Servodyn-D

RSU
Redundant Safety Monitoring

Edition

101

Servodyn-D

RSU
Redundant Safety Monitoring

1070 066 026-101 (99.08) GB

Contents

1 Safety Instructions

Please read this manual before putting the RSU redundant safety monitoring into operation in the Servodyn-D system. Store this manual in a place to which all users have access at all times.

1.1 Intended use

This manual contains all information required for the intended use of this product.

The drive inverters described

- have been developed, manufactured, tested and documented in compliance with the relevant safety standards. These products normally pose no danger to persons or property if they are used in accordance with the handling stipulations and safety notes prescribed for their configuration, mounting, and intended operation.
- comply with the requirements of
  - the EMC Directive (89/336/EEC, 93/68/EEC and 93/44/EEC)
  - the EMC product standard EN 61800-3
  - the Low-Voltage Directive (73/23/EEC)
  - the harmonized standards EN 50178 (VDE 0160) and EN 60146-1-1 (VDE 0558-11)
- are designed for operation in industrial environments (emission class A), i.e.
  - no direct connection to public low-voltage power supply,
  - connection to the medium- or high-voltage system via a transformer.

  In residential environments, in trade and commerce as well as small enterprises class A equipment may only be used if it does not inadmissibly interfere with other equipment.

☞ **This is a class A device which may cause radio interference in residential environments. In this case, the operator may be required to take suitable countermeasures and to bear the cost of the same.**

Before putting the drive inverters into operation, ensure that the machine which the inverters are to be installed in meets the stipulations of the machinery directive (98/37/EC, 98/79/EC), the Low-Voltage Directive (73/23/EEC) and the EMC directive (89/336/EEC).

The faultless, safe functioning of the product requires proper transport, storage, erection and installation as well as careful operation.

1.2 Qualified personnel

The requirements as to qualified personnel depend on the qualification profiles described by ZVEI (central association of the electrical industry) and VDMA (association of German machine and plant builders). Please refer to the following publication (in German language):
Weiterbildung in der Automatisierungstechnik
edited by: ZVEI and VDMA
MaschinenbauVerlag
Postfach 71 08 64
D–60498 Frankfurt

The present manual is designed for **drive engineering personnel** and **drive specialists**. They need special knowledge of safety regulations and protective provisions.

Programming, start and operation as well as the modification of program parameters is reserved to properly trained personnel! This personnel must be able to judge potential hazards arising from programming, program changes and in general from the mechanical, electrical, or electronic equipment.

Interventions in the hardware and software of our products, unless described otherwise in this manual, are reserved to our specialized personnel.

Tampering with the hardware or software, ignoring warning signs attached to the components, or non-compliance with the warning notes given in this manual can result in serious bodily injury or property damage.

Only electrotechnicians as recognized under IEV 826-09-01 (modified) who are familiar with the contents of this manual may install and service the products described.

Such personnel are

- those who, being well trained and experienced in their field and familiar with the relevant norms, are able to analyze the jobs being carried out and recognize any hazards which may have arisen.
- those who have acquired the same amount of expert knowledge through years of experience that would normally be acquired through formal technical training.

Please note our comprehensive range of training courses.
Our training center will be pleased to provide you with further information, telephone: +49 (6062) 78-258.

1.3 Safety markings on products

Warning of dangerous electrical voltage!

Electrostatically sensitive components!

Danger of hazardous light emissions (optical fibre cable emitters)

PE conductor

Conductor shield

1.4 Safety instructions in this manual

DANGEROUS ELECTRICAL VOLTAGE
This symbol is used to warn of a **dangerous electrical voltage.** Insufficient or lacking compliance with the instructions in this manual may result in **personal injuries**.

DANGER
This symbol is used wherever insufficient or lacking compliance with instructions in this manual may result in **personal injuries**.

CAUTION
This symbol is used wherever insufficient or lacking compliance with instructions in this manual may result in **damage to equipment or data files**.

☞ This symbol is used to draw the user's attention to special circumstances.

1.5 Safety instructions concerning the product described

DANGER
Retrofits or modifications may adversely affect the safety of the products described!

The consequences may include severe injuries, damage to equipment, or environmental hazards. Possible retrofits or modifications to the system using third-party equipment therefore have to be approved by Bosch.

DANGER
Danger of life through inadequate EMERGENCY-STOP devices!
EMERGENCY-STOP devices must be active and within reach in all system modes. Releasing an EMERGENCY-STOP device must not result in an uncontrolled restart of the system!
First check the EMERGENCY-STOP circuit, then switch the system on!

DANGER
Health hazards through destroyed electrical components!
Do not destroy any built-in components. Dispose of destroyed components in a proper manner.

DANGER
Please note your local, system-specific regulations and requirements as well as the proper use of tools, hoisting and transport equipment as well as the applicable standards, regulations, and accident prevention regulations.

DANGEROUS ELECTRICAL VOLTAGE
Unless described otherwise, maintenance works must be performed on inactive systems! The system must be protected against unauthorized or accidental reclosing.

Measuring or test activities on the live system are reserved to qualified electrical personnel!

DANGEROUS ELECTRICAL VOLTAGE
Lethal voltages of up to 375 V DC against ground on all power connections and DC link connections!

The drives must not be switched on unless all covers have been fitted!
When the drive has been disconnected from mains, wait for up to 5 minutes until the system is de-energized before removing any covers.

The drive must always be examined for safe isolation from supply!

CAUTION
Only spare parts approved by Bosch may be used!

CAUTION
Observe all precautions for ESD protection when handling modules and components! Avoid electrostatic discharge!

The following protective measures must be observed for modules and components sensitive to electrostatic discharge (ESD)!

- The personnel responsible for storage, transport, and handling must have been trained for ESD protection.
- ESD-sensitive components must be stored and transported in their prescribed protective packaging.
- ESD-sensitive components may only be handled at special ESD-workplaces.
- Personnel, working surfaces, as well as all equipment and tools which get in contact with ESD-sensitive components must have the same potential (e.g., by grounding).
- Wear an approved grounding bracelet. The grounding bracelet must be connected with the working surface through a cable with an integrated resistor of 1 MΩ.
- ESD-sensitive components must by no means get in contact with chargeable objects, including most plastic materials.
- When ESD-sensitive components are installed in or removed from equipment, the equipment must be de-energized.

1.6 Documentation, software release and trademarks

Documentation

The present manual provides information on the redundant safety function (RSU) of the Servodyn-D series of drives.

Overview of the entire documentation range for drives with RSU:

Manuals	Part no. German	English	French	Italian
Configuration – Manual for overview and rating	1070 066 009	1070 066 029	1070 066 059	1070 066 049
Servo motors SF, SR	1070 066 004	1070 066 024	1070 066 048	1070 066 046
Asynchronous motors DU	1070 066 007	1070 066 027	–	–
Interface conditions	1070 066 010	1070 066 030	1070 066 060	1070 066 050
Servodyn-D, all interfaces – Parameter manual	1070 066 018	1070 066 038	–	–
Servodyn-D with SERCOS interface – Parameter and commissioning manual	1070 066 011	1070 066 031	–	1070 066 051
Diagnostics, maintenance	1070 066 012	1070 066 032	1070 066 062	1070 066 052
Redundant safety monitoring RSU	1070 066 006	1070 066 026	–	–
EMC manual	1070 066 072	1070 066 074	1070 066 075	1070 066 076
External load switching module	1070 066 077	1070 066 080	–	–

Special keys or key combinations are shown in pointed brackets:

- Special keys: e.g. <enter>, <pgup> , <del>
- Key combinations (pressed simultaneously): e.g. <ctrl> + <pgup>

★ This character indicates that you have to perform an activity.

Release

☞ **The current software release number can be viewed by selecting parameter S-0-0030 with the DSS-D Commissioning and Service System, or in the "Software" field of the module configuration display (DIAGNOSTICS ▶ MODULE CONFIGURATION).**

☞ **The current VM software release can only be read from the 7-segment display during test operation. For this purpose, turn dip switch "T" on the VM's personality module "on":**

The following appears in a running, flashing display:
"**Cxx.ZZ.ddmmyyyy**"

Where:
xx = software release number
ZZ = (internal)
dd = software creation day
mm = software creation month
yyyy = software creation year

☞ **The present manual applies to the following releases:**
VM software: 0.040 or higher
DM software: 0.040 or higher
DSS software: 0.003 or higher

Trademarks

All trademarks for software installed on Bosch products upon delivery are the property of the respective manufacturers.

Upon delivery, all installed software is copyright-protected. The software may only be reproduced with the approval of Bosch or in accordance with the license agreement of the respective manufacturer.

MS-DOS® and Windows™ are registered trademarks of Microsoft Corp.

SERCOS interface® is a registered trademark of Interessengemeinschaft SERCOS interface e.V.

Type examination certificate

Zertifizierungsstelle
SIBE Schweiz

SQS 046

Akkreditierte Zertifizierungsstelle SIBE Schweiz nach EN 45011

Baumusterbescheinigung Nr. 1016

Produkt	Antriebssystem
Marke	BOSCH
Type	Servodyn-D RSU, Personality Module: PM VMS/...-D; PM SMS/...-D; PM FOS/...-D
Sicherheitsangaben	Kategorie 3 nach EN 954-1 In diesem Antriebssystem sind redundante Sicherheitsüberwachungen integriert. Diese sind: Not-Aus; Betriebsarterwahlschalter; Zustimmtaster mit Überwachung; Schutztürzuhaltung; Stillstandsüberwachung und reduzierte Geschwindigkeitsüberwachung.
Herstelleradresse	Robert Bosch GmbH Geschäftsbereich Automationstechnik Berliner Strasse 25 D-64711 Erbach / Odw.
Gesuchstelleradresse	Robert Bosch GmbH ATIEAN Berliner Strasse 25 D-64711 Erbach / Odw.
Ablaufdatum	6. April 2004

Das überprüfte Baumuster entspricht den einschlägigen Bestimmungen des Rates vom 22. Juni 1998 zur Angleichung der Rechtsvorschriften der Mitgliedstaaten für Maschinen (98/37/EG) und deren Änderungen vom 27. August 1998 (98/79/EG).

Diese Bescheinigung gilt zusammen mit den allenfalls vorstehend erwähnten Beilagen sowie den auf der Rückseite aufgeführten allgemeinen Bestimmungen.

Ausstelldatum
6. April 1999

Die Zertifizierungsstelle:
NSBIV AG
Zertifizierungsstelle SIBE Schweiz
Postfach 3918
CH-6002 Luzern

Der Sicherheitsingenieur
M. Luzzatto

Der Zertifizierungsleiter
A. Retsch

Declaration of conformity

EG Konformitätserklärung
EC declaration of conformity
Déclaration "CE"

Hiermit erklären wir, daß unser Produkt, Typ:
We hereby declare that our product, type:
Nous déclarons par la présente que notre produit, type:

Sicherheitsbauteil RSU bestehend aus Personality

Modulen: PMVMS/...-D, PMSMS/...-D und PMFOS/...-D

in Verbindung mit dem SERVODYN-D-Antriebssystem

folgenden einschlägigen Bestimmungen entspricht:
complies with the following relevant provisions:
correspond aux dispositions pertinentes suivantes:

☒ **Maschinenrichtlinie** (98/37/EG, RL 98/79/EG und 93/44/EWG)
Machinery Directive (98/37/EEC, RL 98/79/EEC and 93/44/EEC)
Directive sur les machines (98/37/CEE, RL 98/79/CEE et 93/44/CEE)

☐ **Niederspannungsrichtlinie** (73/23/EWG, 93/68/EWG und 93/44/EWG)
Low voltage Directive (73/23/EEC, 93/68/EEC and 93/44/EEC)
Directive sur les basses tensions (73/23/CEE, 93/68/CEE et 93/44/CEE)

☐ **EMV-Richtlinie** (89/336/EWG, 93/68/EWG und 93/44/EWG)
EMC Directive (89/336/EEC, 93/68/EEC and 93/44/EEC)
Directive EMV (89/336/CEE, 93/68/CEE et 93/44/CEE)

Angewendete harmonisierte Normen, insbesondere:
Applied harmonized standards, in particular:
Normes harmonisées utilisées, notamment:

EN 954-1 Sicherheitskategorie 3
prEN 61800-5 (61800-5/CD IEC 1998)
Sicheres Stillsetzen und sicherer Halt in allen Betriebsarten
Sicherer Betriebshalt oder sicher begrenzte Geschwindigkeit im Sonderbetrieb

Angewendete nationale Normen und technische Spezifikationen, insbesondere:
Applied national technical standards and spezifications, in particular:
Normes et specifications techniques nationales qui ont été utilisées, notamment:

EG-Baumusterbescheinigung Nr. 1016
Zertifizierungsstelle: NSBIV AG, SIBE Schweiz, Inseliquai 8, CH-6002 Luzern,
Akkreditierung Nr. SCES 046

6.4.99 Weber
Datum / Unterschrift / Entwicklungsleitung

6.4.99 W8
Datum / Unterschrift / Technische Betriebsleitung

BOSCH

Robert Bosch GmbH
Geschäftsbereich Automationstechnik
Betrieb Erbach
Postfach 1162
D-64701 Erbach/ Odw.

Formular 10/00749/6 - 103W611

Blatt 1 von 1	Sach-Nr. 1070 81706 -101 _ 474

Your notes:

2 Safety-relevant standards

Standards EN 60204-1 and EN 292-1, which are based on the European Machinery Directive 89/392/EEC, define the following terms concerning the guards of the machines affected by this Directive:

❑ **Stop function** (EN 60204-1)

There are three categories of stop functions:

- □ **Category 0**
  Stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop),
- □ **Category 1**
  Controlled stop with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved,
- □ **Category 2**
  Controlled stop with power left available to the machine actuators.

❑ **Guard** (EN 292-1)

Defined as the part of a machine which specially serves as some type of physical barrier for the protection of persons. Depending on its design, a guard may be a housing, a cover, a screen, a door, an enclosure, etc.

❑ **Fixed guard** (EN 292-1)

Defined as a guard fixed with fastening elements (screws, nuts, etc.) or in another lasting manner (e.g. welded) to the machine so that it cannot be removed or opened without a tool.

❑ **Interlocking guard** (EN 292-1)

Defined as a guard equipped with an interlocking mechanism which ensures that

- □ the hazardous machine functions fenced off by the guard cannot be executed when the guard is open
- □ a stop command is initiated when the guard is opened during hazardous machine functions
- □ hazardous machine functions can be performed if the guard is closed without being initiated by simply closing the guard.

❑ **Interlocking guard with guard locking** (EN 292-1)

Defined as an interlocking guard with an additional guard locking so that

- □ the hazardous machine functions fenced off by the guard cannot be executed unless the guard is closed and interlocked
- □ the guard remains closed and interlocked even when a halt command has been given until the risk of injuries caused by the hazardous machine functions has passed
- □ the hazardous machine functions can be performed if the guard is closed and interlocked, but are not initiated by simply closing the guard.

Your notes:

3 Technical implementation

For the technical implementation of the safety standards, the safety functions listed in this section have been defined for machinery construction. Safety-relevant components in electronic control systems must be implemented as Category 3 equipment in accordance with EN 954-1.

3.1 Safety related stopping process

Stopping process is defined as slowing down any motion to standstill. This process starts when the stopping signal is output and ends when the motion has stopped.

Safety related stopping process means that, depending on the dangerous situation, the drive is stopped by:

- braking at the current limit
- braking according to an internal ramp, or
- setpoint-controlled braking.

In order to safely prevent a restart, one of the following two functions will be immediately activated when the drives have come to a complete stop:

- safety related standstill, or
- safety related operating standstill.

The safety related stopping process is monitored by a safe time delay. If the drives have not yet come to a stop when the time delay has elapsed, the mains contactor will be immediately switched off.

3.2 Protection against unexpected start

3.2.1 Safety related standstill

Standstill is the condition in which the mechanical components are at standstill and there is no power supply to the drives.

A **safety related standstill** supposes that the power supply to the drives has been safely interrupted by:

- switching the mains contactor in the mains connection module off
- locking the power units of the three-phase modules, and
- quick discharge of the D.C. link (in preparation).

DANGER
Axis movement by external forces!
If external forces have to be expected during a safe halt, e.g. in the case of hanging axes, this movement must be safely prevented by taking additional measures, e.g. mechanical brakes.

3.2.2 Safety related operating standstill

Operating standstill is the condition in which the mechanical drive components are maintained at standstill by active drives which have power supply. In certain applications, it is necessary to stop the drive system at a natural point of the production process. This operating standstill corresponds to stop category 2 as defined in EN 60204-1 (cf. page 2–1).
All control functions between the electronic control and the drives are maintained.

The **safety related operating standstill** prevents the drives by means of additional control measures from performing dangerous movements because of faults.
The admissible deviations from the standstill position are password-protected and therefore cannot be modified by unauthorized external interventions.
When the safety related operating standstill has been canceled, e.g. by closing a guard and issuing the start command, the operating movement of the drives can be immediately resumed at the point where it had been interrupted.

3.3 Safe speed limitation

In accordance with the machinery directive (98/37/EEC, RL 98/79/EEC), a hazard analysis has to be performed including a subsequent risk assessment.
The values for the safe speed limitations are to be derived therefrom. The following table contains guide values for different machine types.

Guide values

The following guide values for a safe speed limitation in different applications are an extract from standards and working papers concerning safety measures during manual mode, executed in accordance with EN 954-1, Category 3.

Machining centers		**Automatic lathes**		**Drilling and milling machines**		**Robots**	**Automatic manufacturing systems**
Axes	**Spindles**	**Axes**	**Spindles**	**Axes**	**Spindles**		
SSL = 2 m/min + jogging	SSL = 2 rpm + jogging + confirmation	SSL = 2 m/min + jogging	SSL = 50 m/min (1 m/s) + jogging + confirmation	SSL = 2 m/min + jogging	SSL = 2 rpm + jogging + confirmation	SSL = 15 m/min + jogging	SSL = 2 m/min (15 m/min) + jogging + EMERGENCY STOP

SSL = Safe Speed Limit

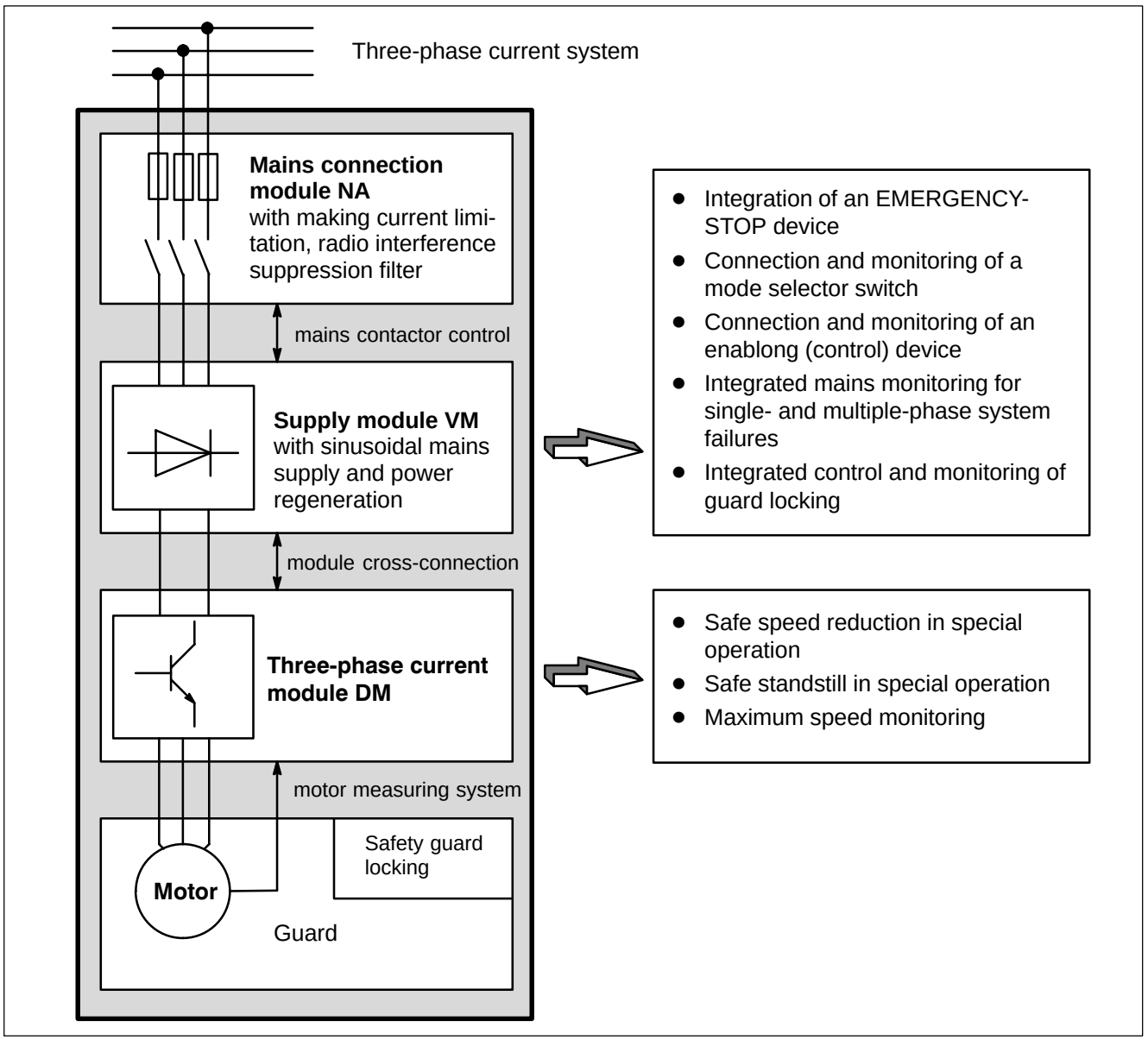
Control measures are provided to safely prevent the drives from exceeding the specified speed limits. The speed limits are password-protected, therefore, they cannot be modified by unauthorized external interventions.

4 Implementation in the Servodyn-D drive system

Using the inverters of the Servodyn-D drive system, safety-relevant parts of Category 3 in accordance with EN 954-1 can be implemented for a machine control.
The supply modules have redundant input signals which generate safety-relevant output signals or act directly on the power control elements.

Prerequisites:

- Supply module VM..,B,C,D with mains feedback
- Mains connection module NA
- Three-phase modules DM or DS with SERCOS interface
- Personality module PM..S with RSU
- SF motors and DU motors
- Asynchronous motors with ring gear encoder (sin/cos 1 V_{pp})
- Asynchronous motors with resolvers



RSU safety concept with Servodyn-D

4.1 Safety-relevant input/output signals

Safe input/output signals are required in order to transmit the statuses safely detected by the drive system (e.g. safety related operating standstill) to other system components (e.g. interlocking guard with guard locking) in order to enable this component to initiate a response for the process. The input/output signals meet safety category 3.

Emergency-Stop (NH)

Input, 2 channels at VM, for safety related stopping process, with subsequent safety related standstill.
A short-circuit between the cables of the Emergency-Stop buttons will be detected. Both inputs are active low and thus resistant to broken wires, simultaneous operation is monitored internally by the VM.

Drive On (AE)

Input, 1 channel at VM, for switching on the mains contactor in the mains connection module (e.g. when the Emergency-Stop function has been canceled). Monitored start. The input is active high, only the edge is evaluated.

Normal/Special operation (NO)

Input, 2 channels at VM, for safe mode selection. Using the special operation mode, the safety related operating standstill is immediately activated. Both inputs are monitored for a clear status. In the event of an error, the special operation mode becomes active. Both inputs are active high and thus resistant to broken wires.

Enabling (control) device (ZT)

Input, 2 channels at VM, for safe enabling (control). A short-circuit between the cables of the enabling (control) keys will be detected.
Both inputs are active high and thus resistant to broken wires, simultaneous activation is monitored internally in the DM.

Guard locking (ST-S), feedback (ST-R)

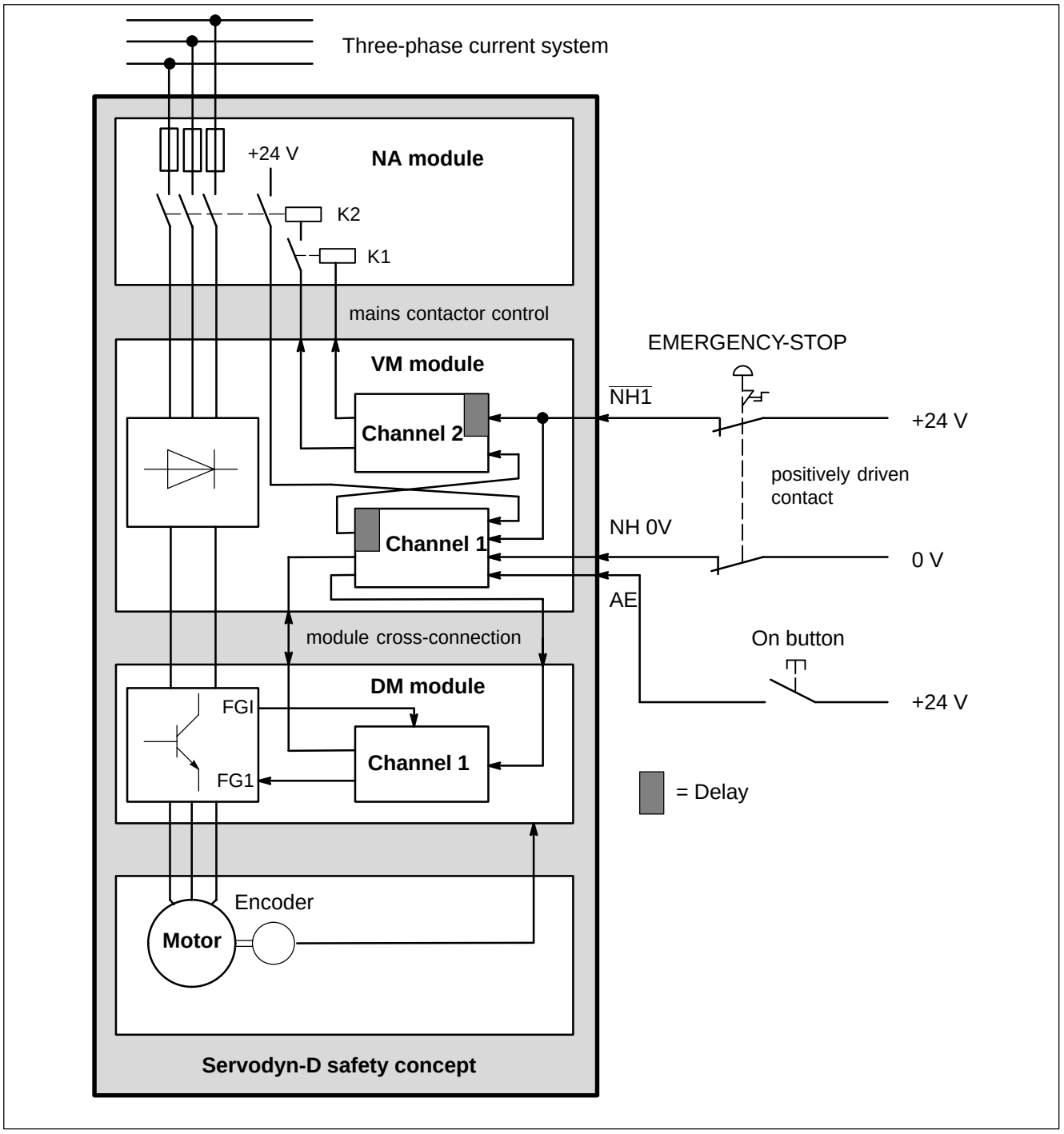
Output ST-S, 1 channel at VM, for releasing the guard locking. The output is active high and thus resistant to broken wires, it is monitored for manipulation in connection with the feedback signal ST-R.
Input ST-R, 1 channel at VM, for signaling an unlocked guard.

4.2 Mode of functioning of safe monitoring

4.2.1 EMERGENCY-STOP (function)

The 2-channel EMERGENCY-STOP devices are evaluated through two independent channels within the drive, which in the event of EMERGENCY-STOP

- halt the drive
- open the mains contactor in the mains connection module NA (channel 2), and
- lock the power output stage in the three-phase current module via FG1 (channel 1).



Mode of functioning of EMERGENCY-STOP function (stop function of category 1)

The EMERGENCY-STOP switches connected to $\overline{NH1}$ and NH 0V initiate a category 1 stop function to EN 60 204-1 in connection with the internal tripping delay of the VM.

☞ **A category 1 stop function is defined as controlled stopping where power supply to the drives is maintained in order to stop them, and is not interrupted before the drive has come to a complete stop.**

Power supply is switched off before or when the tripping delay has elapsed. This delay can be set with switch S1 on the VM front panel between 1..15s in 1 s steps.
In the software, a maximum value of 16s is permanently set.

☞ **When the axes and spindles have come to a stop, the power supply is immediately switched off (category 0 stop function).**

Stopping the drives and the drop-out of the mains contactor in the mains connection module are monitored so that the drives cannot be switched back on before they have come to a stop and the mains contactor has dropped out.

Input $\overline{NH1}$ directly influences the control of auxiliary contactor K1 and mains contactor K2 in the mains connection module via the internal hardware time stage.

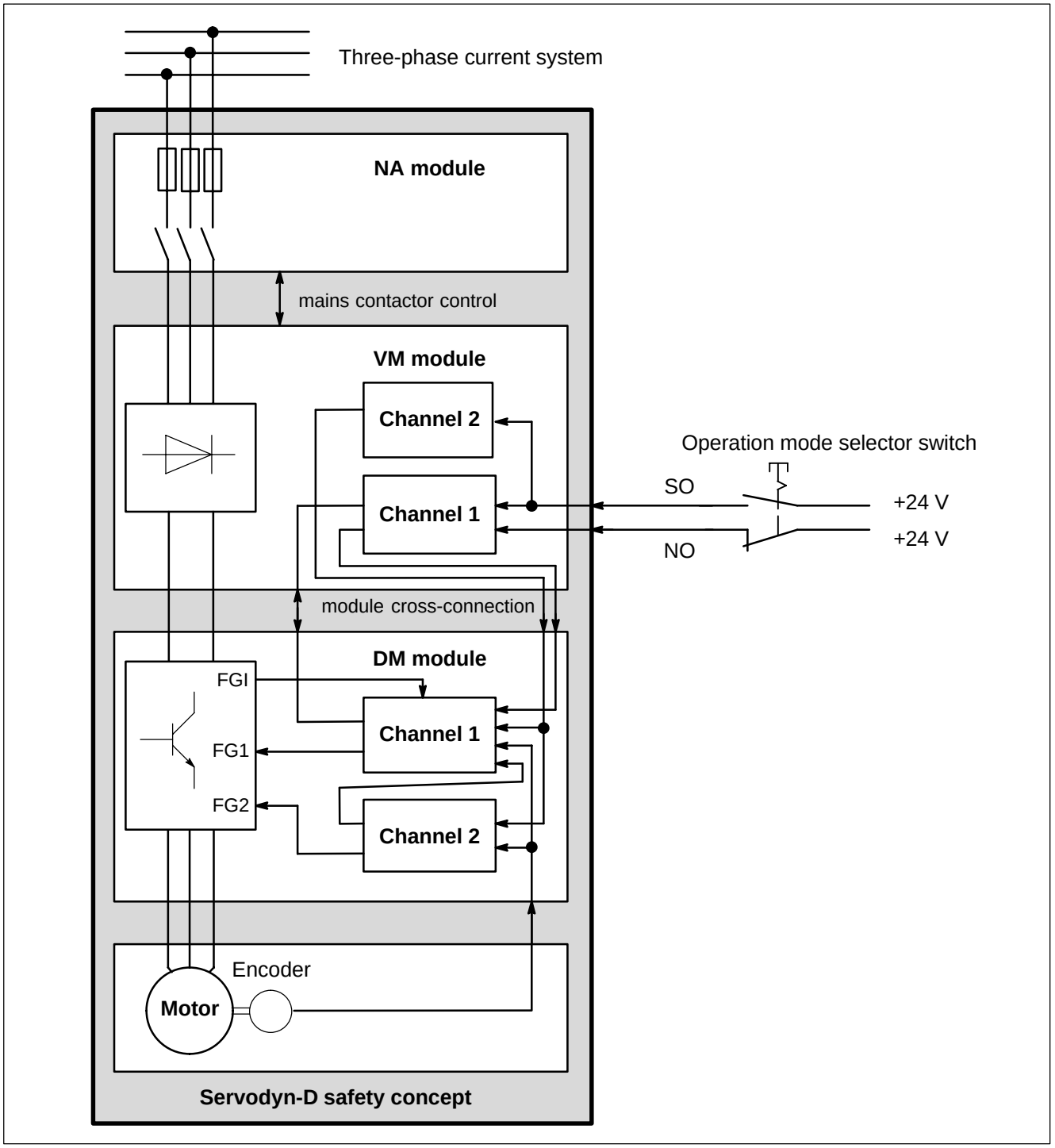
In order to initiate EMERGENCY-STOP, $\overline{NH1}$ and/or NH 0V must be interrupted for at least 0.1 s. Both channels should be operated at the same time within 0.5 s, otherwise, the VM will output error F41 (channel error Emergency-Stop).
The EMERGENCY-STOP function initiates the ”Drive stopping” function in the DM modules which can be defined individually for each axis in P-0-0004:

- Halting in shortest possible time (S-0-0138)
- Halting drive-controlled via ramp (S-0-0260)
- Halting setpoint-controlled by master

Fault monitoring:

- A short-circuit occurring between the two Emergency-Stop channels after the Emergency-Stop switches will be detected.
- The diverse channels $\overline{NH1}$ and NH 0V will be monitored for simultaneous status changes (within 0.5 s).
- Input AE is edge-monitored, only a positive edge will set the signal.

4.2.2 Special operation with standstill monitoring



Mode of functioning of standstill monitoring in special mode

Operation mode change-over

A distinction is made between the following operation modes:

- **Normal operation:** The machine runs as desired, in compliance with its intended use and design.
- **Special operation:** All other modes are defined as special modes, e.g.:
  - Maintenance
  - Correction of a machine fault or production fault
  - Manual mode
  - Programming
  - Test run
  - Control measurement
  - Part change
  - Tool change
  - Removal of waste (chips)

In **normal operation NO**, the maximum speed monitoring function (S-0-0091) is active in the drives.

For manual mode, the special operation has to be selected. Changing from ”normal operation” to ”special operation” should only be performed when the drives have been stopped via the machine control, e.g. after Feed halt and Spindle stop.

Only one operation mode can be active at any one time, a change between operation modes must be selected within 2 s, otherwise, the VM will issue the fault message F42 (channel error Mode).

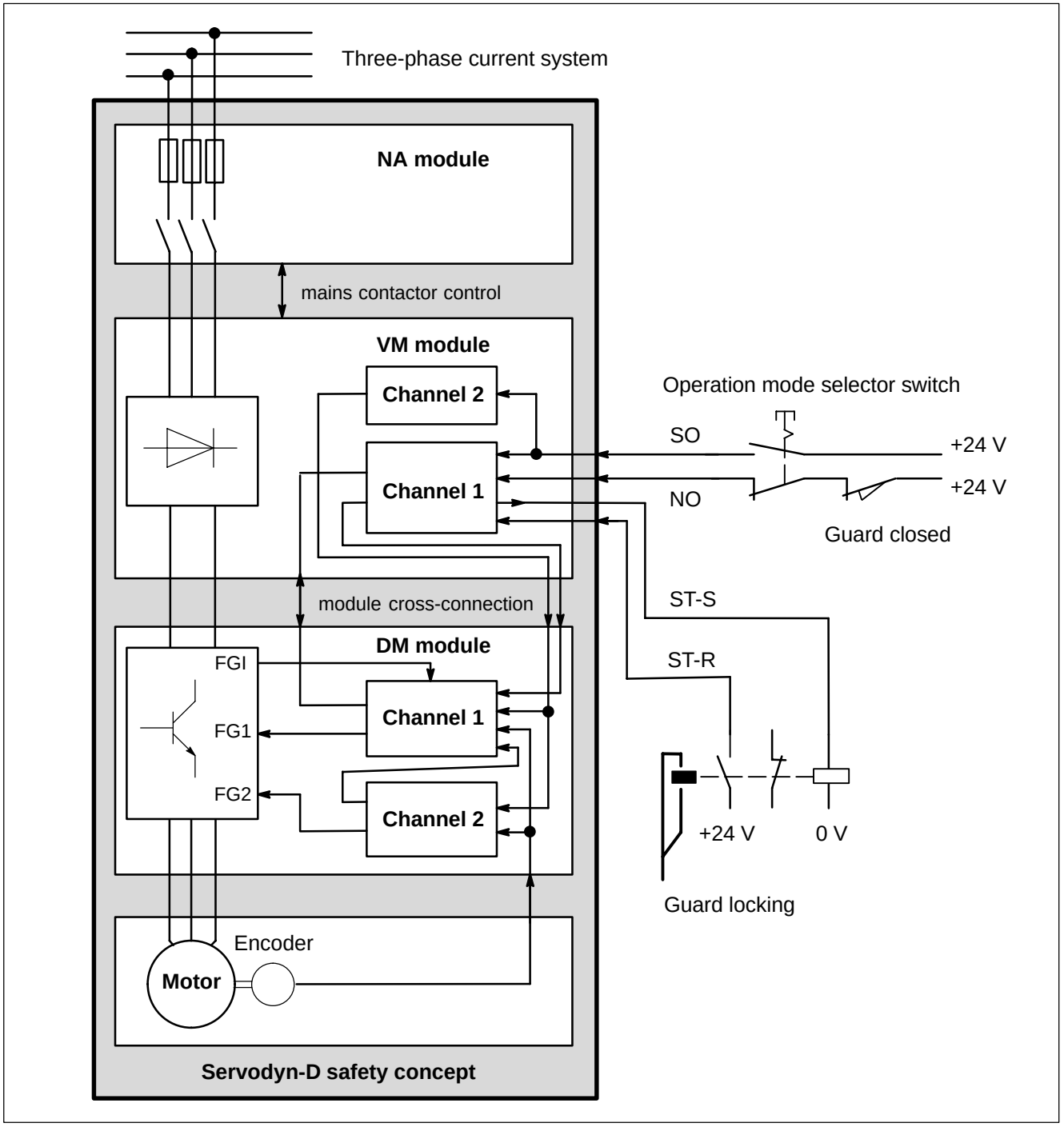
In **special operation SO**, standstill monitoring is active in the drives. Power supply is fully maintained, a possible movement will cause the drive to be switched off immediately and without delay.
In connection with stopping the drives via the machine control, SO provides a category 2 stop function in accordance with EN 60 204-1:

☞ **A category 2 stop function is defined as controlled stopping where power supply to the drives is maintained.**

Fault monitoring:

- Redundant NO and SO channels are monitored for simultaneous status changes (within 2 s).
- The simultaneous activation of both modes will initiate a category 1 stop function in the supply module.
- If a digression from standstill is detected (P-0-0022), the DM will output fault messages F15 and/or F16 (deviation from safe standstill).

4.2.3 Special operation with standstill monitoring and guard locking



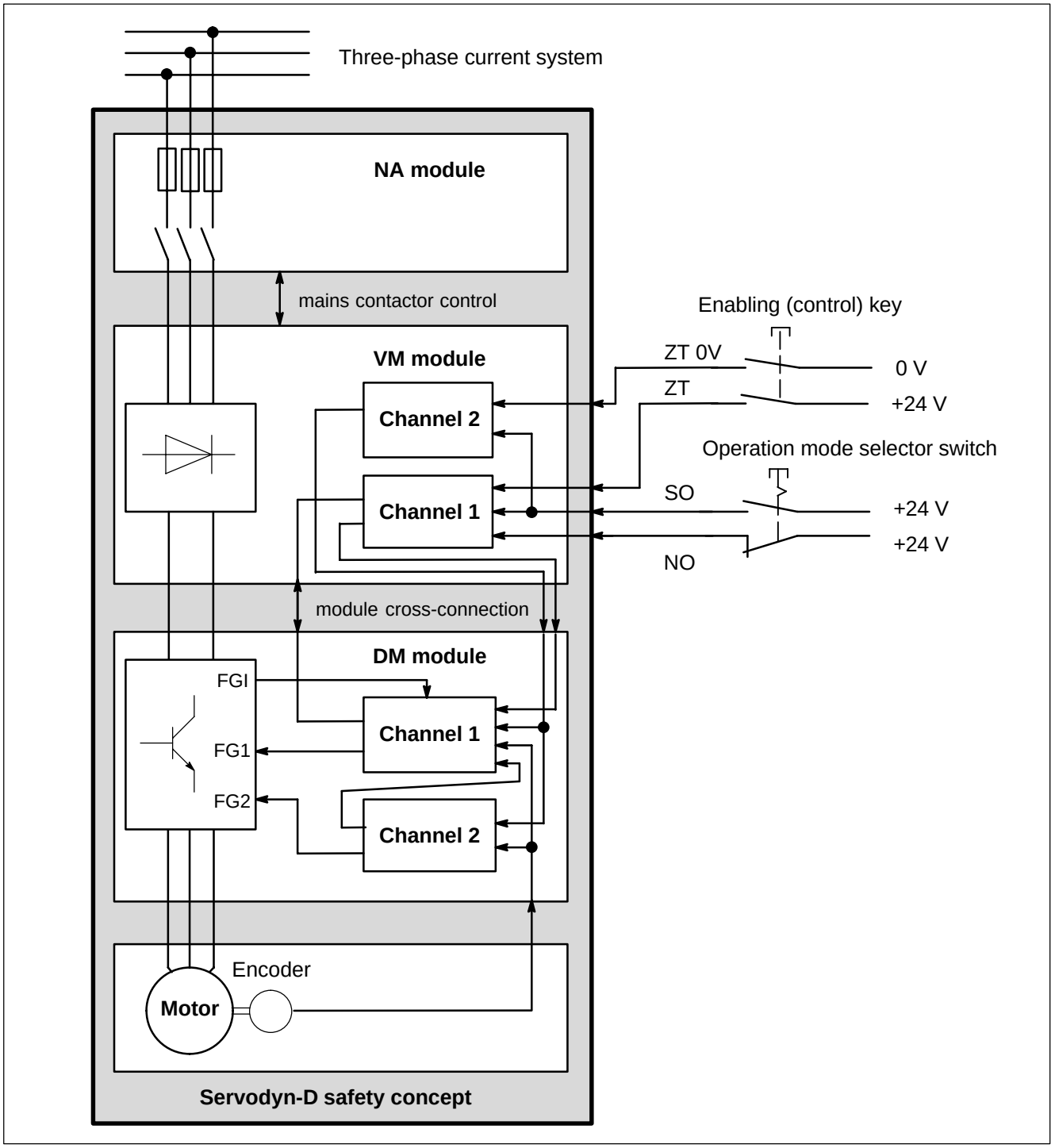
Way of functioning of the guard locking

The **ST-S release signal** releases the machine's guard when the drives have been stopped and special operation mode has been activated with standstill monitoring of the drives.
Within 3 s the **ST-R feedback signal** (guard unlocked) must be output, otherwise, the VM will detect fault F45 (channel error Guard locking), thereby initiating the "Drive stopping" function.

Fault monitoring:

- The ST-R feedback signal detects possible short-circuits.
- Manipulated opening of the guard in normal operation will initiate a category 1 stop function.

4.2.4 Special operation with speed monitoring



Way of functioning of speed monitoring in special mode

Enabling (control) key

Speed monitoring in special operation is activated by the enabling (control) device (change-over from standstill monitoring to speed monitoring). By actuating the enabling (control) key, movements can be executed at limited speed while the guard is open.
In case of an excessive speed (P-0-0012), the DM will output fault messages F15 and/or F16 (deviation from safe speed).

Fault monitoring:

The enabling (control) key must be actuated for at least 0.1 s.
Within 30 s (P-0-0023), the key must be released and pressed again. An inadmissible mechanical or electrical bridge between the keys will thus be detected.
The DM monitors both enabling (control) key channels for simultaneous actuation within 2.0 s (P-0-0024). A short-circuit between the channels will be detected.
In case of a fault, the DM will output the fault message F46 (channel error Confirmation).

5 Interface conditions

5.1 Earthing and electromagnetic compatibility (EMC)

☞ **Please note the information in the EMC manual, Servodyn-D**

Language	Part no.
German	1070 066 072
English	1070 066 074
French	1070 066 075
Italian	1070 066 076

5.2 Mains connection

CAUTION
Inverter modules may only be operated on earthed systems. Operation on indirectly earthed systems (IT systems) is not permitted because clearances and creepage paths in the module may be overloaded.

IEC 364-3: 1993, mod (HD 384.3 S2, VDE 0100-300) defines mains systems relative to their type of earth connection.
Accordingly, in an IT system, all live parts are separated from earth, or one point is connected to earth via an impedance.

The conductive parts of an electrical plant are either

- earthed individually, or
- earthed jointly, or
- jointly connected to the system's earth.

DANGEROUS ELECTRICAL VOLTAGE
Only permitted protective measure in accordance with EN 50 178: Protective earth.
The PE conductor cross-section must be at least 10 mm^2.
Earthing the DC link on one side if operated with an isolation transformer is not permitted!

The mains system is directly connected to the mains connection module NA..–D, usually via a mains filter.
If the available mains voltage does not coincide with the specified system voltage, an autotransformer may be used.

DANGEROUS ELECTRICAL VOLTAGE
Leakage currents emerging from the DC link may disable e.l.c.b.'s type A.
Operation at a separate circuit protected by an e.l.c.b. type B is permissible. Please note the leakage currents of radio-interference suppression circuits.

- Supply voltage U = 380 ... 415 V ±10 %, 48 ... 62 Hz
- Voltage drop between no load and full load ΔU = max. 5 %
- total system voltage dip in accordance with EN 60204 at rated voltage max. 10 ms (except power electronics).
  In the case of a mains failure, the drive is halted with setpoint control at the current limit.
- Peak voltages 2 x U_N for max. 1.5 ms
- It is assumed that a lightning protection system is available in the subdistribution which limits transient overvoltages to 4 kV. All clearances and creepage paths are rated for 4 kV (impulse withstand voltage between conductor and earth).
- The power connections are designed for overvoltage category 3 in accordance with the requirements.

Conductor cross-section

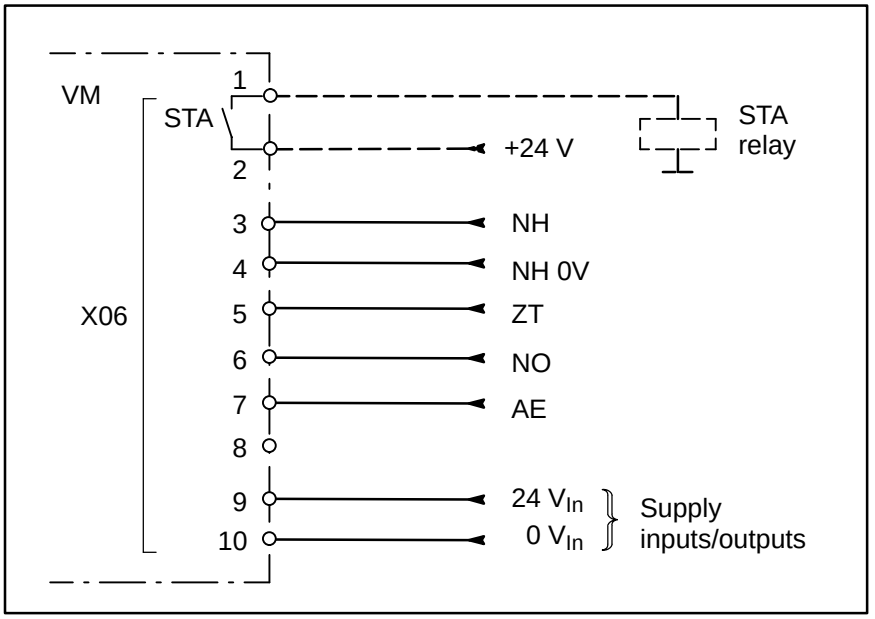
Mains supply cable for the mains connection module in accordance with EN 60 204 Part 1 for installation in a cable duct at an ambient temperature of 45°C:

Supply module	Mains supply cable up to ϑ_{amb} = 45°C
VM..20K	4 mm^2
VM..35B	6 mm^2
VM..70C	25 mm^2
VM..90D	2 x 25 mm^2

5.3 RSU control connections on the VM

For wiring, see section 5.4 .

Terminal strip X06



X06.1/2 STA Status message

Floating relay contact. Max. load 24 V / 1000 mA.
For a description, refer to ”Interface conditions” manual.

X06.3/4 NH / NH 0V Emergency stop, channel 1

Optocoupler input for Emergency Stop function,
active with LOW level.

If a low level (open contact on NH 0V) is applied, all axes are halted as defined in the setting of parameter P-0-0004:

- within the shortest possible time
- drive-controlled via ramp S-0-0260
- setpoint-controlled by master

When completely stopped, the torque is removed from the motors.
For connection refer to page 5–8.

X06.5 ZT Enabling (control) key, channel 1

Optocoupler input for enabling (control) key,
active with +24 V_{DC} (16...30 V).

If 24 V are applied to ZT and channel 2 is active (ZT 0V), the system changes from standstill monitoring to speed monitoring if special operation mode is active. Therefore movements can be performed at limited speed while the guard is open.

X06.6 **NO** **Normal operation**
7 segment display: 

Optocoupler input, active with +24 V_{DC} (16...30V).

If 24 V are applied to NO, the normal operation mode (monitoring of the maximum speed of the drives) is active. Low level will switch to special operation mode if SO/SO 0V is additionally activated within 2 s. For connection of mode change-over, refer to page 5–7 or 5–9.

X06.7 **AE** **Drive on / RESET**
Display by means of the “AE” and “FGI” LED’s

Optocoupler input to switch the drive on and to clear errors on the VM.
Active with +24 V DC (16...30 V), both LED’s illuminate when the drive is on.

AE must be operated for at least 0.1s.
An active error message is cleared if the error has been corrected. If several errors have occurred the error with the higher next priority is then displayed. The VM will be activated if no more errors exist and the Emergency Stop channels have not been interrupted:

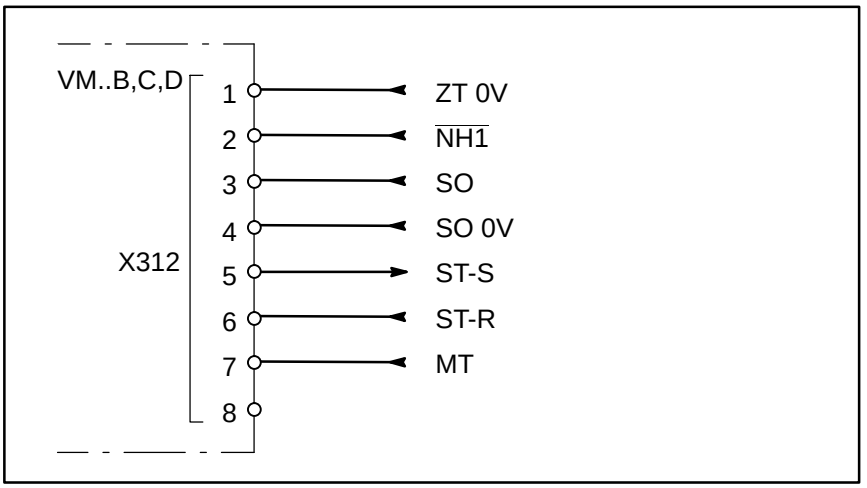
- The mains contactors in the NA module are switched on
- The d.c. link voltage controller is activated
- VM initiates central enable FGZ
- STA contact is closed.

The On key is controlled against manipulation. The On key is only switched on by a positive edge if the Emergency Stop channels remain uninterrupted.

X06.9/10 **$24V_{In}$, $0V_{In}$** **Supply of the outputs**

Input and output supply voltage at X06 and X34.

Terminal strip X312



X312.1 ZT 0V Enabling (control) key, channel 2

Optocoupler input for enabling (control) key,
active with LOW level.

If low level is applied to X312.1 and channel 1 is active (ZT), the system changes from standstill monitoring to speed monitoring if special operation mode is active. Therefore movements can be performed at limited speed while the guard is open.

X312.2 $\overline{\text{NH1}}$ Emergency-Stop 1, channel 2

Optocoupler input for the Emergency-Stop function,
active with LOW level.

If a low level (open contact on X312.2) is applied, all axes are halted as defined in the setting of parameter P-0-0004.
Also refer to Emergency-Stop, channel 1, page 5–3. For connection cf. page 5–8.
$\overline{\text{NH1}}$ switches auxiliary contactor K1 and mains contactor K2 in the mains connection module.

X312.3/4 SO, SO 0V Special operation
7-segment display: 

Optocoupler input, active with +24 V_{DC} (16...30V).

If 24 V are applied to SO, the special operation mode for the open guard is active, i.e. a standstill monitoring function is active for the drives with full power supply.
With low-level, the system switches to normal operation mode if NO/NO 0V is additionally activated within 2 s.
For connection of mode change-over, refer to page 5–7 or 5–9.

X312.5 ST-S Guard enable signal

Digital output +24VDC, 0.3 A for special mode.

The output signal changes to +24 V when the drives have been stopped and the special operation mode with standstill monitoring is active.
This signal releases the guard of the machine so that it can be opened.

☞ **Removing SO (X312.3) will immediately deactivate output ST-S.**

X312.6 ST-R Guard signal feedback

Optocoupler input, active with +24V_{DC}.

This feedback signal is used by the VM to monitor the ST-S enable signal. The feedback must be given within 2 s of the ST-S enable signal, otherwise, the drive will be switched off with the guard locking channel error (F45).

X312.7 MT Measuring probe input

Optocoupler input for a measuring probe, active with +24V.

For a description, refer to ”Interface conditions” manual.

5.4 Circuit example

If the following standards are observed, dangerous machine movements may even be performed without a guard:

EN 292-2 Safety of machinery, section 3.7
Application of safety principles in the design of control systems

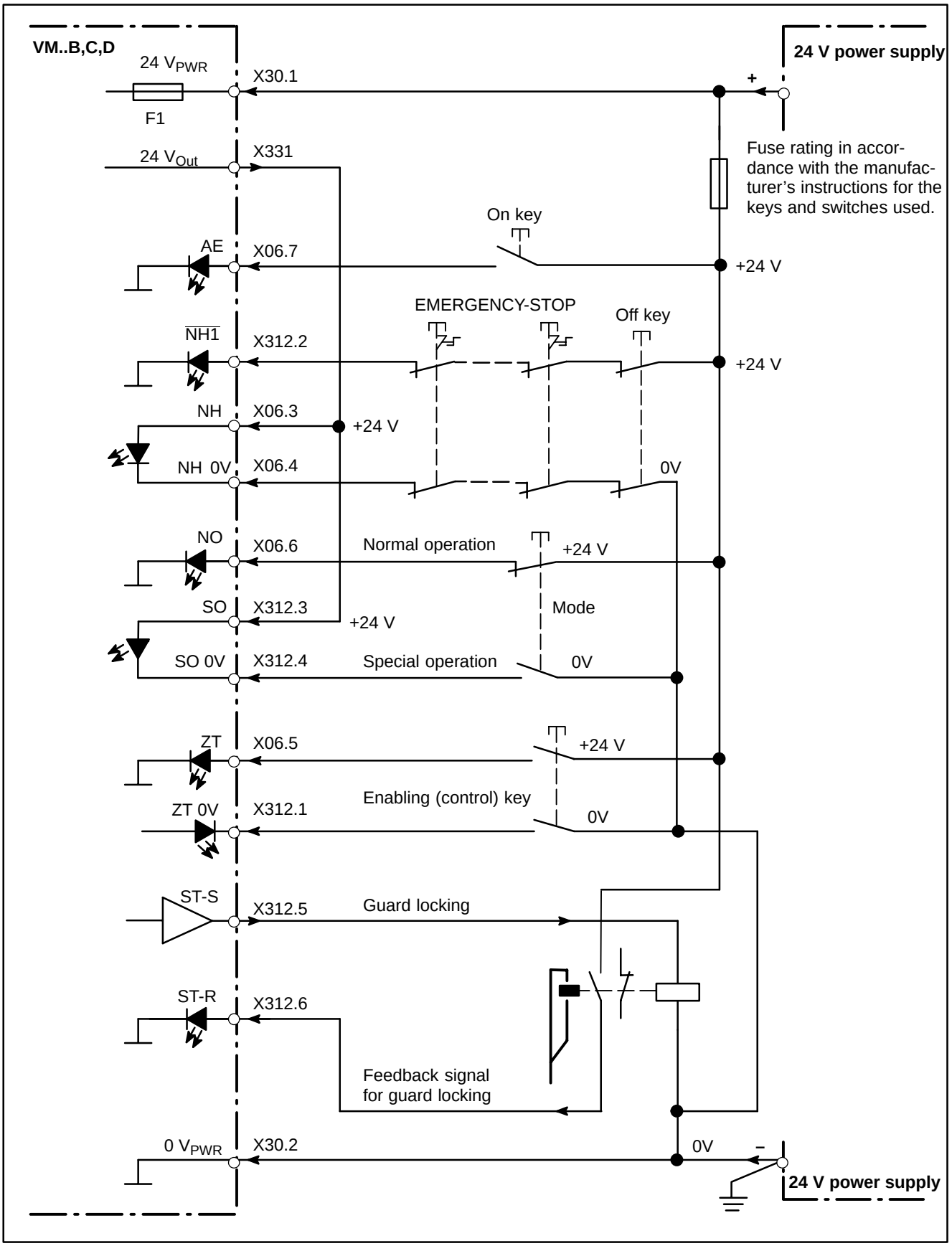
EN 954-1 Safety-related parts of control systems

EN 60204-1 Electrical equipment of machines,
section 9.4 Control functions in case of errors
section 11.3 Programmable equipment

The two-channel structure of all monitoring and interlocking facilities of the Servodyn-D drives complies with these requirements:

- 2-channel **Emergency-Stop function** (stopping in case of an emergency)
- 2-channel change-over from normal to **special operation,**
- Control of **guard locking** with signal feedback,
- 2-channel **standstill or speed monitoring**,
- 2-channel **enabling (control) keys**.

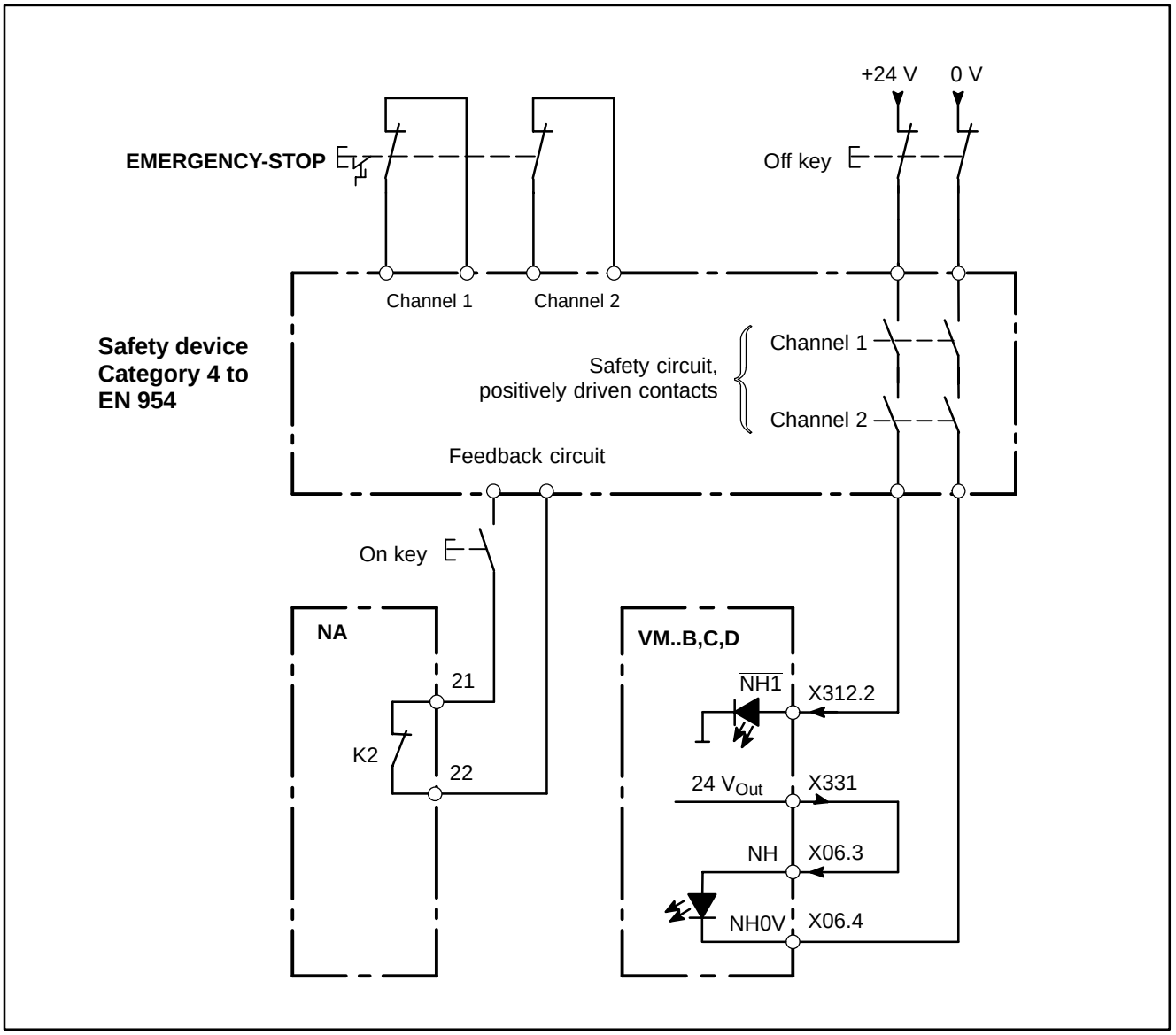
Connection with 2-channel monitoring and interlock structure



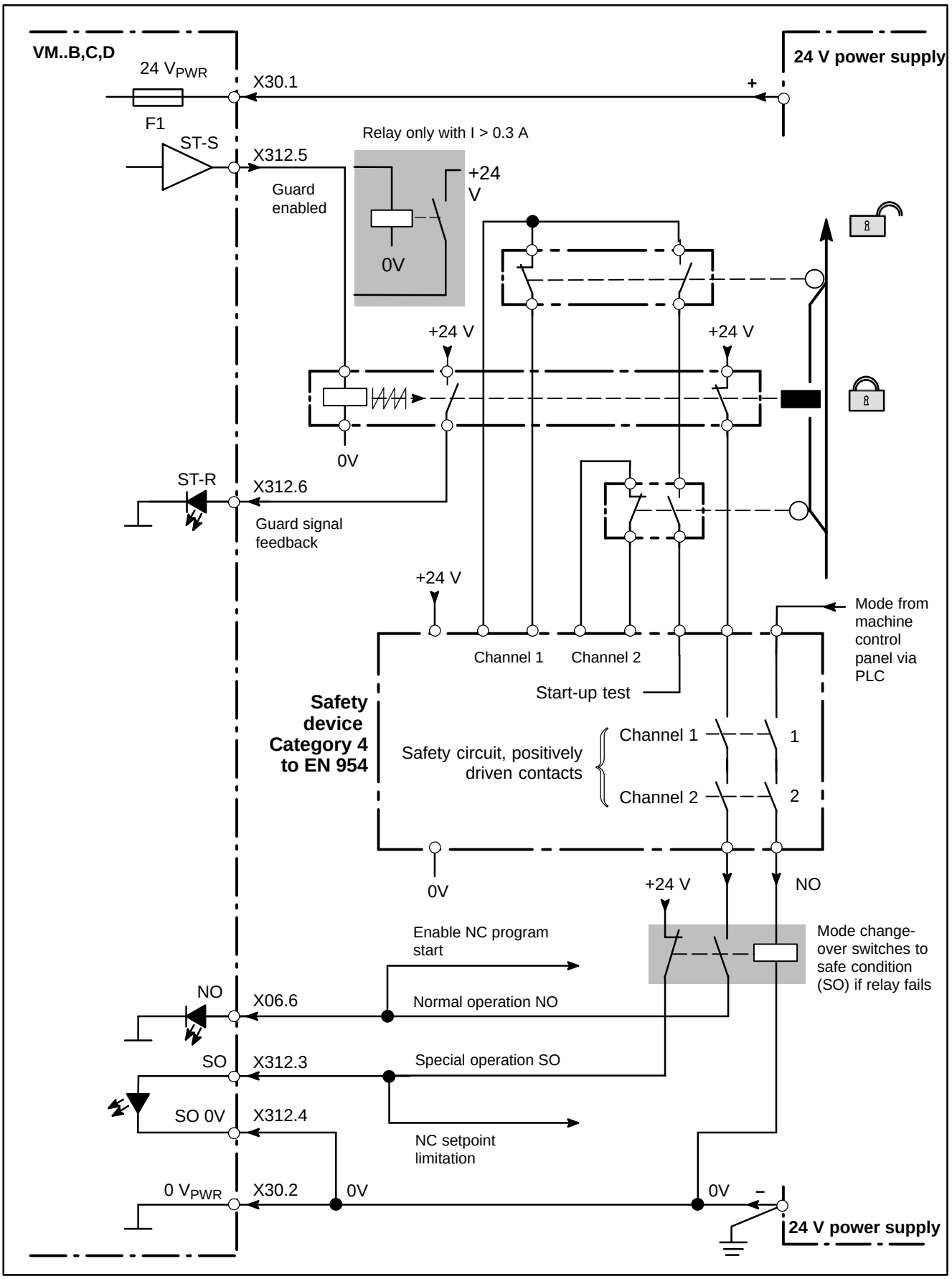
Connection of EMERGENCY-STOP via external safety device

The external safety device does not require a tripping delay.

The NH and $\overline{\text{NH1}}$ inputs at the supply module are switched without delay by the external safety device in the case of EMERGENCY-STOP.
However, the VM control will disconnect mains contactor K2 of the NA mains connection module with a certain delay, i.e. when the drives have come to a stop.

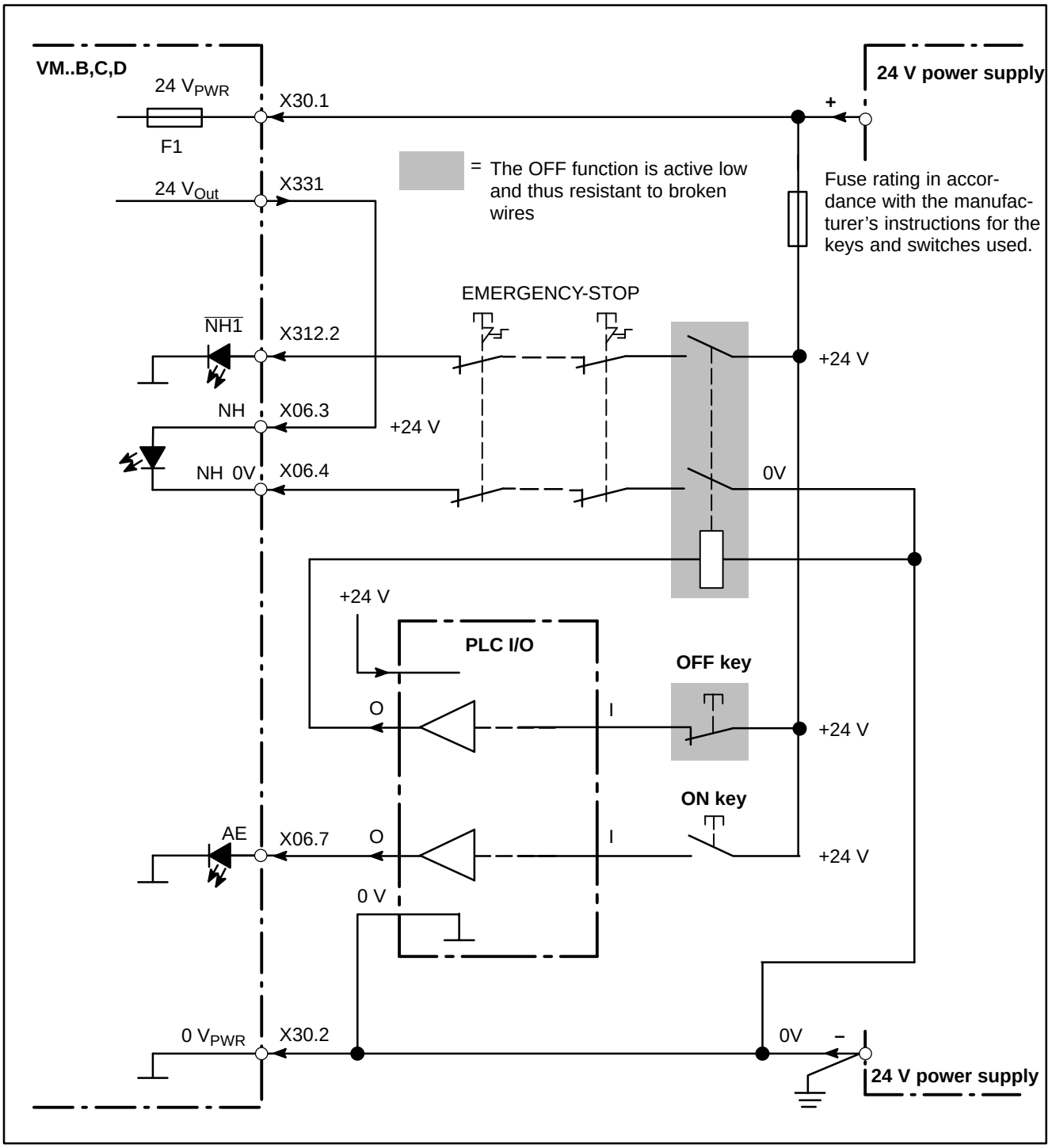


Connection of two-channel guard monitoring with guard locking and start-up test

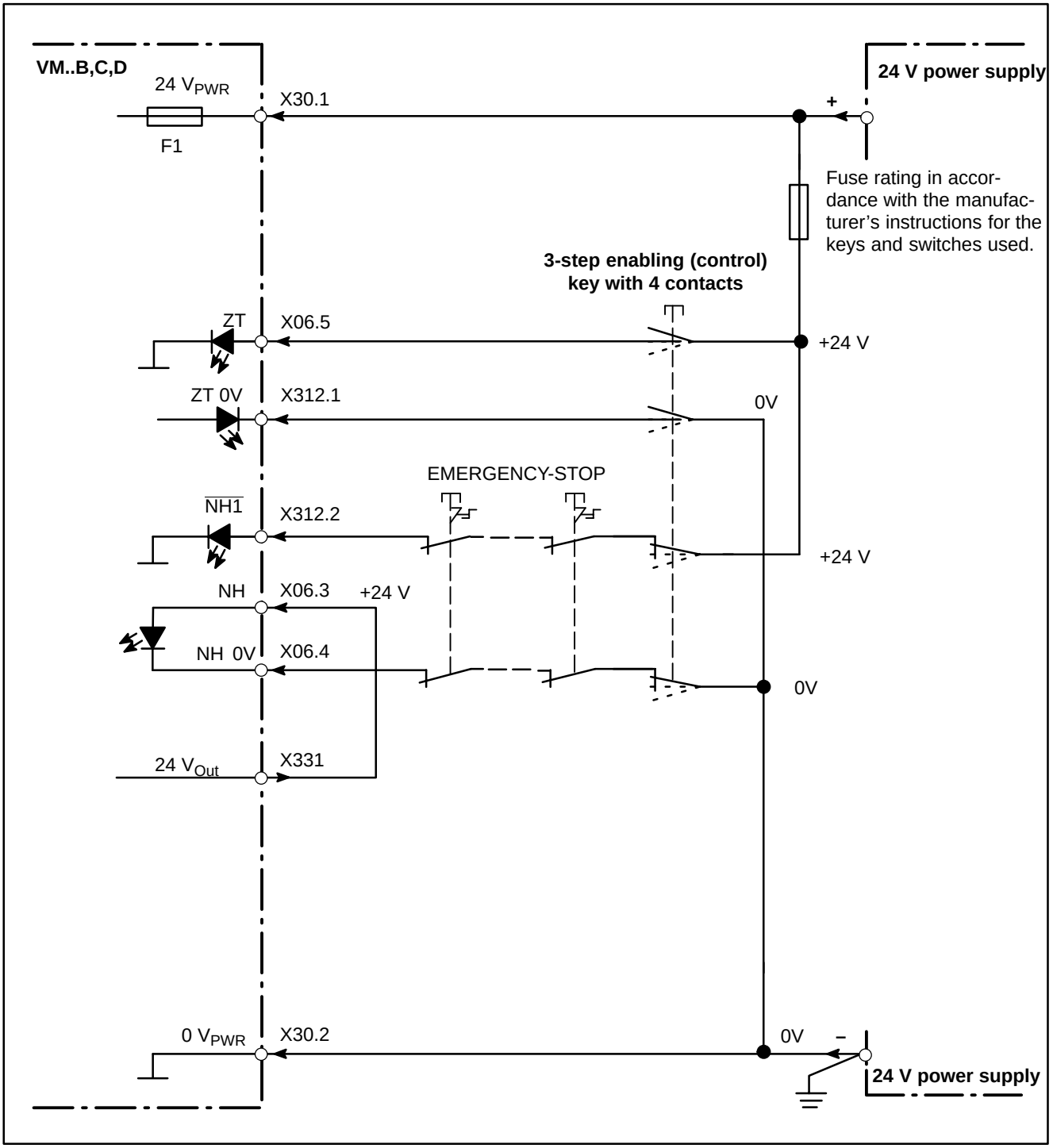


Connection with key function for Drives On/Off via PLC

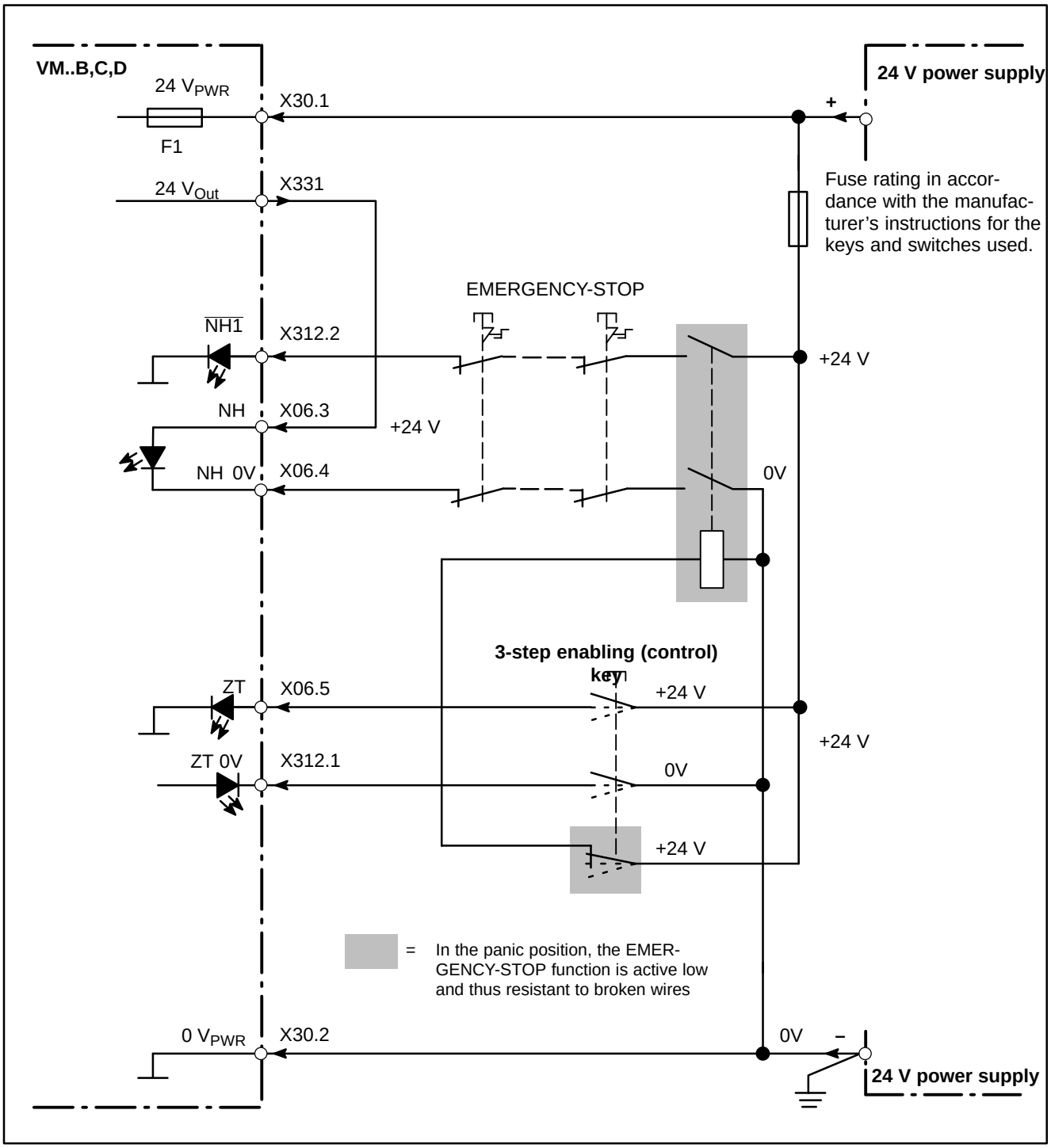
The Off function is active low and therefore resistant to broken wires.
The key functions Drives On/Off can also be transmitted to the PLC, e.g., from the control panel via a CAN bus.



Connection of enabling (control) key with 4 contacts (2 normally-open contacts, 2 normally-closed panic contacts) and effect on EMERGENCY-STOP circuit



Connection of 3-step enabling (control) key with effect on EMERGENCY-STOP circuit



6 Data and settings

6.1 RSU settings on the VM

The tripping delay can be adjusted between 1...15 sec in steps of 1 sec using the S1 step switch (in the upper part of the VM front panel). The tripping delay depends on the braking behavior of the largest axis/spindle.

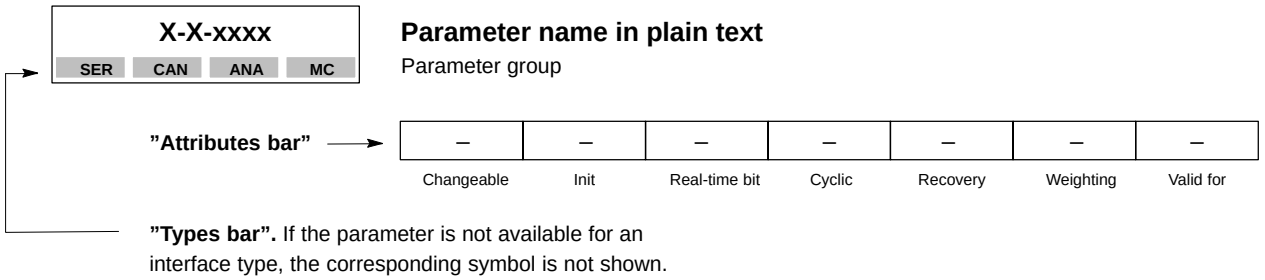
Another tripping delay (diverse) is permanently set to 16 sec inside the drive.

☞ **Step switch S1 must be protected against position changes after commissioning. For this purpose, you should use the seal from the accessory set of the PM VMS/...–D Personality Module.**

6.2 RSU settings on the DM

The limit values of the firmware-controlled safety monitoring are contained in the RSU parameters described below.

Parameter representation



This **types bar** shows the interface type for which this parameter is available and can be used:

SER: SERCOS interface
CAN: CAN bus
ANA: Analog interface
MC: Motion Control

The individual fields of the **attributes bar** contain the following information:

- "**Changeable**" field:
  Specifies in which phase the parameter can be changed. If nothing is entered here, the parameter can only be read.
- "**Init**" field:
  Specifies in which phase the parameter has to be initialised in the drive. If nothing is entered here, the drive initialises the parameter itself through its firmware.
- "**Real-time bit**" field:
  Specifies whether the parameter can be transmitted between the master (or DSS-D) and the drive in real time. For example, this is necessary for signalling certain events, or for triggering actions.
  "M → D" means: transfer from master to drive possible
  "D → M" means: transfer from drive to master possible.
- "**Cyclic**" field:
  Specifies whether the parameter can be transmitted cyclically between the master (or DSS-D) and the drive. This is necessary, e.g., for the transmission of setpoints or actual values.
  "MDT" means: cyclic transfer from master to drive
  "DT" means: cyclic transfer from drive to master
- "**Recovery**" field:
  Specifies whether the parameter can be saved in the drive's FEPROM. If yes, "FEPROM" has been entered in this field.
- "**Weighting**" field:
  Specifies the weighting parameters used for interpreting the data of the corresponding parameter.
- "**Valid for**" field:
  The attribute values of some parameters are different for the individual interface types. In these cases, several attributes bars are given.
  This field specifies the interface type for which the attributes bar is valid. If it is valid for all types, there will be no entry in this field.

RSU data

P-0-0004
SER

Halting mode with drive off

Drive On/Off

Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for
2,3,4	–	–	–	FEPROM	–	

This parameter determines how the drive is halted with **delayed** switching to torque-free state (P-0-0125 = 0).

Parameter configuration:

15 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 X X

X is assigned the 0 or 1 below it.

0 0 halting in shortest possible time w/o ramp
0 1 halting with ramp S-0-0260
1 0 setpoint-controlled halting

Precondition:

- External enable FG provided (24 V at X06.3, DM module)
- Drive enable provided (bit 14 = 1)

Delayed switching to torque-free state occurs after an error following EMERGENCY-STOP or when the signal ”Drive on” has been cleared.

P-0-0012
SER

Acceptance tests 3 and 4

Speed limit for manual mode

RSU

Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for
Phase 3,4	Phase 2	–	–	FEPROM	–	

Limit value for the maximum admissible safe speed in the special operation mode with enabling (control) device. If the CNC control commands setpoints > P-0-0012 in special operation mode, the drive signals F13 (excessive controller deviation).

Range: 0 ... 9000 rpm
Default setting 50 rpm

Response time: 1...6 ms (until shut-down)

☞ **When this value has been changed, acceptance tests 3 and 4 have to be performed and recorded.**

P-0-0022
SER

Acceptance tests 1 and 2

Standstill monitoring angle

RSU

Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for
Phase 3,4	–	–	–	FEPROM	–	

Tolerance range for the maximum permissible angle of rotation with safe standstill in the special oeration mode.

Range: 0 ... 11.2 degrees
Default setting 4 degrees

Response time: 0.5...2 ms (until shut-down)

☞ **When this value has been changed, acceptance tests 3 and 4 have to be performed and recorded.**

P-0-0023

SER

Acceptance test 6

Maximum enabling (control) time

RSU

Phase 3,4	Phase 2	–	–	FEPROM	–	
Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for

Time period for releasing the enabling (control) key and pressing it again. This time serves for monitoring the keys for unauthorized manipulation.

☞ **This parameter should be set to the same value in all DM's. Otherwise, if the lowest value is exceeded, "Drive stopping" will be output, and the fault message will not appear at the halted axis, but rather at the axis with the lowest value.**

Range: 0 ... 6553.5 sec
Default setting 30 sec

☞ **When this value has been changed, acceptance test 6 has to be performed and recorded.**

P-0-0024

SER

Acceptance test 5

Channel monitoring tolerance time

RSU

Phase 3,4	Phase 2	–	–	FEPROM	–	
Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for

Monitoring of redundant channels for identical information:
For the time set in this parameter, the channels may contain different pieces of information.

Range: 0.5 ... 10 sec,
Default setting 2 sec

☞ **When this value has been changed, acceptance test 5 has to be performed and recorded.**

6.3 Limits of RSU settings on DM

Response thresholds for speed monitoring

Safe speed:	P-0-0012 [rpm]
Monitoring of channel 1	n_1 = P-0-0012 + 10 %
Monitoring of channel 2: • Encoder division 2048 • Encoder division 128	$n_2 = n_1 \bullet y$, y = f(P-0-0012, encoder divisions) n_{2_min} = 14 rpm; n_{2_max} = 13.600* rpm n_{2_min} = 229 rpm; n_{2_max} = 217.600* rpm

*) n_{2_max} is also limited by the motor or the mechanics

6.4 Examples of parameter settings in the DM

6.4.1 Linear axis

Safe speed

P-0-0012 Limit value for safe speed → 50 rpm (motor)

S-0-0123 Feedrate constant (spindle pitch) → 5 mm/rev

Axis speed v = P-0-0012 · S-0-0123 = 250 mm/min

With velocities > 250 mm/min, speed monitoring will halt the axis and turn the VM off.

Safe standstill

P-0-0022 Standstill monitoring angle → 10°

S-0-0123 Feedrate constant (spindle pitch) → 5 mm/rev

Position deviation x = (P-0-0022 / 360°) · S-0-0123 = 0.13888mm

In case of a position deviation > 0.13888 mm, standstill monitoring removes the torque from the axis and turns the VM off.

6.4.2 Spindle

Safe speed

P-0-0012 Limit value for safe speed → 150 rpm (motor)

Load gearbox input revolutions S-0-0121 → 9000 rpm

Load gearbox output revolutions S-0-0122 → 3000 rpm

Spindle speed n = (S-0-0122 / S-0-121) · P-0-0012 = 50 rpm

With spindle speeds > 50 rpm, speed monitoring will halt the spindle and turn the VM off.

Safe standstill

P-0-0022 Standstill monitoring angle → 10°

Load gearbox input revolutions S-0-0121 → 9000 rpm

Load gearbox output revolutions S-0-0122 → 3000 rpm

Rotary angle deviation α = (S-0-0122 / S-0-121) · P-0-0022 = 3.333°

7 Warning of residual hazards

7.1 Spindle drive

DANGER
Deviations from standstill position with safe operating halt!

A 2-pole asynchronous motor can turn mechanically by maximally 360° with maximum torque (a 4-pole motor by up to 180° mechanically) if the following 3 errors occur at the same time:

- **Break-down of a power semiconductor**
- **Simultaneous break-down of another semiconductor**
- **In this case, two out of six semiconductors are affected in such a way that the motor shaft aligns itself.**

When the encoder coupling breaks, the asynchronous motor runs up to 350 rpm until it detects the error and inhibits the power unit if the following 2 errors occur at the same time:

- **Complete break of the encoder coupling in standstill**
- **Unexpected motor start due to internal drive error.**

You should only intervene manually in the spindle area when the power supply has been safely interrupted!

A manual tool change must not be possible unless the power supply to the spindle drive has been **safely interrupted**, i.e. a 2-channel interruption has been performed, and the feedback signal has been received:

Channel 1: Inhibit drive-enable (e.g. S-0-0135),
Feedback (e.g. S-0-0135)

Channel 2: Turn mains contactor of the NA mains connection module off via inputs NH and $\overline{\text{NH1}}$ on the VM.
Feedback: STA output (X06.1/2) on VM.

Or:
Turn off contactor in power cable to the motor.
Feedback via normally-open contact of the contactor.

7.2 Servo drive

DANGER
Deviation from the standstill position with safe operating halt!

A 4-pole servo motor can turn mechanically by maximally 180° with maximum torque (a 6-pole motor by up to 120° mechanically) if the following 3 errors occur at the same time:

- **Break-down of a power semiconductor**
- **Simultaneous break-down of another semiconductor**
- **In this case, two out of six semiconductors are affected in such a way that the motor shaft aligns itself.**

When the encoder coupling breaks, a 4-pole servo motor can turn mechanically by maximally 180° with maximum torque (a 6-pole motor by up to 120° mechanically) if the following 2 errors occur at the same time:

- **Complete break of the encoder coupling in standstill**
- **Unexpected motor start due to internal drive error.**

DANGER
A hanging axis may fall freely if the power unit fails!
For a hanging axis, you should always use a counterweight.

8 Commissioning

For commissioning and the operation of the RSU function, a safe data management system ensures that:

- the default setting of the drive is not associated with any dangers,
- any change has to be deliberately made,
- any intervention is logged over the entire life of the drive,
- a cyclic data comparison permanently checks the value settings.

☞ **The control and drives should be interlocked so that changing over into special operation mode is not possible unless the drive has come to a stop. Otherwise, the RSU hardware monitoring system will respond and switch off the mains contactor.**

This interlock can be achieved, e.g., by initiating ”Feed Halt” and ”Spindle Stop” inside the control (NC/PLC) so that the operaton mode change-over is not transmitted to the 24 V inputs of the VM unless the system has come to a standstill (query INPOS window).

When the special operation mode has been selected, the CNC control may only output setpoints below the manual mode speed limit P-0-0012. Otherwise, the drive will signal error F13 (excessive controller deviation).

Software updates

During a software update via the Personality Module, all current data is loaded to the RAM memory with default values. When the modules have been turned on, the cyclic data comparison will thus detect an error in the RAM and signal F46.

★ With the following set of operations, the drives can be started without performing another acceptance test:

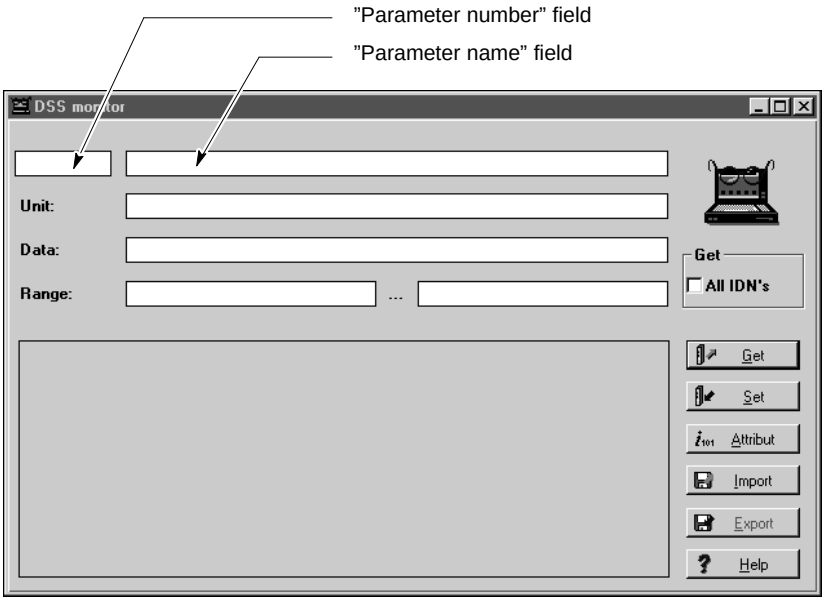
1. Load the RSU data from the module’s EEPROM memory to the RAM with P-0-0602.
2. Save the working memory on the Personality Module with S-0-0264.

Afterwards, the previous values will be available again in the area of the current data when the unit is switched on, and the axis can be used without an error message.

8.1 Data entry

The default values of the RSU data are stored in the RSU memory (EEPROM) of the drive and in the PM..S Personality Module (FEPROM). They are set to extremely low values not suitable for real operation.
These values, which are protected by the password ”Bosch”, have to be adjusted with the help of the DSS monitor of the DSS-D Commissioning and Service System, or by another control via SERCOS interface. The new values should be protected by another password.

★ Start the ”Monitor”



DSS Monitor

★ Enter the desired parameter in the ”Parameter number” field, e.g. P12. Then press the Enter key or click on the ”Get” command button.
In the ”Data” field, the DSS will now display the value of the parameter twice (e.g. 50.000,50.000)

- The first number shows the value currently stored in the RAM
- The second number shows the value loaded from the RSU memory and transferred to the RAM (cf. figure on page 8–3).

★ You should first change the password because the RSU data is write-protected. For this purpose, select parameter P-0-0600 and enter the following for the change:

- ”OLD NEW NEW” (with a blank in between)
  Then press the Enter key or click on the ”Get” command button. Afterwards the display will show ”GESPERRT” (NO ACCESS).
- Enter the new password. Pressing the Enter key will change the display to ”FREI” (ACCESS).
  All RSU data can now be changed.
- The password is inhibited again by entering any desired character in P-0-0600.

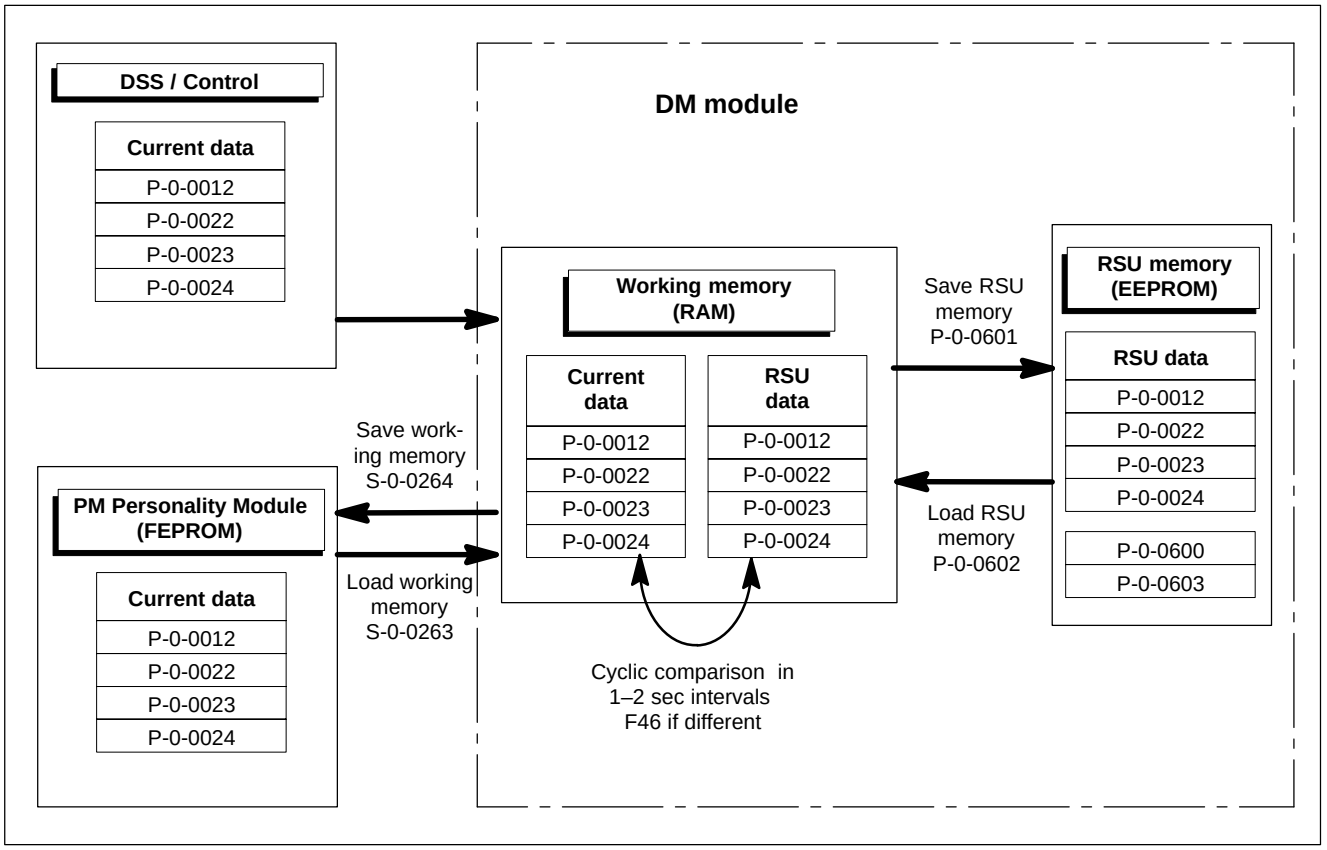
★ Select the RSU parameters one by one, and enter the new values in the ”Data” field. In order to check input errors, the value must be entered twice, e.g. 50,50 for 50 rpm.
Press the Enter key or click on the ”Get” command button.

With the help of the permanent cyclic comparison between the RAM areas ”Current data” and ”RSU data” (cf. figure below), the changed current data will lead to error message F46 (channel error safety-oriented data).

★ When all RSU data has been changed, it has to be loaded to the RSU data area of the RAM and at the same time to the drive's EEPROM by entering the command ”Save RSU memory” (P-0-0601).

☞ **This command can only be given when the password has been released.**

Now, error F46 can be cleared and the new settings tested in operation by entering the command ”Reset diagnostics class 1” (S-0-0099).



Management of safety-oriented data

P-0-0600
SER

RSU password

RSU

Phase 3,4	Phase 2	–	–	EEPROM	–	
Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for

Password protection for changing parameters P-0-0012, P-0-0022, P-0-0023, P-0-0024 and for the command ”Save RSU memory ” (P-0-0601). The factory settings can be returned to at any time by entering ”RSU-CLEAR”.

Range: Word comprising max. 10 letters/digits
Default setting ”BOSCH”
(upper/lower case letters not supported)

P-0-0601
SER

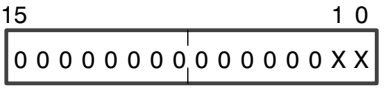
Command ”Save RSU memory”

RSU

Phase 3,4	–	–	–	–	–	
Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for

This command saves the current (RSU) data modified in the main memory (RAM) to the internal RSU memory (EEPROM) of the drive and the RSU data range of the RAM.
Whenever this command is executed, the alteration index (P-0-0603) will be incremented.

Parameter configuration:



X is assigned the 0 or 1 below it.

0 0 No command
1 1 Execution of command

P-0-0602
SER

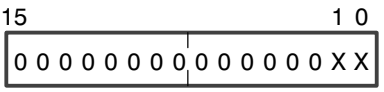
Command ”Load RSU memory”

RSU

Phase 3,4	–	–	–	–	–	
Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for

This command loads the RSU data stored in the internal EEPROM of the drive to the main memory (RAM) of the drive.
The command is automatically executed when the drive is started up.

Parameter configuration:



X is assigned the 0 or 1 below it.

0 0 No command
1 1 Execution of command

8.2 Operation

When all data has been input, the RSU data changed in the RAM must be saved to the PM..S Personality Module by entering the command ”Save working memory” (P-0-0264).

CAUTION
FEPROM will be deleted!
All FEPROM data will be replaced with the parameters currently contained in the RAM by entering the command ”Save working memory”. This process cannot be reversed.
If you are not sure whether you still need the old FEPROM data, ask your systems administrator before executing the command.

☞ **The ”Save working memory” command cannot be used instead of a backup!**
For example, parameters set and optimized during initial commissioning can only be used for another drive if a backup was made.

When switched on again, the drive will read the RSU data

- from the EEPROM to the ”RSU data” area of the RAM
- from the PM to the ”Current data” area of the RAM

The cyclic data comparison between both areas prevents errors caused by PM modules not properly plugged in.
In order to feed back a faultless special operation mode to the control, the drive sets the RSU special operation mode active parameter (P-0-0605).

★ If RSU data is to be loaded from the PM module during operation, you should switch back the drive to phase 2 with the DSS or the control unit and then enter the command ”Load working memory”.

CAUTION
Loss of data!
All RAM data will be replaced with the parameters currently contained in the FEPROM by entering the command ”Load working memory”. This process cannot be reversed.
Make sure that you no longer need this data.

★ If you do not remember your individual password, or if you want to re-activate the default values for the RSU data for any other reason, you should enter the following in the Data field of the RSU password P-0-0600 in the DSS Monitor:
“**RSUCLEAR**” (no blanks, upper/lowercase letters not supported).

Thus, the password is returned to ”Bosch”, i.e. the RSU data may be accessed again. However, the values have been reset to the default values.

CAUTION
Loss of data!
RSUCLEAR will replace the RSU data in the RAM. This process cannot be reversed.
Make sure that the data is stored in the FEPROM of the personality module or is no longer needed.

☞ **After commissioning, and whenever a Personality Module or an inverter module has been replaced, an acceptance test has to be performed (cf. section 9)!**

It is not necessary to perform the complete acceptance test for any type of change:

- **Partial acceptance test** required
  when safety-relevant data has been changed:
  - Position of switch S1 on the VM front panel
  - P-0-0012, P-0-0022, P-0-0023. P-0-0024 in the DM's
- **Complete acceptance test** required :
  - when a Personality Module has been replaced
  - when an inverter module has been replaced

8.3 Alteration index

In order to provide complete tracing and protection of the RSU data, an alteration index is incremented whenever the command **"Save RSU memory"** is entered, i.e. with every effective change. The counter range is sufficient for the life of the drive.

☞ **The RSU data is safety-relevant.**
After every intervention, you should record the counter status (P-0-0603) and the date of the change.

8.4 Messages via SERCOS interface

P-0-0603			
SER			

RSU alteration counter
RSU

Phase 3,4	Phase 2	–	–	FEPROM	–	
Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for

Counter for the number of completed "Save RSU memory" commands.

P-0-0604			
SER			

RSU status word

RSU

Phase 3,4	Phase 2	–	–	FEPROM	–	
Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for

In the event of an error, this status message provides for a more detailed diagnostics of the cause of the error.

Parameter configuration:

15 8 7 0

X X X X X X X X X X X X r X X X

X=0: no error
X=1: error detected
r: reserved

	Module display during Init	during operation
Bit 0: Special operation	–	–
Bit 1: Safe speed active	–	–
Bit 2: Drive in safe stanstill	–	–
Bit 4: Hardware error	–	F16
Bit 5: Firmware error	–	F15
Bit 6: Channel error ”Safe signal transmission”	–	F46
Bit 7: Time limit for enabling (control) exceeded (time-out)	–	F46
Bit 8: Reading the RSU memory not possible	F66	–
Bit 9: Writing to RSU memory not possible	F66	–
Bit 10: Incorrect data in RSU memory	F66	F46
Bit 11: Error in cyclic data comparison	–	F46
Bit 12: Encoder divisions do not match RSU data	–	F46
Bit 13: Removal of FG did not inhibit output stage	–	F46
Bit 14: All RSU data with default values	–	–
Bit 15: PM..S plugged in	–	–

Incorrect data in the RSU memory (bit 10) sets bit 11 in manufacturer diagnostics class 1 (P-0-0129), thus causing an error in diagnostics class 1 by which the drive is halted in the shortest possible time with subsequent torque removal.

The error message F66 occurs when the drive runs up and can only be cleared by entering RSUCLEAR (return RSU data to default values) with subsequent RESET.

P-0-0605			
SER			

RSU special operation mode active

RSU

–	–	D → M	DT	–	–	
Changeable	Init	Real-time bit	Cyclic	Recovery	Weighting	Valid for

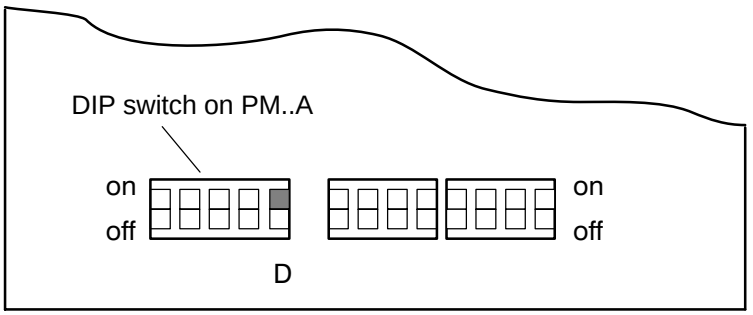
The drive sets this message in special operation without any errors.
Precondition:

- A Personality Module PM..S is used
- The drive has been switched to special mode SO.

8.5 Combining RSU and standard modules

If not all modules of a drive combination are equipped with the optional RSU Redundant Safety Monitoring function, the following must be noted during commissioning:

- All RSU modules are equipped with a PM..S Personality Module
- For all standard modules in this combination, DIP switch D on the standard PM..A Personality Module must be set ”on”.
  This is to ensure that safety-relevant signals are transmitted to the mains connection module.



DIP switch	Function
D on off	Combination with RSU modules: Operation together with RSU modules Operation together with standard modules (ex factory)

☞ **The required DIP switch is only available on Personality Modules with software release 0.040 or higher.**

9 Acceptance test

9.1 Acceptance procedure

During commissioning of the machine and after all software or hardware changes (including, e.g., changes by data transmission), a **complete acceptance test** has to be performed by authorized personnel.

When only some of the safety-relevant data has been changed, this data has to be checked by a **partial acceptance test**.

☞ **In any case, the changes and the performance of the test have to be recorded.**

Complete acceptance test

A complete acceptance test comprises a check of all safety functions provided (e.g. compliance with limit values, functions of the command output devices, function of actuators). The fault response becomes physically active. The safety functions are examined for their proper functioning.
The complete acceptance test is performed in accordance with the checklist given in section 9.2.

☞ **For more information, please refer to prEN 61800-5 (Tests upon commissioning).**

Partial acceptance test

A partial acceptance test is a test of those safety functions which are affected by a modification of safety-oriented data.
The required tests are selected from the checklist in section 9.2 and performed accordingly.

☞ **For more information, please refer to prEN 61800-5 (Tests upon commissioning).**

9.2 Checklist for acceptance test

Commissioning must have been completed before the safety tests described below can be performed.

Every test must be carried out for every individual DM or VM module.

9.2.1 Safety functions of the DM

Safe standstill

In special operation the safe standstill monitoring is active.

★ **Test 1 (individual test):**
Select operation modes NO and SO in turns while the axis/spindle is at standstill (P-0-0022 Standstill monitoring angle).

	DM tested	other DM's	VM
Effect:	none		
Fault message:	none		

Test 1 has been completed.

★ **Test 2 (individual test):**
Run the axis/spindle in normal operation at low speed, then switch to SO mode.

	DM tested	other DM's	VM
Effect:	halted without braking	–	switches mains contactor off
Fault message:	F15 and/or F16	F98	–
Clear fault:	F15 (software error) with "Reset diagnostics class 1", F16 with RESET on DM, re-initialize SERCOS ring. Switch mains contactor on with "AE".		

Test 2 has been completed.

Safe speed

Monitoring for safe speed is active in SO mode if enabling (control) has been given.
The monitored speed results from the limit value programmed in P-0-0012 in connection with the feedrate constant for linear axes or the gear adjustment for spindles. For an example, cf. page 6–5.

★ **Test 3 (individual test):**
Run the axis/spindle in normal operation at a speed **below** the limit value calculated from P-0-0012 and the feedrate constant/gear adjustment. Then enter enabling (control) and switch to SO mode.

	DM tested	other DM's	VM
Effect:	keeps on turning	–	none
Fault message:	none		

Switch back to NO mode.
Test 3 has been completed.

★ **Test 4 (individual test):**
Run the axis/spindle in normal operation at a speed **above** the limit value calculated from P-0-0012 and the feedrate constant/gear adjustment. Then enter enabling (control) and switch to SO mode.

	DM tested	other DM's	VM
Effect:	halted without braking	–	switches mains contactor off
Fault message:	F15 and/or F16	F98	–
Clear fault:	F15 (software error) with "Reset diagnostics class 1", F16 with RESET on DM, re-initialize SERCOS ring. Switch mains contactor on with "AE".		

Test 4 has been completed.

Enabling (control) key ZT, ZT1

In special operation, the enabling (control) key changes motion monitoring for the axis/spindle from standstill to safe speed.
Only if both inputs are driven simultaneously within the time difference programmable in P-0-0024, enabling (control) is given.

★ **Test 5 (collective test for all DM's) :**
Interrupt one of the two inputs ZT, ZT1, change to SO mode and operate the enabling (control) key.

	DM's tested	VM
Effect:	–	switches mains contactor off
Fault message:	F46	–
Clear fault:	"Reset diagnostics class 1"	AE (mains contactor on)

Test 5 has been completed.

Time limit for enabling (control)

In special operation, the operating time (P-0-0023) for the enabling (control) is monitored.

★ **Test 6 (collective test for all DM's):**
Operate the enabling (control) key beyond the time programmed in P-0-0023 in SO mode.

	DM's tested	VM
Effect:	–	switches mains contactor off
Fault message:	F46	–
Clear fault:	"Reset diagnostics class 1"	AE (mains contactor on)

Test 6 has been completed.

9.2.2 Safety function of the VM

Tripping delay

In the event of EMERGENCY-STOP or STOP, the mains contactor is switched off with a certain delay, for example, in order to first brake the spindle until it has come to a complete stop.

★ **Test 7:** Operate EMERGENCY-STOP with the axis/spindle halted.

	VM tested	DM's
Effect:	switches mains contactor off without delay	–
Fault message:	–	F98
Clear fault:	AE (mains contactor on)	"Reset diagnostics class 1"

Test 7 has been completed.

★ **Test 8:** Operate EMERGENCY-STOP with the spindle turning fast.

	VM tested	DM's
Effect:	switches mains contactor off at standstill	brakes until standstill
Fault message:	–	F98
Clear fault:	AE (mains contactor on)	"Reset diagnostics class 1"

Correct the time delay with rotary switch S1 on the VM's front panel if the mains contactor is deactivated too early or much too late.
Seal rotary switch S1 on the VM's front panel against unauthorized access (cf. information attached with the Personality Module for VM).

Test 8 has been completed.

9.2.3 Safety functions of the VM tested in the factory

These safety functions are permanently incorporated in the VM control and **cannot be changed**.
A proof of these safety functions was obtained during the type test of the supply module. Additional tests after commissioning are not required.

Switching on with ON button (AE)

The mains contactor can only be switched on by operating the ON key.

★ **Test 9:**
Operate the EMERGENCY-STOP button with the ON key depressed:

	VM tested
Effect:	• When the ON key is depressed, the mains contactor must not be switched on when EMERGENCY-STOP has been released. • Release ON key and operate it again. The mains contactor now has to be switched on.
Fault message:	none

Test 9 has been completed.

Switching off with Emergency-Stop (NH, $\overline{\text{NH1}}$)

An interruption at either input NH or $\overline{\text{NH1}}$ will switch the mains contactor off.

★ **Test 10:** Interrupt one of the two inputs:

	VM tested	DM's
Effect:	switches mains contactor off	–
Fault message:	F41	F98
Clear fault:	AE (mains contactor on)	"Reset diagnostics class 1"

Test 10 has been completed.

Tripping delay

In the event of EMERGENCY-STOP or STOP, the mains contactor is switched off with a certain delay, for example, in order to first brake the spindle until it has come to a complete stop.

★ **Test 11:** Interrupt ”FG” (at X06.3) while the spindle is turning fast and then operate EMERGENCY-STOP.

	VM tested	DM’s
Effect:	switches mains contactor off after 1...15 s (depending on position of switch S1)	halted without braking
Fault message:	F40	–
Clear fault:	AE (mains contactor on)	–

Release EMERGENCY-STOP.

Test11 has been completed.

★ **Test 12:** Interrupt ”FG” (at X06.3) with the spindle turning fast and then operate the OFF button for a short time.

	VM tested	DM’s
Effect:	switches mains contactor off after 16 s	halted without braking
Fault message:	–	–
Clear fault:	AE (mains contactor on)	–

Test12 has been completed.

Normal operation (NO), special operation (SO)

The operation mode can only be changed over by mutually driving inputs NO, SO.

★ **Test 13:** Drive both inputs simultaneously.

	VM tested	DM’s
Effect:	switches mains contactor off	–
Fault message:	F42	F97
Clear fault:	AE (mains contactor on)	“Reset diagnostics class 1”

Test13 has been completed.

★ **Test 14:** Do not drive any of these two inputs:

	VM tested	DM’s
Effect:	switches mains contactor off	–
Fault message:	F42	F97
Clear fault:	AE (mains contactor on)	“Reset diagnostics class 1”

Test14 has been completed.

Guard locking (ST-S)

ST-S releases the guard locking. Output ST-S is only driven in SO mode when the axes are stopped.

★ **Test 15:** Change the mode from NO to SO with the spindle turning fast.
It must not be possible to open the guard while the spindle is turning.

	VM tested	DM spindle	other DM's
Effect:	switches mains contactor off	halted without braking	–
Fault message:	–	F15 and/or F16	F98
Clear fault:	F15 (software error) with "Reset diagnostics class 1", F16 with RESET on DM, re-initialize SERCOS ring. Switch mains contactor on with "AE".		

Test15 has been completed.

★ **Test 16:** Bridge output ST-S in NO mode with +24V.

	VM tested	DM's
Effect:	switches mains contactor off	–
Fault message:	F42 after approx. 2 sec	F97
Clear fault:	AE (mains contactor on)	"Reset diagnostics class 1"

Test16 has been completed.

Guard feedback signal (ST-R)

The feedback signal monitors the guard release for possible manipulations.

★ **Test 17:** Interrupt the feedback signal line of ST-R in SO mode.

	VM tested	DM's
Effect:	switches mains contactor off	–
Fault message:	F45 after approx. 2 sec	F97
Clear fault:	AE (mains contactor on)	"Reset diagnostics class 1"

Test17 has been completed.

9.3 Acceptance protocol

The acceptance protocol contains the settings of the RSU parameters and the numbers of the acceptance tests passed in accordance with manual no. 1070 066 026-101, section 9.2, for every axis.

Manufacturer:

. . . . . .

Machine / Type:

. . . . . .

Description axis/spindle					
DM module type					
Serial number					
Software release					
P-0-0012 (safe speed)					
P-0-0022 (safe standstill)					
P-0-0023 (maximum enabling time)					
P-0-0024 (channel monitoring tolerance time)					
P-0-0603 (alteration counter)					
Acceptance test passed from no. ... up to no. ...					

Module type	**Serial number**	**Software release**	**S1 position (VM front panel)**	**Acceptance test passed from no. ... to no. ...**
VM				

Date, signature:

. . . . . .

Your notes:

10 Safety-relevant components

Redundant safety monitoring (RSU) can be provided for Servodyn-D modules with SERCOS interface.
The RSU functions are implemented by using certified Personality Modules according to the following overview.

☞ **Personality Modules with RSU functions are characterized by a yellow front panel. Axes suitable for the RSU function can therefore be clearly recognized from outside.**

Designation		Part no.
Mains connection module:	NAA.../.–D	on request
Supply modules:	VMA ... R ... – D	on request
in connection with Personality Module:		
	PM VMS/... – D	on request
Three-phase modules with SERCOS interface and 40 MHz computer board:	DM ..K 1... – D DMA ... 1... – D	on request
in connection with Personality Module for		
axis functions: spindle functions:	PM SMS/... – D PM FOS/... – D	on request
Servo motors SF	All designs with single-turn encoder and multi-turn encoder	on request
Asynchronous motors DU		on request
Asynchronous motors with ring gear encoder		on request
Asynchronous motors with resolver		on request

Your notes:

A Appendix

A.1 Index

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