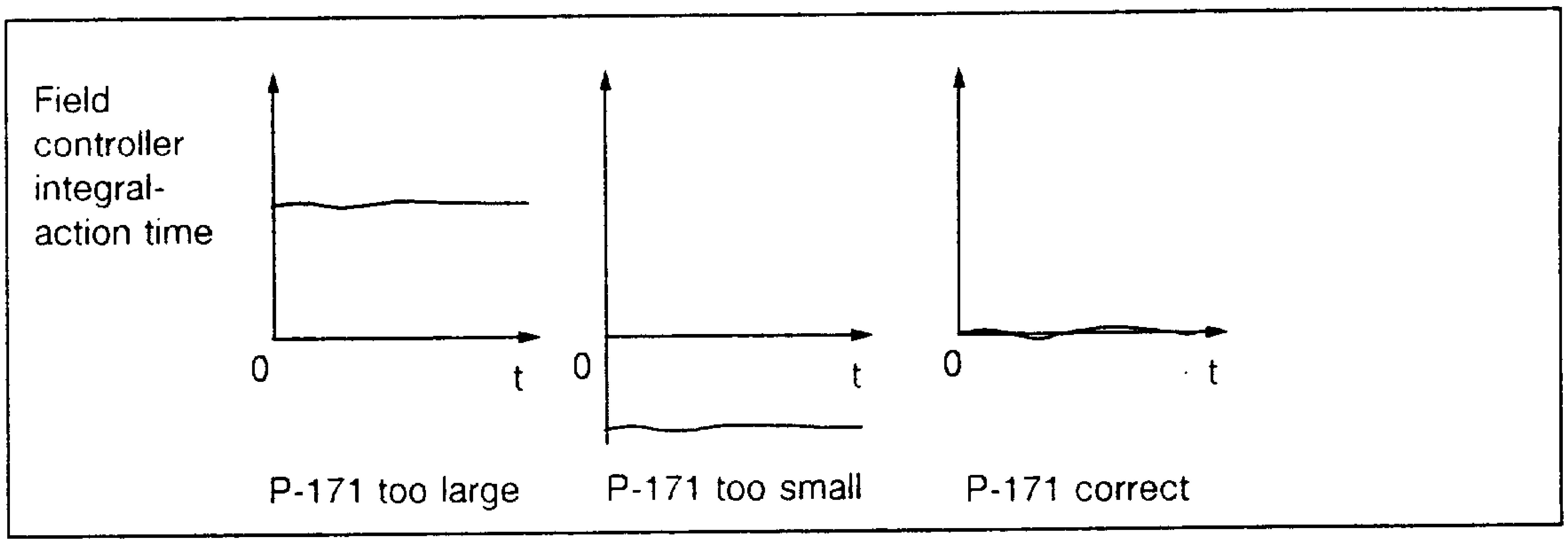
9.6.7 Main field reactance, P-171

The field controller pre-control ensures, that under no-load conditions, the field controller must not be activated, if the correct motor data was entered. If the field controller must intervene, then this is due to an erroneous value of the main field reactance. Thus, P-171 can be adjusted via the integral-action time of the field controller. The following procedure is recommended:

- Connect the integral action time of the field controller to a D/A converter, if required shift and observe on an oscilloscope
  For example: [P-068] = 116AH
  [P-069] = 3
- Enter the field weakening speed P-173 as speed setpoint. P-172 must be smaller than this setpoint!
- Adjust the integral action time of the field controller to approx. 0 using P-171.

1) *The no-load speed is the speed at rated frequency and 0 slip.*

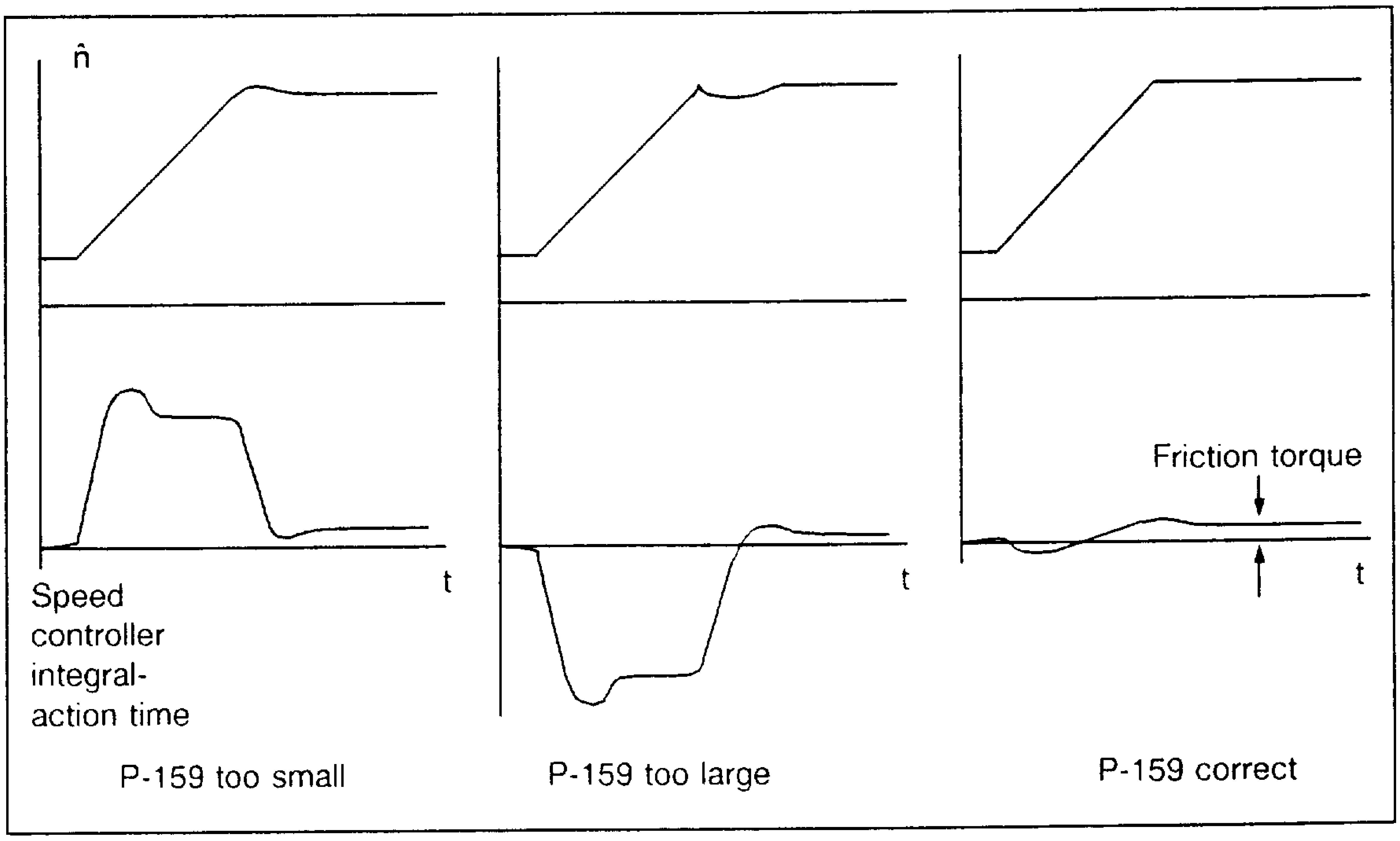
 6SC6111-6AD76
SIMODRIVE 611 (BE)



9.6.8 Moment of inertia, P-159

With the speed controller, pre-control ensures that when accelerating without load torque, the speed controller must not be activated if the moment of inertia was correctly set. The moment of inertia can be adjusted by adjusting the speed controller integral-action time to approx. 0 during acceleration.

- Connect the speed controller integral-action time to a D/A converter, and the calculated speed to the other and if required shift.
  For example: [P-066] = 1110H
  [P-068] = 117CH
  [P-069] = 3
  Observe the D/A converter outputs on the oscilloscope.
- Starting from a speed greater than P-172, enter a setpoint step towards a higher speed (if possible, up to the maximum speed).
- Adjust the moment of inertia according to the rules indicated in the following diagram. The characteristics in the diagram refer to a positive sign for the speed.

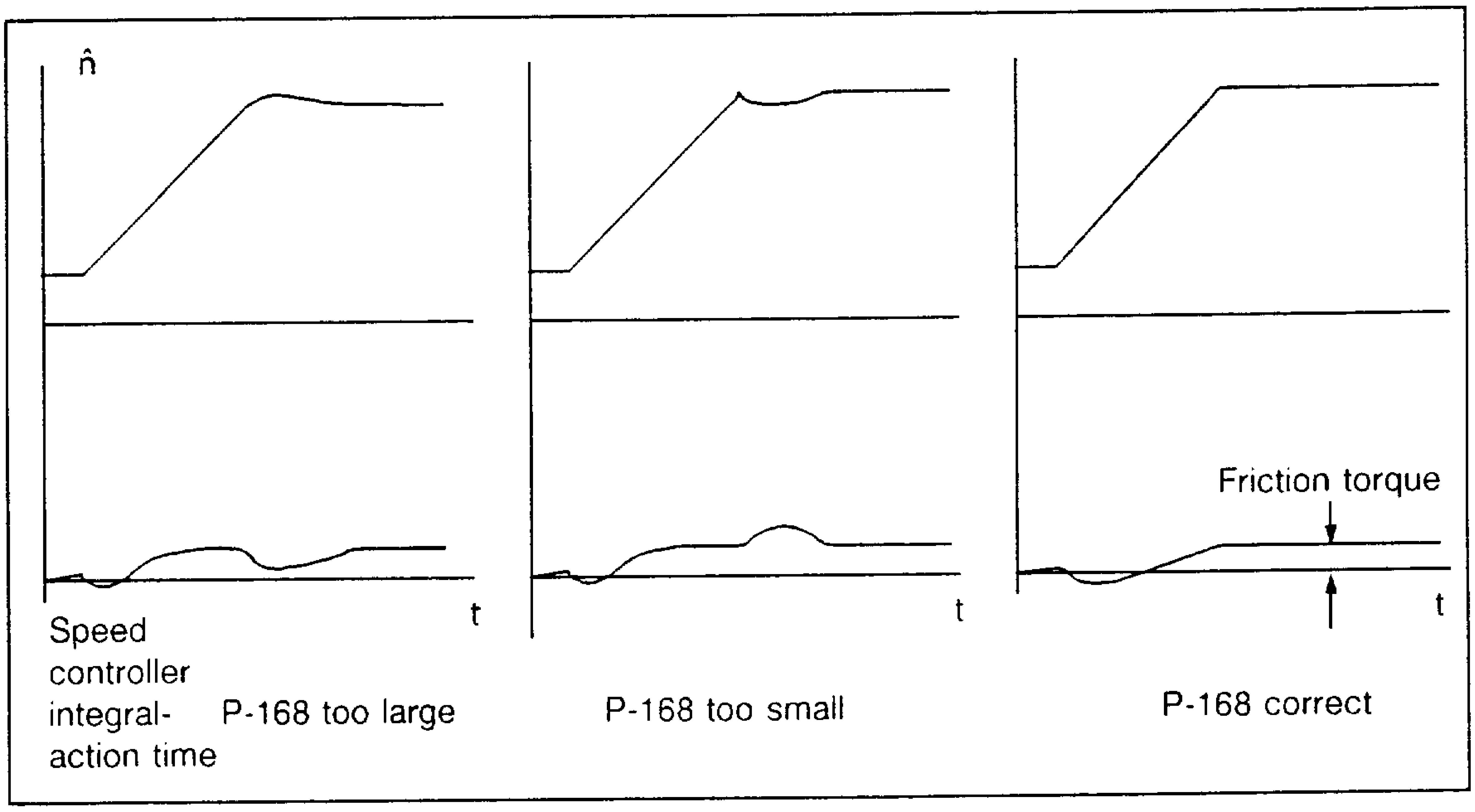


9.6.9 Rotor resistance, P-168

It is not possible to set the rotor resistance using the following technique for motors with deep-bar squirrel-cage rotors (refer to Section 9.6.3).

The rotor resistance is used in the slip calculation, so that an incorrect value in P-168 results in an erroneous slip pre-control for the motor torque. Thus, the calculated speed deviates from the actual speed by this slip error. When the torque is quickly reduced (i.e. slip reduced) this error becomes evident, and must be compensated for by the field-orientation controller. Thus, overshoot occurs after a speed setpoint step. If the rotor resistance is far too high, this can even result in self-excited speed oscillations. In order to eliminate overshoot due to incorrect moment of inertia, the moment of inertia should be previously adjusted. The procedure is as follows:

- (Generally not posssible for deep-bar, squirrel-cage rotors!)
- (First adjust the moment of inertia)
- Assign the D/A converters as before and use the same setpoint steps as when setting the moment of inertia (refer to Section 9.6.8)
- Adjust as defined in the following diagram:



When P-159 and P-168 have been adjusted, the speed setpoint is approached as fast as possible without overshoot. Further, the steady-state speed deviation under load is extremely small, as the slip is correctly specified (no speed sensing!).

9.6.10 Faults on the analog setpoint channel

Faults on the analog setpoint channel result in uneven running characteristics if this setpoint was selected. This has an even more significant effect due to the speed pre-control, the higher the moment of inertia (P-159). A counter-measure is to select another setpoint (fixed setpoint, digital setpoint). If this is not possible, the grounding and screening should be checked. If this is not successful, the speed setpoint can be digitally smoothed or an adjustable hysteresis inserted so that setpoint changes are only permitted when they exceed a specific set threshold. With the latter solution, it should be noted that the setpoint resolution deteriorates.

- Smoothing time constant for digital setpoint smoothing:
  Address 10BAH 1000 (decimal) = 10 ms time constant
  (change with P-250 to P-253, P-051 = 10H! Handling, refer to Section 4.7.3)
- Speed setpoint hysteresis
  Address 10ACH 3H = 14.6 mV analog voltage
  (change with P-250 to P-253, P-051 = 10H! Handling, refer to Section 4.7.3)

9.6.11 Field weakening speed, P-173

In Section 9.6.6, it was explained that the converter can output voltages of approximately 420 V (phase-to-phase, RMS). In order to fully utilize the full converter voltage, P-173 can be set, so that in the field weakening range and under no-load conditions, a max. of 400 V is indicated in P-010 (converter output voltage). With the motor torque, the voltage increases and 20 V voltage reserve is provided for this purpose. If P-173 is set too high, so that more than 420 V_{RMS} is required, and then the current controller goes into voltage limiting, the current deviates significantly from the sinusoidal waveform and the motor runs unevenly and can even stall. For stator frequencies above 300 Hz, P-173 can be reduced as in this case, the current controller has a higher voltage reserve.

9.7 Parameter list

The parameters in brackets are display parameters.

		Sub-parameter	Handled in Section	Valid from software release
(P-000)	Operating display	–	4.1.1	2.00
(P-001)	Speed setpoint (RPM)	–	4.1.2	2.00
(P-002)	Speed actual value, calculated (RPM)	–	4.1.2	2.00
(P-003)	Torque-generating current (% of the rated motor current	–	4.1.2	2.00
(P-004)	Utilization (% of the actual limit)	–	4.1.2	2.00
(P-005)	Machine frequency (Hz)	–	4.1.2	2.00
(P-006)	DC link voltage (V)	–	4.1.2	2.00
(P-007)	Absolute current (%of the rated motor current)	–	4.1.2	2.00
(P-008)	Field current components (% of the rated motor current)	–	4.1.2	2.00
(P-009)	Active power (% of the rated motor output)	–	4.1.2	2.00
(P-010)	Output converter voltage (V, phase-to-phase, RMS)	–	4.1.2	3.00
(P-011)	Input terminal status (hex)	–	4.1.3	2.00
P-012	Fine normalization D/A converter 1 (%)	–	4.2.3	2.00
P-013	Fine normalization D/A converter 2 (%)	–	4.2.3	2.00
P-014	Reference speed, analog setpoints (RPM)	4M[1)]	4.3.4	2.00
P-015	Offset analog setpoint 1 (hex)	–	4.3.4	2.00
P-016	Ramp-up time, ramp-function generator 1 (s)	4M[1)]	4.3.3	2.00
P-017	Ramp-down time, ramp-function generator 1 (s)	4M[1)]	4.3.3	2.00
P-018	Initial rounding-off (ms)	–	4.3.3	2.00
P-019	Offset, analog setpoint 2 (hex)	–	4.3.4	2.00
(P-020)	Executed self-tuned functions (hex)	4M[1)]	4.1.4	3.00
P-021	Threshold $\lvert n_{act} \rvert < n_{min}$ relay (RPM)	8B[2)]	4.9.1	2.00
P-022	Internal minimum speed (RPM)	4M[1)]	4.7.1	2.00
P-023	Threshold $\lvert n_{act} \rvert < n_x$ relay (RPM)	8B[2)]	4.9.3	2.00
P-024	Normalization, analog setpoint input 1 (V)	–	4.3.4	2.00
P-025	Normalization, analog setpoint input 2 (V)	–	4.3.4	2.00
P-026	free			

1) *M ≙ motor-specific*
2) *B ≙ machining-specific*

		Sub-parameter	Handled in Section	Valid from software release
P-027	Speed tolerance bandwidth $n_{act} = n_{set}$ (RPM)	8B[2]	4.9.2	2.00
P-028	Diagnostics (hex)	–	–	3.00
P-029	Speed limiting (RPM)	8B[2]	3.3.5. 4.6	2.00
P-030	Steady-state minimum speed (RPM)	4M[1]	4.3.9	2.00
P-031	P gain. speed controller (arithmetic format)	4M[1]	4.5.2, 3.3.4	2.00
P-032	Speed controller integral-action time (ms)	4M[1]	4.5.2, 3.3.4	2.00
P-033	Free			
P-034	Field controller P gain (A/Vs)	4M[1]	4.5.3, 3.3.4	2.00
P-035	Field controller integral action time (ms)	4M[1]	4.5.3	2.00
P-036	Converter changeover frequency (hex)	4M[1]	4.5.1, 3.3.4	2.00
P-037, P-038	Free			
P-039	1st torque limit (% of the rated motor torque)	8B[2]	3.3.5, 4.6	2.00
P-040	Free			
P-041	2nd torque limit (% of the rated motor torque)	8B[2]	3.3.5, 4.6	2.00
P-042	Ramp-up time, ramp-function generator 2 (s)	4M[1]	4.3.3	2.00
P-043	Ramp-down time. ramp-function generator 2 (s)	4M[1]	4.3.3	2.00
P-044 to P-046	Free			
P-047	Threshold $\|M_d\| < M_{dx}$ relay (% of the actual limit)	8B[2]	4.9.2	2.00
P-048 P-049	Free			
P-050	Changeover speed. 2nd torque limit (RPM)	8B[2]	4.6	2.00
P-051	Write protection (hex)	–	4.7.4	2.00

1) M ≙ motor-specific

2) B ≙ machining-specific

		Sub-parameter	Handled in Section	Valid from software release
P-052	Transfer into the EEPROM (hex)	–	4.7.4	2.00
P-053	Control bits (hex)	–	4.7.4	2.00
P-054	Speed range inhibit, lower speed (RPM)	4M[1)]	4.3.8	2.00
P-055	Speed range inhibit, upper speed (RPM)	4M[1)]	4.3.8	2.00
P-056	Motor selection	–	4.7.4	2.00
P-057	Steady-state current in the open-loop control range (% of the rated motor current)	4M[1)]	3.3.5, 4.5.5	2.00
P-058	Accelerating torque in the open-loop control range (% of the rated motor torque)	4M[1)]	3.3.5, 4.5.5	2.00
P-059	Current limiting (% of the rated motor current)	4M[1)]	3.3.5, 4.6	2.00
P-060	Output limit (% of the rated motor output)	4M[1)]	4.6	2.00
P-061	Fixed DC link voltage (V)	–	4.7.4	2.00
P-062 to P-065	Free			
P-066	Address for D/A converter 1 (hex)	–	4.2.3	2.00
P-067	Shift factor for D/A converter 1 (hex)	–	4.2.3	2.00
P-068	Address for D/A converter 2 (hex)	–	4.2.3	2.00
P-069	Shift factor for D/A converter 2 (hex)	–	4.2.3	2.00
(P-070)	Transistor diagnostics (hex)	–	5.4.2	2.00
P-071 to P-074	Free			
P-075	Reset transistor diagnostics (hex)		5.4.2	2.00
P-076, P-077	Free			
P-078	Offset, D/A converter 1 (hex)		4.2.3	2.00
P-079	Offset, D/A converter 2 (hex)		4.2.3	2.00
P-080	Free			
P-081	Function assignment, input terminal E1	–	4.8	2.00
P-082	Function assignment, input terminal E2	–	4.8	2.00
P-083	Function assignment, input terminal E3	–	4.8	2.00
P-084	Function assignment, input terminal E4	–	4.8	2.00

1) M ≙ motor-specific

		Sub-para-meter	Handled in Section	Valid from software release
P-085	Function assignment, input terminal E5	–	4.8	2.00
P-086	Function assignment, input terminal E6	–	4.8	2.00
P-087	Function assignment, input terminal E7	–	4.8	2.00
P-088	Function assignment, input terminal E8	–	4.8	2.00
P-089	Function assignment, input terminal E9	–	4.8	2.00
P-090	Control parameter display (hex)		4.7.4	2.00
P-091 to P-094	Free			
P-095	Converter code number (initialization)	–	4.7.2	2.00
P-096	Motor code number (initialization)	4M[1]	4.7.2	2.00
P-097	Start initialization (hex)	–	4.7.2	2.00
P-098	Free	–		
(P-099)	Software release	–	4.1.5	2.00
(P-100)	Operating display	–	4.1.1	2.00
(P-101)	Speed setpoint (RPM)	–	4.1.2	2.00
(P-102)	Speed actual value, calculated (RPM)	–	4.1.2	2.00
P-103 to P-112	Free		5.6	3.00
P-113	Standard setpoint selection	–	4.3.2	2.00
P-114	Fixed setpoints/motorized potentiometer setpoint (RPM)	8	4.3.5	2.00
P-115	P gain, current controller, base speed range (hex)	4M[1]	4.5.1	2.00
P-116	P gain, current controller, field weakening range (hex)	4M[1]	4.5.1	2.00
P-117 to P-150	Free			
P-151	Write protection (hex)		4.7.4	2.00
P-152	Transfer into the EEPROM (hex)		4.7.4	2.00
P-153	Calculate motor/controller data (hex)		4.7.4	2.00
P-154	Oscillation setpoint 1 (RPM)		4.3.7	2.00
P-155	Oscillation setpoint 2 (RPM)		4.3.7	2.00
P-156	Oscillation time interval 1 (s)		4.3.7	2.00
P-157	Oscillation time interval 2 (s)		4.3.7	2.00

1) *M ≙ motor-specific*

		Sub-para-meter	Handled in Section	Valid from software release
P-158	Series reactor inductance (mH)	4M[1]	4.4	2.00
P-159	Moment of inertia (gm^2)	4M[1]	4.4	2.00
P-160	Rated motor output (kW)	4M[1]	4.4	2.00
P-161	Rated motor current (A_{RMS})	4M[1]	4.4	2.00
P-162	Rated motor voltage (V_{RMS})	4M[1]	4.4	2.00
P-163	Rated motor speed (RPM)	4M[1]	4.4	2.00
P-164	Rated motor frequency (Hz)	4M[1]	4.4	2.00
P-165	Free			
P-166	No-load current (A_{RMS})	4M[1]	4.4	2.00
P-167	Stator resistance (Ω)	4M[1]	4.4	2.00
P-168	Rotor resistance (Ω)	4M[1]	4.4 3.3.4	2.00
P-169	Stator leakage reactance (Ω)	4M[1]	4.4	2.00
P-170	Rotor leakage reactance (Ω)	4M[1]	4.4	2.00
P-171	Main field reactance (Ω)	4M[1]	4.4 3.3.4	200
P-172	Changeover speed, closed-loop/open-loop control (RPM)	4M[1]	4.5.4	2.00
P-173	Field weakening speed (RPM)	4M[1]	4.5.4	2.00
P-174	Max. motor speed (RPM)	4M[1]	4.4	2.00
P-175	Thermal motor time constant (I^2t pre-alarm) (min)	4M[1]	4.9.4	2.00
P-176	Stalling torque speed (RPM)	4M[1]	4.5.4	2.00
P-177	Free			
P-178	cos Φ (power factor)	4M[1]	4.4	2.00
P-179	Start min/max monitoring (hex)	–	5.4.3	2.00
P-180	Free			
P-181	Min/max monitoring address (hex)	–	5.4.3	2.00
(P-182)	Minimum value display (hex)	–	5.4.3	2.00
(P-183)	Maximum value display (hex)	–	5.4.3	2.00
P-184	Free			
P-185	Address, variable relay function 1 (hex)	–	4.9.6	2.00
P-186	Threshold, variable relay function 1 (hex)	–	4.9.6	2.00
P-187	Pull-in delay, variable relay function 1(s)		4.9.6	2.00

1) M ≙ motor-specific

 6SC6111-6AD76
SIMODRIVE 611 (BE)

		Sub-parameter	Handled in Section	Valid from software release
P-188	Drop-out delay, variable relay function 1 (s)	–	4.9.6	2.00
P-189	Hysteresis, variable relay function 1 (hex)	–	4.9.6	2.00
P-190	Address, variable relay function 2 (hex)	–	4.9.6	2.00
P-191	Threshold, variable relay function 2 (hex)	–	4.9.6	2.00
P-192	Pull-in delay, variable relay function 2 (s)	–	4.9.6	2.00
P-193	Drop-out delay, variable relay function 2 (s)	–	4.9.6	2.00
P-194	Hysteresis, variable relay function 2 (hex)	–	4.9.6	2.00
P-195	Speed controller adaption, lower speed (RPM)	4M[1]	4.5.2	2.00
P-196	Speed controller adaption, upper speed (RPM)	4M[1]	4.5.2	2.00
P-197	Speed controller adaption, gain, lower speed (arithmetic format)	4M[1]	4.5.2	2.00
P-198	Speed controller adaption, gain, upper speed (arithmetic format)	4M[1]	4.5.2	2.00
P-199	Speed controller adaption, gain (%)	4M[1]	4.5.2	2.00
P-200 to P-202	Free			
P-203	Activate speed controller adaption	4M[1]	4.5.2	2.00
P-204	Function selection, post optimization	–	4.7.4, 3.3.4	3.00
P-205	Start post-optimization	–	4.7.4, 3.3.4	3.00
P-206	Activate transient recorder (hex)	–	5.4.4	2.00
P-207	Trigger condition, transient recorder (hex)	–	5.4.4	2.00
P-208	Address for the start condition (hex)	–	5.4.4	2.00
P-209	Threshold for the start condition (hex)	–	5.4.4	2.00
P-210	Address for the stop condition (hex)	–	5.4.4	2.00
P-211	Threshold for the stop condition (hex)	–	5.4.4	2.00
P-212	Address, record signal 1 (hex)	–	5.4.4	2.00
P-213	Address, record signal 2 (hex)	–	5.4.4	2.00
P-214	Activate transient recorder on D/A's	–	5.4.4	2.00
P-215	Shift factor, recorder output 1	–	5.4.4	2.00

1) M ≙ motor-specific

		Sub-para-meter	Handled in Section	Valid from software release
P-216	Shift factor, recording output 2	–	5.4.4	2.00
P-217	Trigger signal amplitude 1 (hex)	–	5.4.4	2.00
P-218	Trigger signal amplitude 2 (hex)	–	5.4.4	2.00
P-219 bis P-240	Free			
P-241	Function assignment, relay A11	–	4.9	2.00
P-242	Function assignment, relay A21	–	4.9	2.00
P-243	Function assignment, relay A31	–	4.9	2.00
P-244	Function assignment, relay A41	–	4.9	2.00
P-245	Function assignment, relay A51	–	4.9	2.00
P-246	Function assignment, relay A61	–	4.9	2.00
P-247	Relay function control word	–	4.9.8	3.00
P-248	Free			
P-249	Segment address, memory function (hex)	–	4.7.3	2.00
P-250	Address, memory function (hex)	–	4.7.3	2.00
(P-251)	Memory contents display, memory function (hex)	–	4.7.3	2.00
P-252	Transfer value, memory function (hex)	–	4.7.3	2.00
P-253	Transfer control, memory function	–	4.7.3	2.00
(P-254)	Display of the active terminal functions (hex)	–	4.1.3	2.00
(P-255)	Display of the active terminal functions (hex)	–	4.1.3	2.00

9.8 Setting and check data

Display parameters (refer to Section 4.1)

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-000 **P-100**	Operator display	-	-	-	
P-001 **P-101**	Speed setpoint	-	RPM	-	
P-002 **P-102**	Speed actual value	-	RPM	-	
P-003	Torque-generating current	-	% ref. to rated motor current	-	
P-004	Utilization	-	% of actual limit	-	
P-005	Motor frequency	-	Hz	-	
P-006	DC link voltage	-	V	-	
P-007	Absolute current	-	%ref. to rated motor current	-	
P-008	Field-generating current	-	%ref. to rated motor current	-	
P-009	Active power	-	% ref. to rated motor output	-	
P-010	Converter output voltage	-	V_{RMS} (ph.-to-ph.)	-	
P-011	Status of the input terminals	-	Hex	-	
P-254	Display of active functions	-	Hex	-	
P-255	Display of active functions	-	Hex	-	
P-020	Executed self-tuned functions	-	Hex	-	
P-099	Software release	-	-	-	

Setting data, D/A converters (refer to Section 4.2)

Parameter	Significance	Setting range	Dimen-sion	Factory Setting	Setting
P-012	Fine normalization, D/A converter 1	-1000.0... + 1000.0	%	100.0	
P-013	Fine normalization, D/A converter 2	-1000.0... + 1000.0	%	100.0	
P-067	Shift factor, D/A converter 1	0...F	Hex	0	
P-069	Shift factor, D/A converter 2	0...F	Hex	0	
P-066	Address, D/A converter 1	0 0 0 0...F F F F	Hex	11B6	
P-069	Address, D/A converter 2	0 0 0 0...F F F F	Hex	11B8	
P-078	Offset, D/A converter 1	-127... + 127	D/A con. incr.	0	
P-079	Offset, D/A converter 2	-127... + 127	D/A con. incr.	0	

Speed setpoint values, ramp-function generator (refer to Sections 4.3.2 to 4.3.3)

P-113	Standard setpoint value selection	0...9	–	1	
P-016	Ramp-up time, ramp-fct. gen. 1	0.00...32.00	s	0.00	
P-016.1	Motor 1				
P-016.2	Motor 2				
P-016.3	Motor 3				
P-016.4	Motor 4				
P-017	Ramp-down time, ramp-fct. gen. 1	0.00...32.00	s	0.00	
P-017.1	Motor 1				
P-017.2	Motor 2				
P-017.3	Motor 3				
P-017.4	Motor 4				
P-042	Ramp-up time, ramp-fct. gen. 2	0.00...32.00	s	0.00	
P-042.1	Motor 1				
P-042.2	Motor 2				
P-042.3	Motor 3				
P-042.4	Motor 4				

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-043	Ramp-down time. ramp-fct. gen. 2	0.00...32.00	s	0.00	
P-043.1	Motor 1				
P-043.2	Motor 2				
P-043.3	Motor 3				
P-043.4	Motor 4				
P-018	Initial rounding-off	4.00...100.00	ms	0.00	

Speed setpoint values, analog setpoint channels (refer to Section 4.3.4)

P-014	Normalization n_{set}	-29000... + 29000	RPM	0	
P-014.1	Motor 1				
P-014.2	Motor 2				
P-014.3	Motor 3				
P-014.4	Motor 4				
P-024	Normalization n_{set}, channel 1	2.0...10.0	V	10.0	
P-025	Normalization n_{set}, channel 2	2.0...10.0	V	10.0	
P-015	Offset correction n_{set}, channel 1	E 0 0 0...2 0 0 0	Hex (A/D conv. incr.)	0	
P-019	Offset correction n_{set}, channel 2	E 0 0 0...2 0 0 0	Hex (A/D conv. incr.)	0	

Speed setpoint values, fixed setpoint /mot. pot. setpoint (refer to Sections 4.3.5 to 4.3.6)

P-114	Fixed set. values/mot. pot. set. val.	-29000... + 29000	RPM	0	
P-114.1	Fixed setpoint value 1				
P-114.2	Fixed setpoint value 2				
P-114.3	Fixed setpoint value 3				
P-114.4	Fixed setpoint value 4				
P-114.5	Fixed setpoint value 5				
P-114.6	Fixed setpoint value 6				
P-114.7	Fixed setpoint value 7				
P-114.8	Setpoint, motorized potentiometer		RPM		

Speed setpoint value, oscillation generator (refer to Section 4.3.7)

Parameter	Significance	Setting range	Dimen-sion	Factory setting	Setting
P-154	Oscillation setpoint value 1	-29000...29000	RPM	0	
P-155	Oscillation setpoint value 2	-29000...29000	RPM	0	
P-156	Oscillation interval time 1	0.002...60.000	s	1.000	
P-157	Oscillation interval time 2	0.002...60.000	s	1.000	

Speed setpoint values, steady-state minimum speed, speed range inhibit
(refer to Section 4.3.8)

P-030	Steady-state minimum speed	0...29000	RPM	0	
P-030.1	Motor 1				
P-030.2	Motor 2				
P-030.3	Motor 3				
P-030.4	Motor 4				
P-054	Speed range inhibit, lower speed	0...29000	RPM	0	
P-054.1	Motor 1				
P-054.2	Motor 2				
P-054.3	Motor 3				
P-054.4	Motor 4				
P-055	Speed range inhibit, upper speed	0...29000	RPM	0	
P-055.1	Motor 1				
P-055.2	Motor 2				
P-055.3	Motor 3				
P-055.4	Motor 4				

Motor data (refer to Sect. 4.4)

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-158	Inductance, series reactor	0.000...65.000	mH	0.000	
P-158.1	Motor 1				
P-158.2	Motor 2				
P-158.3	Motor 3				
P-158.4	Motor 4				
P-159	Drive moment of inertia	0.0...6500.0	gm^2	0.0	
P-159.1	Motor 1				
P-159.2	Motor 2				
P-159.3	Motor 3				
P-159.4	Motor 4				
P-160	Rated output	0.00...650.00	kW	0.00[1)]	
P-160.1	Motor 1				
P-160.2	Motor 2				
P-160.3	Motor 3				
P-160.4	Motor 4				
P-161	Rated current	0.00...650.00	A_{RMS}	0.00[1)]	
P-161.1	Motor 1				
P-161.2	Motor 2				
P-161.3	Motor 3				
P-161.4	Motor 4				
P-162	Rated voltage	0...650	V_{RMS}	379[1)]	
P-162.1	Motor 1				
P-162.2	Motor 2				
P-162.3	Motor 3				
P-162.4	Motor 4				
P-163	Rated speed	0...65000	RPM	1500[1)]	
P-163.1	Motor 1				
P-163.2	Motor 2				
P-163.3	Motor 3				
P-163.4	Motor 4				

1) if P-096 = 0 at initialization

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-164	Rated frequency	0.00...650.00	Hz	50.00[1]	
P-164.1	Motor 1				
P-164.2	Motor 2				
P-164.3	Motor 3				
P-164.4	Motor 4				
P-166	No-load current	0.00...max. conv. current	A_{RMS}	0.00	
P-166.1	Motor 1				
P-166.2	Motor 2				
P-166.3	Motor 3				
P-166.4	Motor 4				
P-167	Stator resistance	0.000...65.000	Ω	0.000[1]	
P-167.1	Motor 1				
P-167.2	Motor 2				
P-167.3	Motor 3				
P-167.4	Motor 4				
P-168	Rotor resistance	0.000...65.000	Ω	0.000[1]	
P-168.1	Motor 1				
P-168.2	Motor 2				
P-168.3	Motor 3				
P-168.4	Motor 4				
P-169	Stator leakage reactance	0.000...65.000	Ω	0.000[1]	
P-169.1	Motor 1				
P-169.2	Motor 2				
P-169.3	Motor 3				
P-169.4	Motor 4				
P-170	Rotor leakage reactance	0.000...65.000	Ω	0.000[1]	
P-170.1	Motor 1				
P-170.2	Motor 2				
P-170.3	Motor 3				
P-170.4	Motor 4				

1) *if P-096 = 0 at initialization*

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-171	Main field reactance	0.00...650.00	Ω	0.00[1]	
P-171.1	Motor 1				
P-171.2	Motor 2				
P-171.3	Motor 3				
P-171.4	Motor 4				
P-174	Max. speed	0...29000	RPM	1500[1]	
P-174.1	Motor 1				
P-174.2	Motor 2				
P-174.3	Motor 3				
P-174.4	Motor 4				
P-178	Power factor cos Φ	0.000...1.000	–	0.800	
P-178.1	Motor 1				
P-178.2	Motor 2				
P-178.3	Motor 3				
P-178.4	Motor 4				

Controller data, current controller, speed controller (refer to Sections 4.5.1 to 4.5.2)

P-031	Speed controller gain	0.0...327.6	Arith. format	50.0	
P-031.1	Motor 1				
P-031.2	Motor 2				
P-031.3	Motor 3				
P-031.4	Motor 4				
P-032	Speed contr. integral-action time	10...600.0	ms	140.0	
P-032.1	Motor 1				
P-032.2	Motor 2				
P-032.3	Motor 3				
P-032.4	Motor 4				

1) if P-096 = 0 at initialization

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-036	Converter switching frequency	0...1	Hex	0	
P-036.1	Motor 1				
P-036.2	Motor 2				
P-036.3	Motor 3				
P-036.4	Motor 4				
P-115	Phase current controller gain (base speed range)	0...F	Hex	2	
P-115.1	Motor 1				
P-115.2	Motor 2				
P-115.3	Motor 3				
P-115.4	Motor 4				
P-116	Phase current controller gain (field weakening range)	0...F F	Hex	2	
P-116.1	Motor 1				
P-116.2	Motor 2				
P-116.3	Motor 3				
P-116.4	Motor 4				
P-195	Speed controller adaption, lower speed	0...29000	RPM	0	
P-195.1	Motor 1				
P-195.2	Motor 2				
P-195.3	Motor 3				
P-195.4	Motor 4				
P-196	Speed controller adaption, upper speed	0...29000	RPM	0	
P-196.1	Motor 1				
P-196.2	Motor 2				
P-196.3	Motor 3				
P-196.4	Motor 4				
P-197	Speed controller adaption, gain, lower speed	0...327.6	Arith. format	50.0	
P-197.1	Motor 1				
P-197.2	Motor 2				
P-197.3	Motor 3				
P-197.4	Motor 4				

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-198	Speed controller adaption, gain, upper speed	0...327.6	Arith. format	10.0	
P-198.1	Motor 1				
P-198.2	Motor 2				
P-198.3	Motor 3				
P-198.4	Motor 4				
P-199	Speed controller adaption, gain factor	1...150	%	100	
P-199.1	Motor 1				
P-199.2	Motor 2				
P-199.3	Motor 3				
P-199.4	Motor 4				
P-203	Activate speed controller adaption	0...1	-	0	
P-203.1	Motor 1				
P-203.2	Motor 2				
P-203.3	Motor 3				
P-203.4	Motor 4				

Controller data, field controller, other controller parameters
(refer to Sections 4.5.3 to 4.5.4)

P-034	Field controller gain	0...600.0	A/Vs	40.0	
P-034.1	Motor 1				
P-034.2	Motor 2				
P-034.3	Motor 3				
P-034.4	Motor 4				
P-035	Field controller integral-action time	5.0...600.0	ms	30.0	
P-035.1	Motor 1				
P-035.2	Motor 2				
P-035.3	Motor 3				
P-035.4	Motor 4				

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-173	Field weakening speed	0...29000	RPM	1500	
P-173.1	Motor 1				
P-173.2	Motor 2				
P-173.3	Motor 3				
P-173.4	Motor 4				
P-176	Stalling torque speed	0...65535	RPM	32767	
P-176.1	Motor 1				
P-176.2	Motor 2				
P-176.3	Motor 3				
P-176.4	Motor 4				

Controller data, open-loop controlled range (refer to Section 4.5.5)

P-057	Steady-state current open-loop controlled range	0...150	% ref. to rated motor current	100	
P-057.1	Motor 1				
P-057.2	Motor 2				
P-057.3	Motor 3				
P-057.4	Motor 4				
P-058	Accelerating torque in the open-loop controlled range	0...399	% ref. to rated motor torque	50	
P-058.1	Motor 1				
P-058.2	Motor 2				
P-058.3	Motor 3				
P-058.4	Motor 4				
P-172	Changeover speed closed-loop/open-loop control	0...29000	RPM	300	
P-172.1	Motor 1				
P-172.2	Motor 2				
P-172.3	Motor 3				
P-172.4	Motor 4				

Limiting (refer to Section 4.6)

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-029	Speed limiting	0...29000	RPM	6000	
P-029.1	Machining-specific 1				
P-029.2	Machining-specific 2				
P-029.3	Machining-specific 3				
P-029.4	Machining-specific 4				
P-029.5	Machining-specific 5				
P-029.6	Machining-specific 6				
P-029.7	Machining-specific 7				
P-029.8	Machining-specific 8				
P-039	1st torque limiting	0...399	% ref. to rated motor torque	100	
P-039.1	Machining-specific 1				
P-039.2	Machining-specific 2				
P-039.3	Machining-specific 3				
P-039.4	Machining-specific 4				
P-039.5	Machining-specific 5				
P-039.6	Machining-specific 6				
P-039.7	Machining-specific 7				
P-039.8	Machining-specific 8				
P-041	2nd torque limiting	0...399	% ref. to rated motor torque	50	
P-041.1	Machining-specific 1				
P-041.2	Machining-specific 2				
P-041.3	Machining-specific 3				
P-041.4	Machining-specific 4				
P-041.5	Machining-specific 5				
P-041.6	Machining-specific 6				
P-041.7	Machining-specific 7				
P-041.8	Machining-specific 8				

Parameter	Significance	Setting range	Dimen-sion	Factory setting	Setting
P-050	Changeover speed, 2nd torque limit	0...29000	RPM	6000	
P-050.1	Machining-specific 1				
P-050.2	Machining-specific 2				
P-050.3	Machining-specific 3				
P-050.4	Machining-specific 4				
P-050.5	Machining-specific 5				
P-050.6	Machining-specific 6				
P-050.7	Machining-specific 7				
P-050.8	Machining-specific 8				
P-059	Current limiting	0...399	% ref. to rated motor current	100	
P-059.1	Motor 1				
P-059.2	Motor 2				
P-059.3	Motor 3				
P-059.4	Motor 4				
P-060	Power limiting	0...399	% ref. to rated motor current	100	
P-060.1	Motor 1				
P-060.2	Motor 2				
P-060.3	Motor 3				
P-060.4	Motor 4				

Control parameters (Section 4.7)

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-022	Internal min. speed	1...16000	RPM	8	
P-022.1	Motor 1				
P-022.2	Motor 2				
P-022.3	Motor 3				
P-022.4	Motor 4				
P-095	Converter code No.	4...9	–	7	
P-096	Motor code No.	0...6	–	0	
P-097	Start initialization	–	Hex	0	
P-249	Segment address, memory function	0...F F F F	Hex	0	
P-250	Address, memory function	0...F F F F	Hex	0	
P-251	Memory contents display, memory function	–	Hex	–	
P-252	Transfer value, memory function	0...F F F F	Hex	0	
P-253	Transfer control, memory function	–1... +1	–	0	
P-051 **P-151**	Write protection	0...7 F F F	Hex	0	
P-052 **P-152**	Transfer into the EEPROM	0...1	Hex	0	
P-053	Control bits	0...F F F F	Hex	1	
P-056	Motor selection	0...4	-	0	
P-061	Fixed DC link voltage	0...700	V	0	
P-090	Display format, control parameters	0...1	Hex	1	
P-153	Calculate motor controller data	–1... +1	–	0	
P-204	Function selection, post optimization	0...6	–	0	
P-205	Start post-optimization	0...1	–	0	

Freely-programmable terminal function (refer to Section 4.8)

Parameter	Significance	Setting range	Dimen-sion	Factory setting	Setting
P-081	Function assignment, terminal E1	1...21	–	1	
P-082	Function assignment, terminal E2	1...21	–	7	
P-083	Function assignment, terminal E3	1...21	–	3	
P-084	Function assignment, terminal E4	1...21	–	17	
P-085	Function assignment, terminal E5	1...21	–	18	
P-086	Function assignment, terminal E6	1...21	–	19	
P-087	Function assignment, terminal E7	1...21	–	9	
P-088	Function assignment, terminal E8	1...21	–	10	
P-089	Function assignment, terminal E9	1...21	–	11	

Freely-programmable relay function (refer to Section 4.9)

P-241	Function assignment, relay A11	1...20	–	20	
P-242	Function assignment, relay A21	1...20	–	3	
P-243	Function assignment, relay A31	1...20	–	1	
P-244	Function assignment, relay A41	1...20	–	4	
P-245	Function assignment, relay A51	1...20	–	5	
P-246	Function assignment, relay A61	1...20	–	2	
P-021	Threshold $\|n_{act}\| < n_{min}$ relay	0...16000	RPM	10	
P-021.1	Machining-specific 1				
P-021.2	Machining-specific 2				
P-021.3	Machining-specific 3				
P-021.4	Machining-specific 4				
P-021.5	Machining-specific 5				
P-021.6	Machining-specific 6				
P-021.7	Machining-specific 7				
P-021.8	Machining-specific 8				

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-027	Tolerance bandw. $n_{act} = n_{set}$ relay	0...29000	RPM	100	
P-027.1	Machining-specific 1				
P-027.2	Machining-specific 2				
P-027.3	Machining-specific 3				
P-027.4	Machining-specific 4				
P-027.5	Machining-specific 5				
P-027.6	Machining-specific 6				
P-027.7	Machining-specific 7				
P-027.8	Machining-specific 8				
P-047	Threshold $\|M_d\| < M_{dx}$ relay	0.0...100.0	% ref. to the effective torque limit	90.0	
P-047.1	Machining-specific 1				
P-047.2	Machining-specific 2				
P-047.3	Machining-specific 3				
P-047.4	Machining-specific 4				
P-047.5	Machining-specific 5				
P-047.6	Machining-specific 6				
P-047.7	Machining-specific 7				
P-047.8	Machining-specific 8				
P-023	Threshold $\|n_{act}\| < n_x$ relay	0...29000	RPM	3000	
P-023.1	Machining-specific 1				
P-023.2	Machining-specific 2				
P-023.3	Machining-specific 3				
P-023.4	Machining-specific 4				
P-023.5	Machining-specific 5				
P-023.6	Machining-specific 6				
P-023.7	Machining-specific 7				
P-023.8	Machining-specific 8				

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-175	Thermal motor time constants (I^2t limit value)	0.0...500.0	min	1.0	
P-175.1	Motor 1				
P-175.2	Motor 2				
P-175.3	Motor 3				
P-175.4	Motor 4				
P-185	Address, variable relay function 1	0...F F F F	Hex	1110	
P-186	Threshold, variable relay function 1	0...F F F F	Hex	0	
P-187	Pull-in delay, variable relay function 1	0.00...10.00	s	0.00	
P-188	Drop-out delay, variable relay function 1	0.00...10.00	s	0.00	
P-189	Hysteresis, variable relay function 1	0...7 F F F	Hex	1	
P-190	Address, variable relay function 2	0...F F F F	Hex	1110	
P-191	Threshold, variable relay function 2	0...F F F F	Hex	0	
P-192	Pull-in delay, variable relay function 2	0.00...10.00	s	0.00	
P-193	Drop-out delay, variable relay function 2	0.00...10.00	s	0.00	
P-194	Hysteresis, variable relay function 2	0...7 F F F	Hex	1	
P-274	Relay function control word	0...F F F F	Hex	0	

Diagnostic aids (refer to Section 5.4)

Parameter	Significance	Setting range	Dimension	Factory setting	Setting
P-070	Transistor diagnostics	–	Hex	–	
P-075	Reset transistor diagnostics	0...1	Hex	0	
P-179	Start min/max monitoring	0...3	Hex	0	
P-181	Address, min/max monitoring	0...F F F F	Hex	1110	
P-182	Minimum value display	–	Hex	–	
P-183	Maximum value display	–	Hex	–	
P-206	Activate transient recorder	0...1	Hex	0	
P-207	Trigger condition, transient recorder	0...C	Hex	0	
P-208	Address for start condition	0...F F F F	Hex	0	
P-209	Threshold for start condition	0...F F F F	Hex	0	
P-210	Address for stop condition	0...F F F F	Hex	0	
P-211	Threshold for stop condition	0...F F F F	Hex	0	
P-212	Address, record signal 1	0...F F F F	Hex	1110	
P-213	Address, record signal 2	0...F F F F	Hex	10D2	
P-214	Activate transient recorder on D/A converters	0...1	Hex	0	
P-215	Shift factor, record output 1	0...15	–	0	
P-216	Shift factor, record output 2	0...15	–	0	
P-217	Trigger signal amplitude 1	0...F F F F	Hex	0	
P-218	Trigger signal amplitude 2	0...F F F F	Hex	7 F F F	

9.9 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 materials - e.g. plastic foils, insulated desktops, articles of clothing manufactured from man-made fibers.

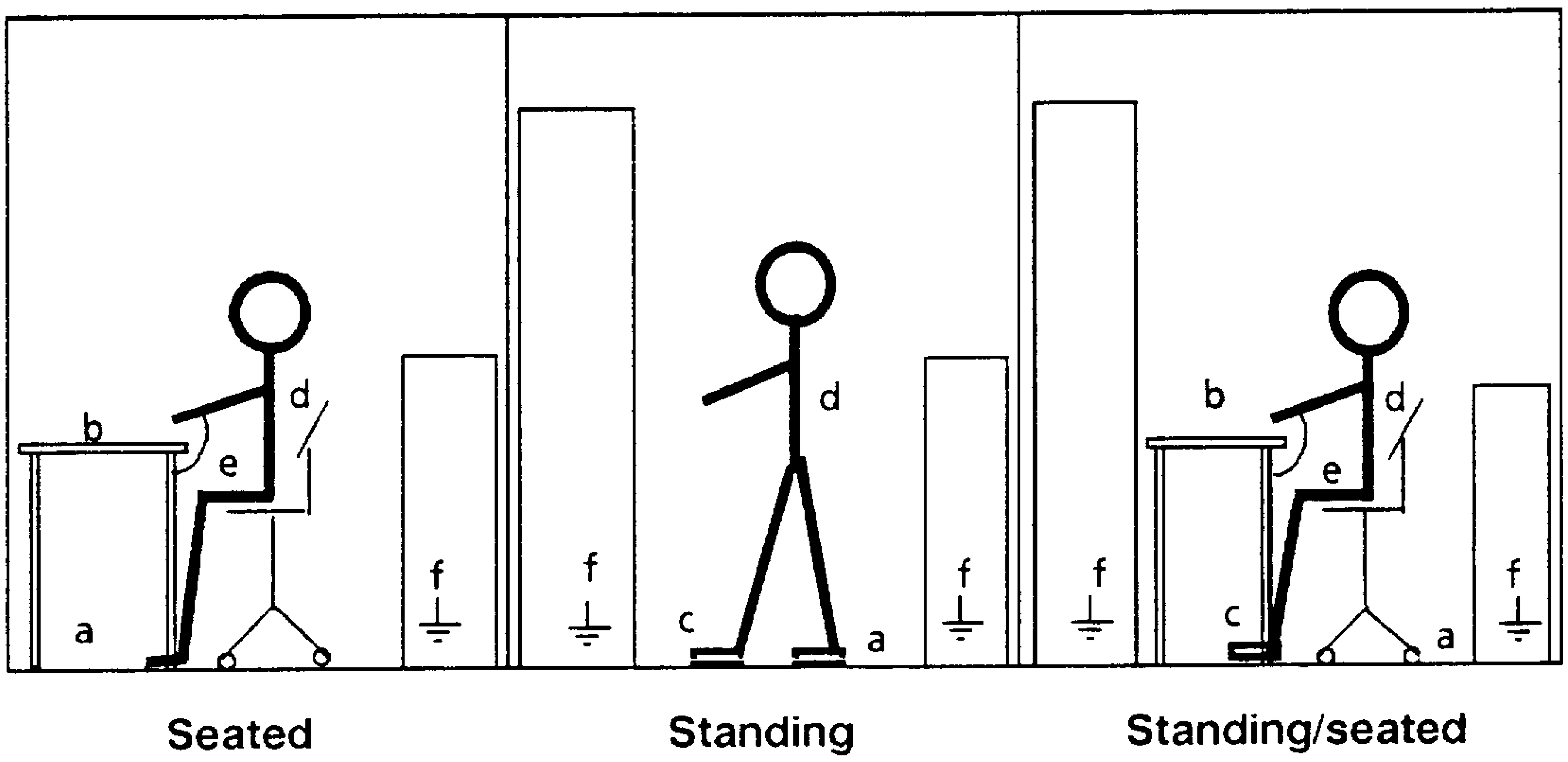
Boards must only be placed on conductive surfaces.

When soldering, the soldering 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 floor surface
b = ECB table
c = ECB shoes
d = ECB overall
e = ECB chain
f = Cubicle ground connection

9.10 Standards and specifications

DIN 40050	IP protection types
DIN 46234	Cable lugs
DIN VDE 0100	Specifications for power systems with voltages up to 1000 V
DIN VDE 0106	Protection against electric shock
DIN VDE 0113	Electrical equipment on industrial machines
DIN VDE 0558	VDE specifications for static converters

Can be obtained from:	DIN:	DIN VDE:
	Beuth-Verlag GmbH Postfach 1145	VDE-Auslieferungsstelle Merianstraße 29
	1000 Berlin 30	6050 Offenbach

Siemens AG

AUT 631
P.O. Box 3180
W-8520 Erlangen
Federal Republic of Germany

Suggestions

Corrections

For Publication/Manual:

SIMODRIVE 611
Modular Transistor PWM Inverters
for AC Drives
Software Release 3.00
Manufacturers Documentation

Instruction Manual
Order No.: 6SC6111-6AD76
(GWE 462 007.9602.76 Ja-101)
Edition: 06.92

From

Name ______________________

Company address/department

Street: ______________________

Zip code: ____________ City: ____________

Telephone: ________ / ________

Should you come across any printing errors when reading this document, we would be grateful if you could inform us using this form. We would also welcome any suggestions you might have for improvements.

Suggestions and/or corrections