

General target specification

Machines, installations and equipment for special purposes

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1 General provisions, area of validity and instructions

1.1 General provisions

The “General target specification **N54 B1**” has been developed by experts of the working group “Electrical control engineering” hosted by CR/APA3.

Main target was, to achieve essential cost reductions by harmonizing plant-specific instructions.

The project-related target specification for electrical equipment N54 B2 and B3 has to be adapted respectively and handed out to the supplier.

1.2 Area of validity

The design guidelines of the “General target specification” apply only to the electrical equipment of

- ▶ Special purpose machines
- ▶ Special purpose installations in production
- ▶ Special purpose equipment in production
- ▶ Special purpose equipment in supply and disposal
- ▶ Special purpose machines in accordance with **DIN EN 60204-1** Appendix A.

1.3 Instructions

The electrical equipment of machines, installations and production equipment is based on the following Bosch-Norms, standards and guidelines always in valid edition.

- ▶ Bosch-Norm **N51M M20**
- ▶ Bosch-Norm **N51M M23**
- ▶ **DIN EN 60204-1**
- ▶ **IEC 60204-1**
- ▶ Machinery Directive **98/37/EU**
- ▶ ESD Directive **2004/108/EU**
- ▶ Directive on low voltages **73/23/EU**
- ▶ Safety of machinery **DIN EN ISO 12100-1, DIN EN ISO 12100-2**

During order preparation, however before manufacturing of the control cabinet and the electrical installation at the latest, a meeting with the person in charge of part of the orderer must take place.

Before manufacturing, circuit diagrams, control cabinet configuration and parts lists have to be presented for release. These documents are commented and given back to the supplier.

The supplier permits the reproduction of the delivered documents for use at Bosch.

The complete documentation and the project-related/project-specific source codes pass into the property of Robert Bosch GmbH.

2 Control cabinet, power supply

2.1 Control cabinet

2.1.1 General provisions

- 1) Planning and design must conform EMC regulations (**N54 B1** Chapter 8).
- 2) Control cabinet in color RAL 7035 Struktur (structured).
- 3) Stand-alone control cabinets must have transport lugs.

- 4) Machinery, equipment and wiring must be installed on a mounting plate.
- 5) Rail systems and cable ducts must be bolted or riveted on the mounting plate. Loose fasteners on the backside of the mounting plate are not permissible.
- 6) Doors must be equipped with vertical metal hinges (opening angle $\geq 120^\circ$) and be lockable with a budget lock size 5.
- 7) If the door is higher than 1,2 m, a rod lock must be used.
- 8) If with certain housings it is not evident that they contain electrical machinery and equipment, they must be identified permanently in accordance with **DIN EN 60204-1** Chapter 16.2.1 with a warning sign adapted to the ambient conditions.
- 9) Air-conditioning appliances must have a final door switch. The temperature regulation must allow for adjustment depending on the installation components. Accruing condensate must be safely drained off outside the control cabinet. The functioning of the air-conditioning appliance must be subject to effective control.
- 10) On each clamping point of the terminal block one line only may be clamped. All control lines leading to the installation have to be guided on strip terminals, installation distribution systems or plug systems. The terminals and/or plug systems have to be identified permanently (not by hand) and corresponding with the plug diagram.

2.1.2 Arrangement of equipment

- 1) For the design of the control cabinet, observe development of heat and the components sensitivity to heat. Arrangement adjusted to EMC and ESD is mandatory (**N54 B1** Chapter 8).
- 2) Contactors and control instruments shall be installed in a sequence from left to right, so that the designation in ascending numbering order is guaranteed.
- 3) Equipment that needs to be operated (e.g. automatic timer, thermostat) shall be accessible without opening the control cabinet. This equipment must be protected against unauthorized operation (observe protection class).
- 4) The service socket must be agreed with the orderer.

2.2 Power supply

2.2.1 General provisions

- 1) The measured current rating and the maximum power have to be notified to the orderer before delivery.
- 2) The introduction of the power line into the control cabinet is done on site. For cross sections up to 16 mm^2 conical threaded fastener are applicable, for larger cross sections cable clips are applied for cord anchorage. The protection class must not be changed when using cable clips.
- 3) Terminals as well as the main switch can be used for the connection of the power feed. The power feed must not be on movable parts. The power supply in the control cabinet shall be carried out in the five-phase TN-S system.
- 4) Besides the external conductor terminal, also suitable terminals for the neutral conductor (N) and the protective conductor (PE) must be available on the power port. The terminals must be identified with L1, L2, L3, N and PE. Terminals for external and neutral conductors must be designed at least finger-safe and marked as supplied with voltage (covering, warning sign).

2.3 Performance

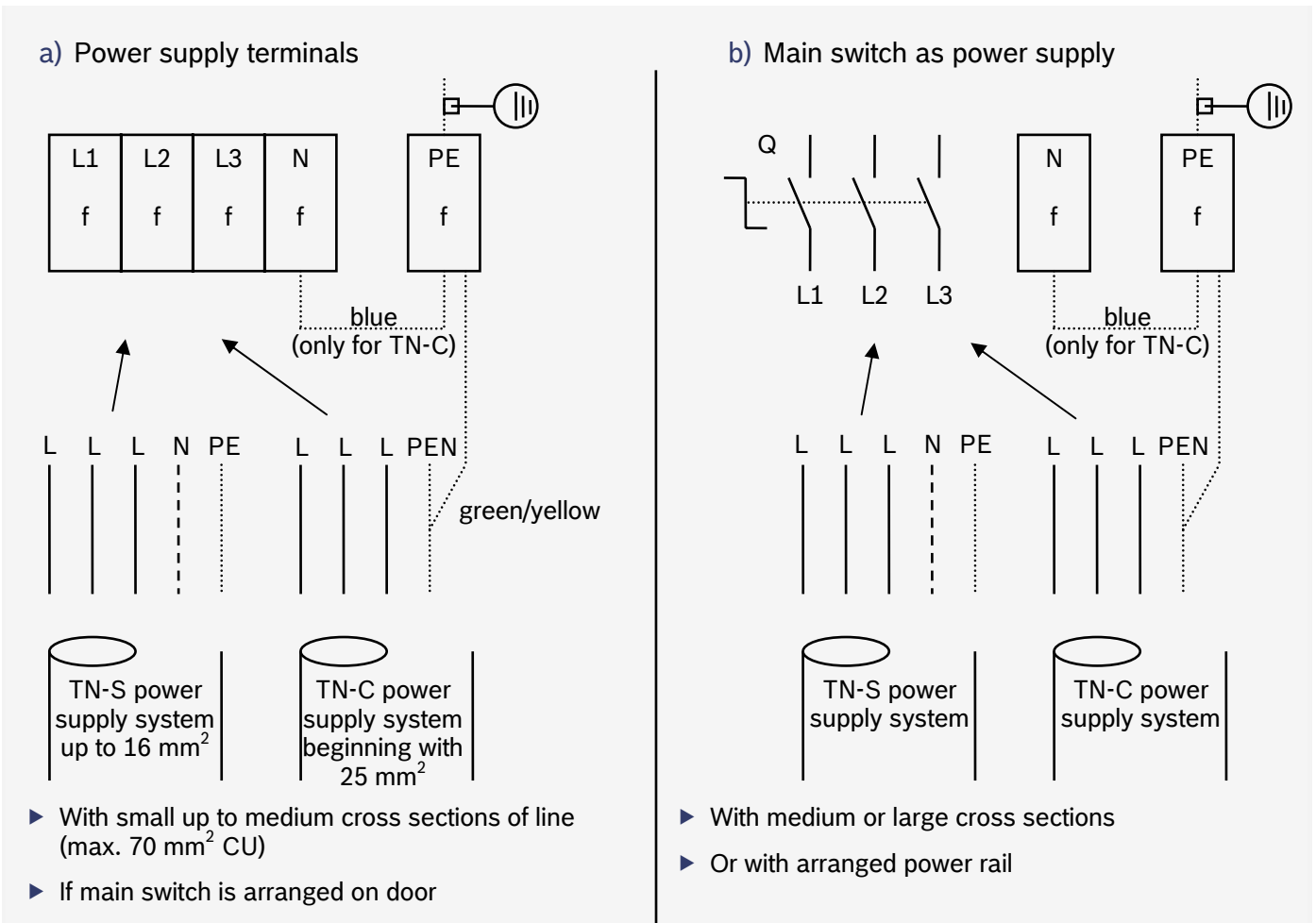


Figure 1 Performance a) Power supply terminals and b) Main switch as power supply

- 1) The terminal for the protective conductor or, if main switch is power supply, the neutral conductor, have to be arranged near the external conductor terminals.
- 2) For the connection to a TN-C system provide a bridge between PE terminal and N terminal (blue color).
- 3) The electrical equipment must not have any further connections between PE and N.
- 4) Single-phase consumers, e.g. electrical/electronic devices such as lighting, vibrators, axle reinforcement, heat and receptacles have to be connected to an L and N conductor. The cross section of the power cord must at least measure 0,75 mm². Distribute single-phase loads symmetrically.

3 Main switch, emergency stop and protective equipment

3.1 Main switch (switch disconnecter)

3.1.1 Requirements

(Application category AC23B: Occasional switching of ohm and inductive loads)

- 1) Interrupting capacity: $I_A = I_1 + I_{n-1}$ (breaking current)
 - I_1 = current of the most powerful motor in blocked condition (normal: 8-fold current rating)
 - I_{n-1} = sum of the operating currents of all other consumers
- 2) Separator property: ≥ 660 V (with 400 V power supply system)

3.1.2 Performance

- 1) Lockable in “OFF position”.
- 2) Operation in red, highlighted in yellow (in black only if it is not the emergency stop function).
- 3) Power supply terminals finger-safe and marked as “Supplied with voltage” (warning sign).

3.1.3 Installation

- 1) In door permitted up to 63 A. If agreed, up to 100 A (35 mm²).
- 2) Main switches with door locking system not permissible. Switching on and off has to be assured with door opened, independently of the arrangement of the main switch.
- 3) For operation, the access must be easy and positioned in a distance of 0,6 m and 1,7 m above the access level.

3.1.4 Plug device

- 1) Up to 16 A rated current and 3 kW total rated power, a plug device may be used instead of a main switch.
- 2) Interrupting capacity see **N54 B1** Chapter 3.1.1.

3.2 Emergency stop

- 1) After an emergency stop occurring during an automatic working cycle it must be possible to finish the ongoing cycle or to bring back the installation to the initial position. The selected solution must be agreed with the orderer.
- 2) Installations with several emergency stop switches must display the action of each one individually (indicator light, diagnosis system).
- 3) The emergency stop concept of loose interlocking systems has to be agreed with the orderer (see **N54 B2** Chapter 1 Emergency stop concepts).

3.3 Protective equipment, key switch

Protective equipment (cf. Applications of safety circuits in **N54 D2**).

The electrical locking unit of the protective equipment has to be designed based on the valid Bosch-Norms and standards, e.g. **DIN EN 1088**, **DIN EN ISO 12100-1**, **DIN EN ISO 12100-2**, **N93 I3.9.2** Separating protective installations, **N93 I3.9.4** Key-operated adjuster.

4 Controlling, computer system

4.1 Controlling concept

The controlling concept and its interfaces must be agreed with the orderer.

4.2 Voltage supply

- 1) The assembly and installation instructions of the manufacturer must be observed.
- 2) Control circuits must be grounded. Grounding of gate voltage has to be conducted over switch terminals and/or terminals with wire straps and to be marked clearly in the circuit diagram as well as in the control cabinet. The grounding point in the control unit has to be marked with a yellow advisory sign (Text: “The installation may only be operated with control circuit in grounded condition. The bridge may only be separated for insulation inspection.”).

4.3 Software

- 1) In case of module-oriented programming, the content of the modules is adapted to certain functions or installation parts.
- 2) Machine operation has to be documented in an appropriate way.
- 3) Description of the machine operation in accordance with **DIN EN 61131-3**, structured text is required for programming.
- 4) Processes must be built-up according to the step chains principle 1 from n. Sensible deviations have to be agreed with the orderer.
- 5) Marking of machinery and equipment has to be observed and logical symbolic designation selected and commentated sufficiently.
- 6) The whole program must be documented with comprehensive headlines. Start of each module requires a short description of the contained program.
- 7) Parameterizable modules must provide precise documentation.
- 8) Delivery of the software includes:
 - a. Image operating system, PC controller with description for its recovery.
 - b. Structured listing in PDF format of all software versions required for functionality.
 - c. Provision of all data required for functionality on CD/DVD with software release stage. Upon agreement on network.

4.4 Diagnosis

- 1) The error diagnosis comprises safety and control elements as well as steps and cycle times.
- 2) The diagnosis concept must be agreed with the orderer.
- 3) The error diagnosis has to be performed in a way that an occurring error is displayed in clear text until the error is solved and the disfunction is acknowledged. If there are several errors occurring simultaneously the first error to occur has to be indicated.
- 4) Plausibility check of signal generators must be done (e.g. cyclic control for both switching states).

4.5 Representation of diagnosis in clear text using symbolism

Example for software: The step chains control the operation of installation. If the step chain conditions are not fulfilled, the step chain switches to fault and activates automatically the diagnosis. The diagnosis module provides an overview on the current step chain condition of the installation. An operand text has to be available for each operand/symbol.

4.6 Computer

If a computer is used, the operating system and the valid issue as well as the programming language have to be agreed with the orderer.

4.7 Protection through automatic interruption of the supply in the current circuit

4.7.1 Circuit diagram

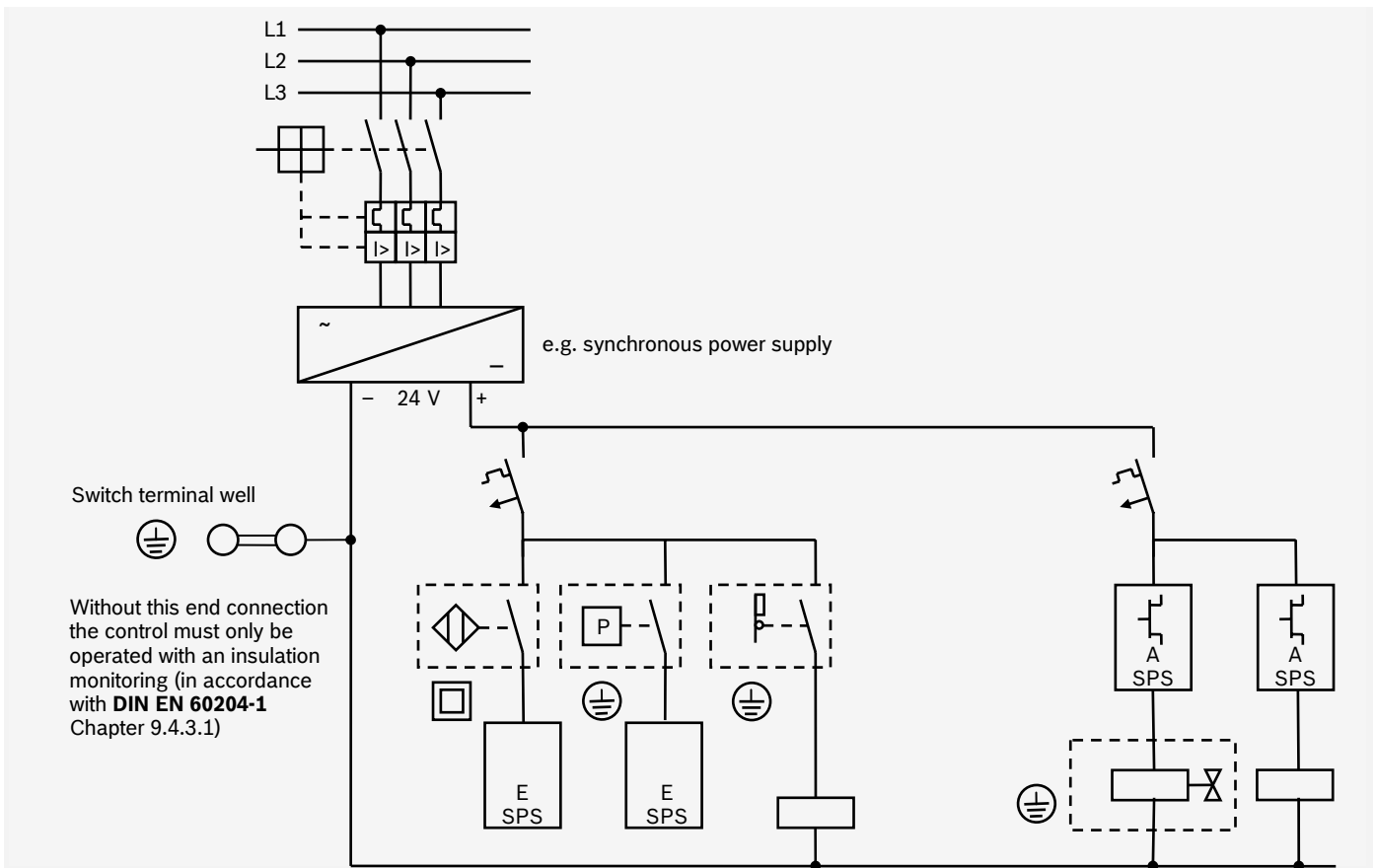


Figure 2 Circuit diagram

Yellow advisory sign: The installation may only be operated with current circuit in grounded condition. The bridge may only be separated for insulation inspection (see **N54 B1** Chapter 4.2).

4.7.2 Measures

- 1) Connection of all bodies – that may assume voltage in case of fault – to the protective conductor system.
- 2) When using signaling/adjusting elements without connection to protective conductor, insulation-protected device is preferable (e.g. proximity switch).
- 3) Use of protective equipment to achieve an automatic interruption of current supply in case of fault for each separate control circuit.
- 4) The dimensioning or adjusting value of the protective equipment depends on the current that, with a conductor cross section given and a possible earth fault or short circuit, starts to flow at the most remote point of the current circuit.
- 5) In case of fault it must be guaranteed that the individual control circuits remain switched off.

5 Control, command and detection systems

5.1 General provisions

- 1) The installation of command and detections systems to the control cabinet or separate operator stations as well as the control concept has to be agreed with the orderer. The designations have to be in the agreed language and/or symbolism.

- 2) The function identification of the discrete command and indicator devices are placed above or on the left side of the equipment.
- 3) Signal generators must not be used as mechanical stop.
- 4) If signal elements have an adjustment possibility, unintentional adjustment must be prevented, e.g. through locking screw, covering. For example pressure switches, temperature and flow control instruments are also considered signal elements.

5.2 Default colors

The colors in accordance with **DIN EN 60204-1** Chapter 10.2.1 apply to switches, sensors, indicator lights relative to the machine condition.

5.3 Colors of push-button actuators

Table 1 Colors of push-button actuators

Color	Explanation	Examples of application
Red	Emergency	Emergency stop
White	ON	In general ON, START, pressing, control ON, program ON, test ON
Black	OFF	In general OFF, STOP
Green	Normal	Actuate to initiate normal conditions
Blue	Mandatory	Acknowledge, resetting
Yellow	Abnormal	Intervention to suppress abnormal conditions (upon agreement with orderer).

- 1) Additional symbol identification not required.
- 2) Sensor arrangement in accordance with **DIN EN 60447** (2004-12) Figure 4.

5.4 Colors for indicator lights (signal beacon)

Table 2 Colors for indicator lights

Color	Explanation	Examples of application
Red	Emergency, process interrupted	General disturbances leading to stop of installation (dysfunction, bad part, set value exceeded, overcurrent release, ...).
Yellow/Orange	Warning	Safety equipment out of order, lack of oil, advance warning of lack of parts (e.g. SPC)
Green	Normal	Basic position, operating pressure, operating temperature reached
Blue	Mandatory	Modification
White	ON	In general "ON conditions", motors ON, control ON, automatic ON, basic functions ON, auxiliary functions ON, modification

Signal beacons must be coded corresponding to the colors of push-button actuators (see **N54 B1** Chapter 5.3) and the colors of indicator lights (see **N54 B1** Chapter 5.4). The order of the above specified colors applies to signal beacons on top of the machine installations. The number of lights has to be agreed with the orderer.

Sensor arrangement in accordance with **DIN EN 60447** (2004-12) Figure 4.

Annotation: Any other meanings or lights have to be agreed with the orderer.

6 Cables, lines, installations

6.1 Protective measures/protection of installations

The following rules have to be observed for the protection against direct and indirect contact:

- 1) Small grounding parts and fastening angles have to be fixed with good conductivity using toothed contact discs on the grounded installation areas.
- 2) Provide individual clamping for each protective conductor.
- 3) Using the respective cross sections, bus bars for protective conductors have to be connected to each other with good conductivity. Protective conductor terminals arranged on the carrier rail in an insulating manner are not permissible.
- 4) The protective conductor on the plugs of single-core lines of movable sheathed cables must be the last to disconnect under a defined load.
- 5) The protective conductor plugs must be corrosion-resistant and secured against loosening. Fixing screws must not be used for the protective conductor plug.
- 6) Miniature circuit-breakers or motor safety switches must be applied to protect current circuits. If it is technically required, exceptions are permissible.

6.2 Cables and lines (general provisions)

- 1) Cables and lines as well as their load have to be in accordance with the valid standards. Selection in accordance with **DIN EN 60204-1** Chapter 13.1.
- 2) For special load cases (e.g. thermal, chemical, etc.) selection of cable upon agreement with orderer.
- 3) For movable units only high-flexible single-core lines in a protective sheath and/or high-flexible multicore lines are permissible. For torsional and bending load special cables shall be used.
- 4) If cables are conducted in energy chain systems, the instructions of the manufacturer on the bending radii have to be observed and the cables shall be tension-released on both sides.
- 5) For wiring only flexible lines may be used. The cross section of motors and other consumers must be designed in relation to their power. Provide for sufficient mechanical strength.
- 6) For the introduction of cables, lines or protective sleeveings, tension-relieving introductions shall be used. The IP degree of protection must be guaranteed.
- 7) Cable introductions preferably coming from bottom or sides. If required, turn equipment introductions (e.g. motor terminal boxes).

6.2.1 Colors

With single-strand lines the wire colors of “Table 3 Wire colors for single-strand lines” must be used.

Table 3 Wire colors for single-strand lines

Function	Symbol	Color
Protective conductor	PE	Green/Yellow
Equipotential bonding lines		Green/Yellow
Neutral conductor of main current circuit	N	Light blue
Main current circuits for alternating or direct voltage		Black
Auxiliary circuit for alternating voltage		Red
Direct voltage		Blue
Chained voltage (introduced external voltage)		Orange
Central control technology (ZLT)		White

The green/yellow strand in multi-strand lines may be used only as protective conductors. If a blue strand is missing, only a black strand may be used as neutral conductor.

6.2.2 Designation

Lines that are outgoing from control cabinet and terminal boxes have to be identified in accordance with **N54 B1** Chapter 9.2 and 9.3. Protective conductor and N conductor need not to be labeled.

6.2.3 Installations before the main switch

- 1) All parts that are active (supplied with voltage) even after the main switch is off, must be covered finger-safe against unintentional contact (power supply terminals, main switch terminals, feed terminals, receptacles, lighting, etc.). Offset arrangement required. The pertinent lines shall be conducted separately or identified preferably with yellow color (orange).
- 2) Components situated before the main switch must be supplied with separate terminals via the power supply terminals (also N terminals).
- 3) All parts must be identified as supplied with voltage by pictures (warning sign) and text.
- 4) Yellow single-core lines are not permissible.

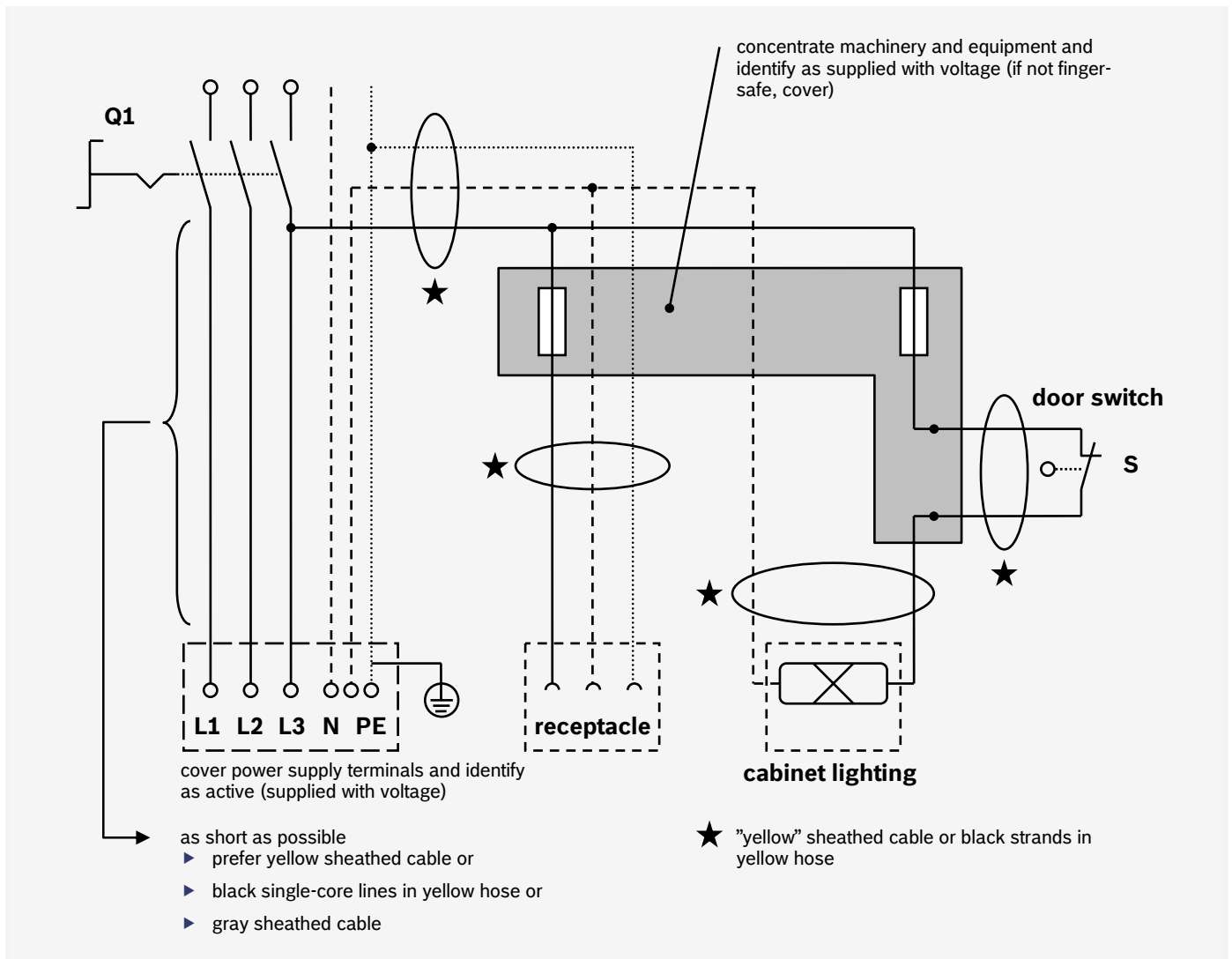


Figure 3 Circuit diagram

6.2.4 Power circuits for supply and locking between control cabinets

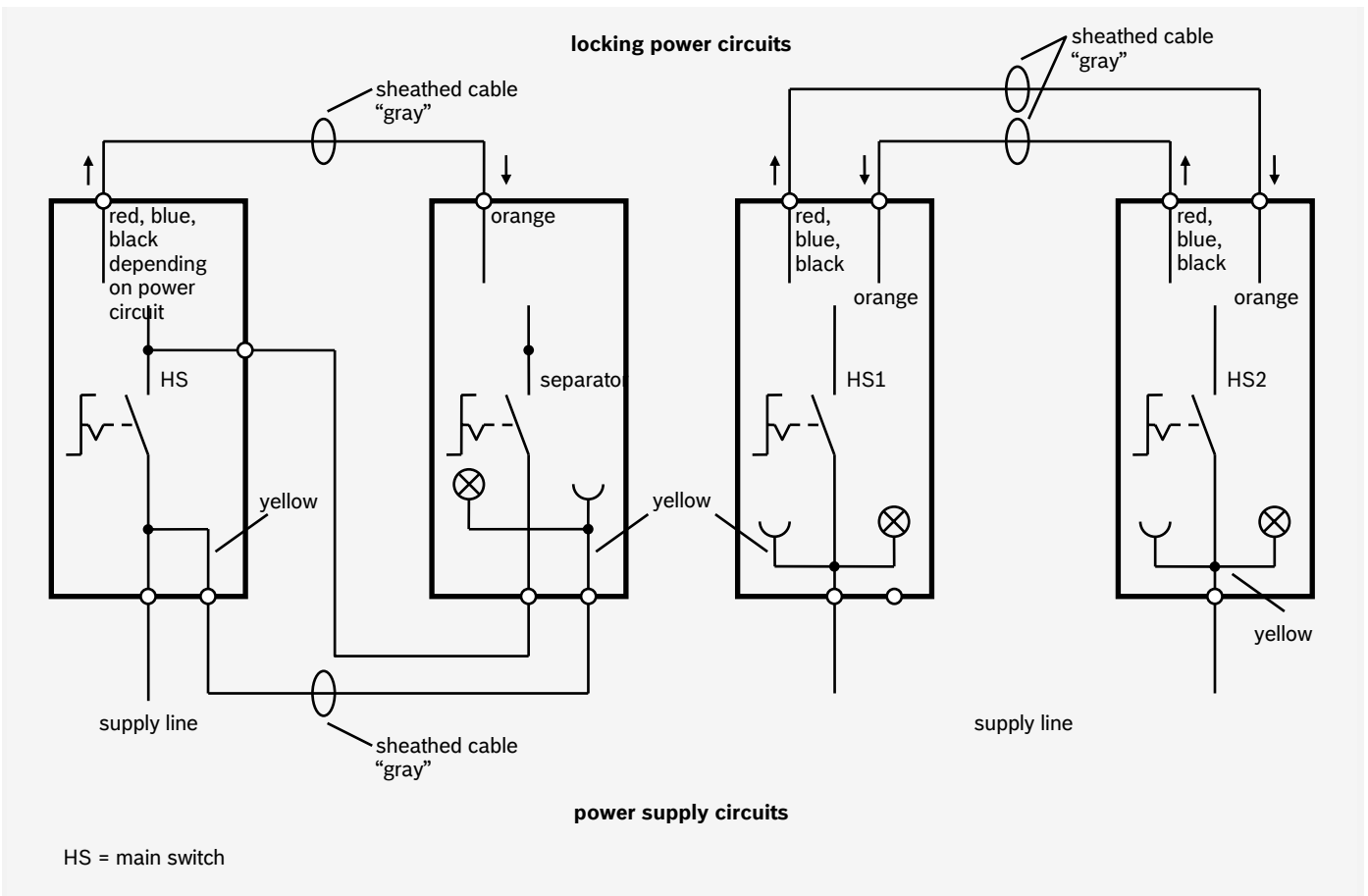


Figure 4 Power circuits for supply and locking between control cabinets

6.3 Installations (general provisions)

- 1) Motors, pumps as well as neighboring aggregates up to 4 kW, the connecting parts of which are difficult to access, must be designed pluggable.
- 2) Power rating plates of adjusting elements and driving devices must be well readable even in installed condition.
- 3) Metal channels must be used for the connection between installation and control cabinet and/or other separately placed aggregates.
- 4) Preferably, all installations, line introductions, threaded connections, terminal boxes and protective sleeveings must correspond to the protection class IP 54. Any other protection class has to be agreed with the orderer (**DIN EN 60204-1** Chapter 11.3). These determinations shall adapt the protection class to the ambient conditions at installation place.
- 5) Line introductions must be permanently tension-released.
- 6) Plug connectors must always be designed without tension (exceptions due to technical reasons are permissible).
- 7) Sealing material must comply to the requirements.
- 8) With reference to sensor technology/actuator technology, prefabricated pluggable lines shall be preferred (line length maximum 1,5 m).
- 9) For control lines, cables identified by numbers shall be preferred.
- 10) In wet areas, valves with cast-on connector and integrated LED must be used.
- 11) Strands in fabricated lines must not be twisted.
- 12) Only cable glands with metric threads in accordance with **DIN EN 50262** are permitted.

- 13) Reserve lines have to be put on terminals and to be identified (grounding in case of EMC problems).

6.4 Terminal boxes

- 1) Coverings of terminal boxes have to be fastened with captive screws or hinges and a budget lock size 5.
- 2) Assure good accessibility.
- 3) Only electrical machinery and equipment may be installed.
- 4) On each clamping point of the terminal block one line only may be clamped. All control lines going out from the control cabinet have to be guided on strip terminals, installation distribution systems or plug systems. The terminals and/or plug systems have to be identified (not by hand) permanently and corresponding with the plug diagram.
- 5) The designation of the terminal block has to be applied on the covering of the terminal box.
- 6) If with certain housings it is not evident that they contain electrical machinery and equipment, they must be identified permanently in accordance with **DIN EN 60204-1** Chapter 16.2.1 with a warning sign that is adapted to the ambient conditions.

6.5 Plug and terminal equipment

- 1) If control lines on the control cabinet shall be pluggable, the connections within the control cabinet can be guided directly to the components (e.g. SPS E/A, contactor, relays etc.).
- 2) Plug connectors shall be located where they are well accessible and protected largely against damage and dirt. Plug equipment of the same type that may be mismounted, must be secured against mixing-up.
- 3) Plug connectors must be identified uniquely, permanently and correspondingly.
- 4) If no plug connectors are planned, all lines have to be guided individually on series terminals.
- 5) For valves and initiators use of three-way terminals is recommended.
- 6) If the control cabinet cannot be transported together with the machine, the electrical connections between control cabinet and machine must be designed pluggable. In this case, measuring lines or prefabricated lines must be conducted over mounting introductions.

6.6 Fieldbus installations

The manufacturer-specific instructions of the applied components have to be observed. The mounting and inspection rules of the Profibus **N54 D4** have to be observed.

7 Electric motors, electrical drives

7.1 General provisions

In addition to **N51M M23** it applies:

- 1) Wherever technically possible, use motor safety switches that are protected against short circuits. These switches have to be adjusted up to the maximum possible extent to the nominal motor current.
- 2) With one motor safety switch several motors can be protected (motors up to 0,5 kW with connected thermal contact).
- 3) Redundant aggregates in the installation (e.g. replacement pump, secondary devices, etc.) have to be put on separate back-up fuses.
- 4) Motors that are operated with frequency converters must be equipped with PTC resistors. The manufacturer's specifications have to be observed.

7.2 Installation

Motors with only one direction of rotation have to be identified permanently with an arrow indicating the direction of rotation. However, for tape drives this arrow may be omitted if the direction of transport of the tape is marked.

7.3 Winding layout and starting conditions

The locking unit of the delta-wye switch of motors must be designed only hardware-related.

7.4 Special motors

- 1) The application of special motors has to be agreed with the orderer.
- 2) Specific properties and constructions must be included in the documentation.

8 EMC-conform design

8.1 General provisions

- 1) Except the design of the human-machine-interface, planning of installations shall be done under technical and not esthetic aspects.
- 2) Avoid not required line lengths. Doing so, coupling capacities remain low.
- 3) Establish a low impedance connection between installation parts, such as control cabinet, machine, cable ducts, auxiliary equipment etc.

8.2 Electricity feed

- 1) Provide the use of filter technology for the energy supply of sensitive equipment (metrological components) in order to avoid disturbing effects. The filter must be positioned directly on the entry point with good ground connection across the surface (do not use filters to snap-on to the top-hat rail).
- 2) Place interference filters directly to the source of interference.
- 3) Place the filters for converters (e.g. for drives) directly on their entry or exit.
- 4) Provide line filters for equipment and devices susceptible for disturbances, and place them directly on the power entry.

8.3 Arrangement of control cabinet

8.3.1 Mechanical arrangement of control cabinet

- 1) The mounting plate must have an electrically conductive, e.g. sendzimized surface.
- 2) Housing parts of mounted equipment and the side walls of the control cabinet must have a ground connection across the surface.
- 3) Connect the door of the control cabinet with a ground strap.
- 4) Top-hat rails applied on the mounting plate must have a good ground connection.

8.3.2 Arrangement of equipment and components

Arrange power components and sensitive sensor technology and/or measurement technology in the most remote distance that is possible. The arrangement of equipment and components must be selected in a way that the wiring of power and sensor technology can be performed separately.

8.3.3 Electrical arrangement of the control cabinet

- 1) Distribute shields and equipotential bonding lines across the surface near the cabinet introductions with suitable terminals and/or rails, and connect them to ground. Any interruption is not permitted. Drain wires are not permitted.

- 2) If the equipotential bonding between equipment and control cabinet is insufficient, an equipotential bonding line with a minimum cross section of 16 mm^2 must be installed.
- 3) Reserve lines have to be put on terminals and to be identified (grounding in case of EMC problems).
- 4) If equipment and components with inductive behavior are used (e.g. transformers, throttles, power units, drives) very short wiring is required.
- 5) The interference of inductive loads (e.g. contactor, relay, solenoid-operated valve, motor) must be suppressed by using RC-link, diode or varistor. Interference suppressing may be omitted if these loads can be connected from control elements with suppressed interference, e.g. SPS output.

8.4 Cable ducts

- 1) Energy and signal lines (e.g. motor cables, lines between frequency converter and measuring lines, or BUS lines etc.) are laid in separate ducts, otherwise ducts with separators must be used.
- 2) Cable ducts between control cabinet and equipment must be metallic. Exceptions are possible for chemical installations.
- 3) Cable ducts must have continuous low impedance ground connections (through mechanical threaded connections). In special cases, e.g. with big installations, technical agreements between manufacturer and operator must define how the ground connection shall be performed. An existing protective conductor connection must be integrated into the protective conductor system.

8.5 Installation

- 1) When using electrical components (in particular motor cables) the installation instructions of the manufacturer have to be observed.
- 2) Run the cable as narrow as possible across a large surface connected to ground.
- 3) Avoid wound-up cable bundles.
- 4) Use the maximum possible cross section for the ground balancing line between cabinet and machine ($\geq 16 \text{ mm}^2$). If further ground balancing lines are necessary, cross sections $\geq 6 \text{ mm}^2$ must be used.
- 5) Separate laying of energy and signal lines, if possible.
- 6) Cable screening across the surface and connected to ground (clip on grounding rail).

9 Identification

9.1 Identification of control equipment

- 1) Valves, motors, limit switches etc. must be identified permanently and correspondingly with the technical documentation. The identification must be unique and distinctively assigned to the equipment.
- 2) If any confusion may be possible among the connection cables of pluggable equipment (e.g. valves, pumps, signal generators), a further identification must be fixed to the cable additionally to the firmly attached identification.
- 3) Identifications must be permanent and resistant to heat, oil, light, chemical effects etc.
- 4) For installations with aggressive media use resistant materials (e.g. plastic with plastic groove pins) and metallic materials (e.g. aluminum) in hot areas.

9.2 Identification inside control cabinets

9.2.1 Identification of machinery and equipment in accordance with DIN EN 61346-2

Permanently on top or beside the equipment (see also **N54 B1** Chapter 9.2.3).

9.2.2 Line identification

Table 4 Line identification

For:	Outgoing lines:
Equipment with relatively long life cycle, such as fuses/automatic circuit breaker, contactors, transformers	Identification <u>not</u> required
Pluggable electronic equipment and pluggable SPS-E/A connections	Identification <u>not</u> required
Firmly connected electronic equipment Firmly connected safety relays	<u>Must</u> be identified with <u>connection number</u>
Output terminals for inside wiring of cabinet	Do <u>not</u> identify
Output terminals, not separable to machine and peripheral equipment	<u>Must</u> be identified with <u>terminal number</u> Identification <u>not</u> required if the <u>assignment</u> of lines identified with numbers or color codes in the <u>circuit diagram</u> is unique.
Output terminals, separable to machine and peripheral equipment	Cable to machine must be identified.
Output plug to machine and peripheral equipment	For cables identified by numbers use logical assignment to plug number. Plug must be labeled, strands in the same way as output terminals.
Equipment in the control cabinet that is directly connected (without output terminals or plug) from outside	<u>Must</u> be identified by the <u>terminal number</u> of the equipment.

9.2.3 Identification of equipment, components and lines in the control cabinet

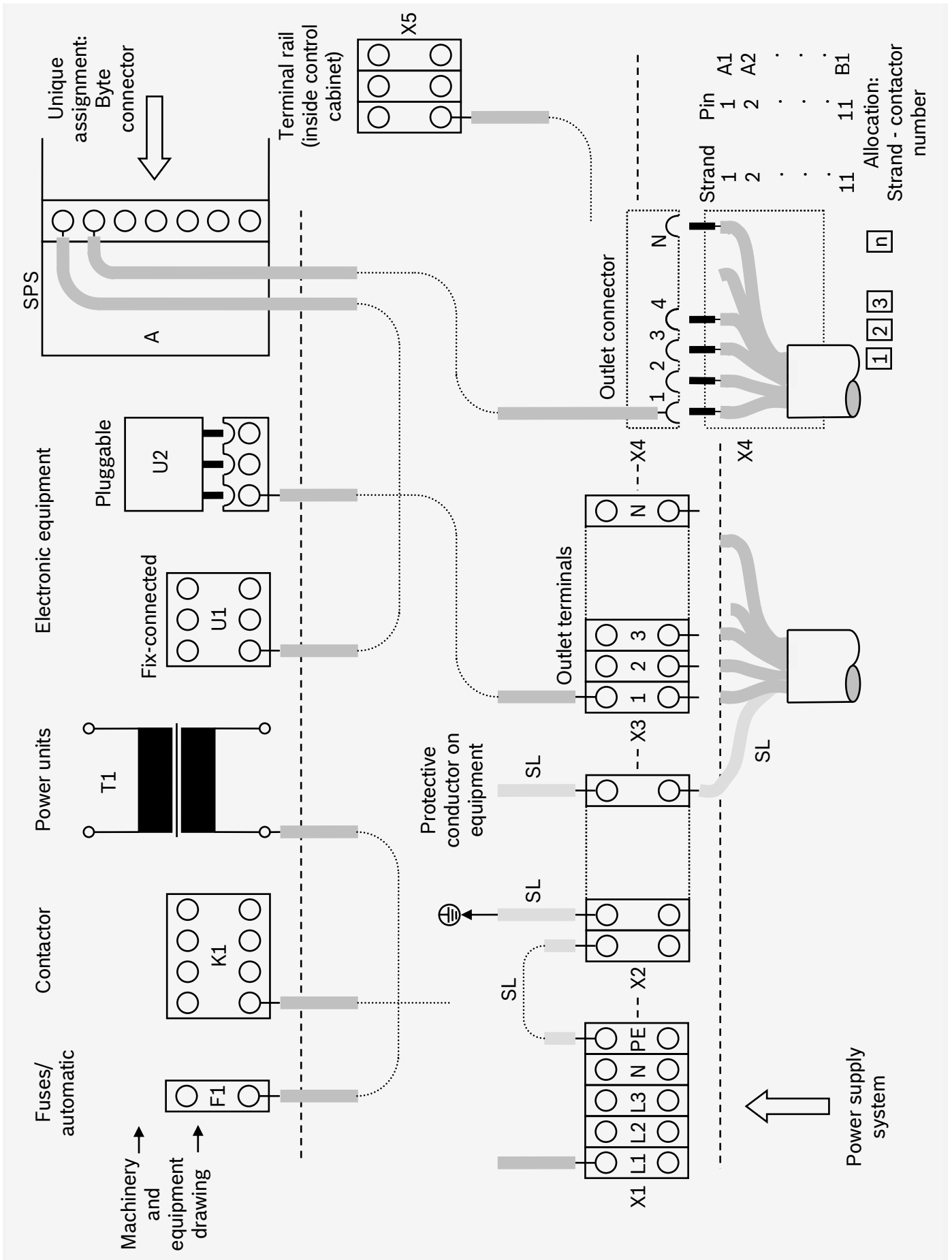


Figure 5 Identification of equipment, components and lines in the control cabinet

9.3 Identification during installation and inside the terminal boxes (signal, adjustment and drive elements)

9.3.1 Line and strand identification of machinery and equipment

Table 5 Line and strand identification of machinery and equipment

For:	Outgoing lines:
Pluggable machinery and equipment	<u>No</u> identification
Machinery and equipment connected via terminals (e.g. motors, ...)	Identification with terminal numbers

9.3.2 Line and strand identification in the terminal box

Table 6 Line and strand identification in the terminal box

For:	Outgoing lines:
Lines outgoing to the control cabinet	With cables identified by numbers no identification if assignment is determined in the circuit diagram. Otherwise identification with terminal number.
Lines to motors and pluggable signal and adjustment elements (proximity switch, valves)	<u>No</u> identification
Connected directly via lines, not pluggable machinery and equipment	<u>No</u> identification

9.3.3 Terminal box

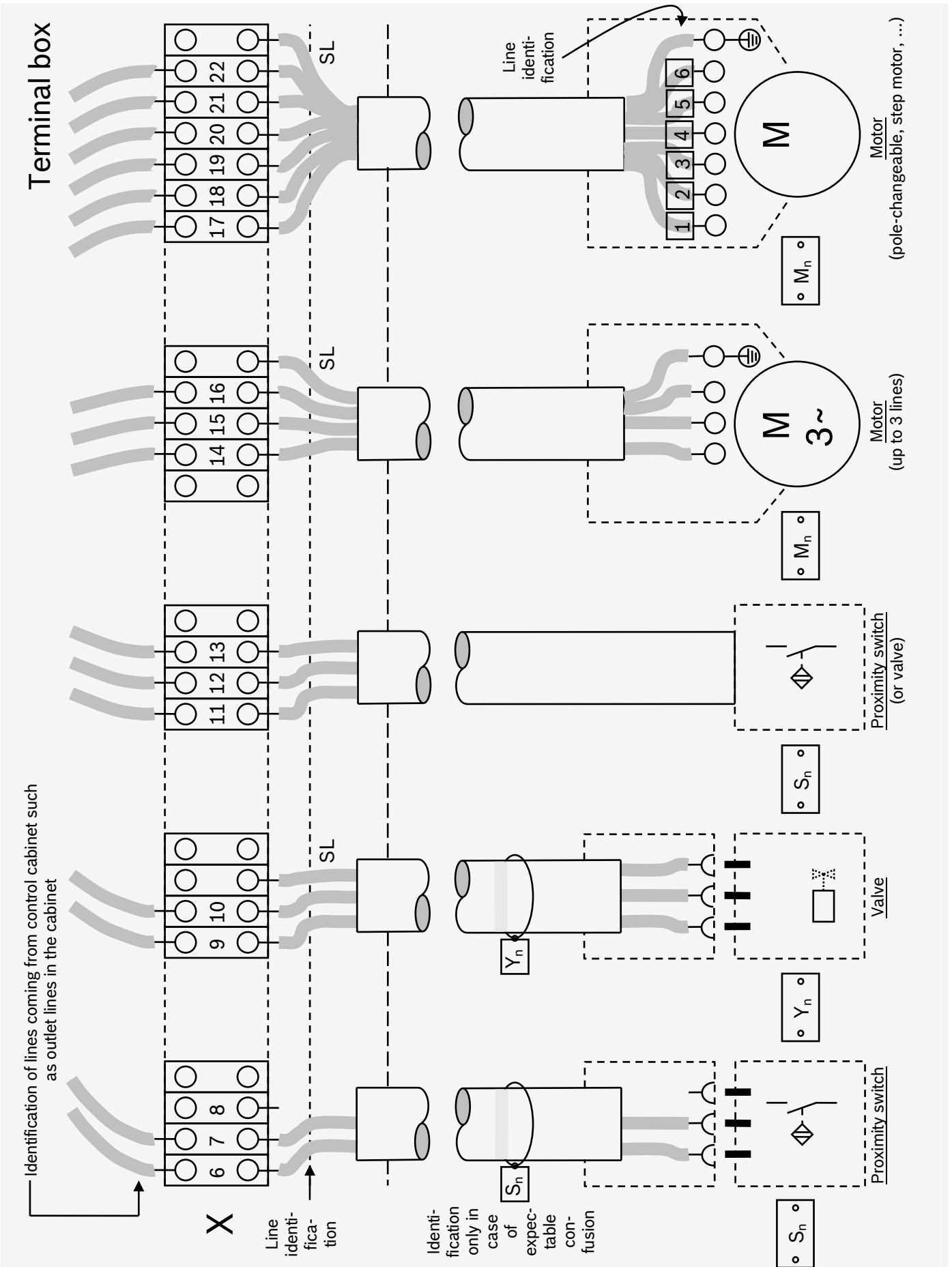


Figure 6 Line and strand identification in the terminal box

10 Documentation of machinery and installation

10.1 Documentation

Electronic documentation is preferable. Neutral formats are standard, e.g. PDF (except e.g. electrical documentation, see Folder 6). Need and extent of exchange formats have to be agreed with the customer (range of quotation), as well as the documentation in paper. The file structure in accordance with "Folder 1-7" applies to electronic data media as well as to paper copies. Upon agreement with the customer, the documentation is delivered in the national language and/or in German or English (upon agreement with ordering plant).

Documents as paper copy:

- ▶ Folder with spine label indicating content
- ▶ Filed in DIN A4, folded if required
- ▶ Chapters ordered by labeled dividers (lettering in accordance with the chapters)

Table 7 Documentation structure

Folder	Tab	Content
Folder 1 Operating instructions	Safety measures	<ul style="list-style-type: none"> ▶ Use according to the rules ▶ Safety equipment of machine ▶ Protective measures for operating staff ▶ Obligations of operator ▶ Remaining risk ▶ Operating and working notes ▶ Hydraulic equipment ▶ Notes on hazardous material
	Transport, installation, connection, disassembly	<ul style="list-style-type: none"> ▶ Delivery ▶ Transport ▶ Installation and connection ▶ Notes on disassembly of machine ▶ Storage and conservation ▶ Notes on liability ▶ Assembly and disassembly of aggregates ▶ Dimensions and weights
	Description of machine	<ul style="list-style-type: none"> ▶ Description of mechanical functions ▶ Description of stations ▶ Components overview ▶ Technical data
	Operation of machine	<ul style="list-style-type: none"> ▶ Operating instructions ▶ Start-up ▶ Operation types ▶ Operation desk/operation table

Folder	Tab	Content
	Action in case of failure	<ul style="list-style-type: none"> ▶ Phone number of hotline/service of equipment supplier ▶ Procedure for clearing in case of failure
	Modification, calibration	<ul style="list-style-type: none"> ▶ Modification ▶ Calibration
	Appendix	<ul style="list-style-type: none"> ▶ CE Declaration of conformity ▶ List of EU Guidelines and EN standards used ▶ Manufacturer declaration (machine parts, equipment, ...) ▶ Hazard analysis and risk evaluation (on demand) ▶ Installation declaration, installation instructions (uncompleted machinery and equipment) ▶ Inspection report DIN EN 60204-1 ▶ Safety data sheet ▶ Range of documentation to deliver
Folder 2 Maintenance		<ul style="list-style-type: none"> ▶ Documents and notes on maintenance incl. all mechanical and electrical purchase parts ▶ Operating and working notes ▶ Maintenance schedule (if possible, incl. evaluation of time expenditure), lubrication plan (DIN 8659-2) ▶ Notes on ordering of spare parts ▶ List of spare parts, wear parts, tools (distinction between mechanical/electrical equipment)
Folder 3 Parts list - Mechanical equipment		<ul style="list-style-type: none"> ▶ The parts list for mechanical equipment must clearly distinguish between purchase parts and standard parts by indicating manufacturer designation and number ▶ All parts lists (incl. standard components, calibration parts, change parts)
Folder 4 Drawing - Mechanical equipment		<ul style="list-style-type: none"> ▶ All component drawings incl. standard component groups ▶ Wear parts, tools and/or workpiece-related drawings, test equipment drawings ▶ Pneumatics, hydraulics, lubrication plans and diagrams

Folder	Tab	Content
Folder 5 Catalogue parts - Mechanical/electrical equipment (purchase equipment)		<ul style="list-style-type: none"> ▶ Alphabetic order by supplier ▶ Technical documents ▶ Operating instructions
	Hardware	<ul style="list-style-type: none"> ▶ Electrical documentation in E-CAD, preferably EPLAN (see Bosch-Norm N54 D6) and one paper copy ▶ Wiring diagram and parts list (ordered by manufacturer designation and number) on CD/DVD, upon agreement on network
Folder 6 Electrical documentation	Software	<ul style="list-style-type: none"> ▶ SPS application programs ▶ Process chart (function chart or function diagram or function description or CTS) ▶ NC or other additional programs ▶ Parameter sets/lists and programs of intelligent equipment incl. necessary software, recovery CD ▶ Image operating system PC control with description of recovery (status end of machine start-up) ▶ Structured listing in PDF format of all software versions required for functionality (service) ▶ Provision of all data on CD/DVD required for functionality (service) upon agreement on network
	Network	<ul style="list-style-type: none"> ▶ Determination of the network connection (e.g. IP addresses), if required
	Test engineering	<ul style="list-style-type: none"> ▶ Test engineering
		<ul style="list-style-type: none"> ▶ Inspection documents and/or test manuals for equipment subject to monitoring (e.g. pressure vessels) ▶ Inspection reports on safety components ▶ BGV A 3 inspection report (for Germany) ▶ BUS inspection reports (e.g. ProfiBus-DP, ETHERNET) ▶ Inspection documents/certificates of catalogue parts ▶ Calibration protocols (assemblies, manufactured parts) ▶ Other documents (e.g. acceptance papers, machine capability)
Folder 7 Inspection documents and certificates		<ul style="list-style-type: none"> ▶ Inspection documents and/or test manuals for equipment subject to monitoring (e.g. pressure vessels) ▶ Inspection reports on safety components ▶ BGV A 3 inspection report (for Germany) ▶ BUS inspection reports (e.g. ProfiBus-DP, ETHERNET) ▶ Inspection documents/certificates of catalogue parts ▶ Calibration protocols (assemblies, manufactured parts) ▶ Other documents (e.g. acceptance papers, machine capability)

Annotation: Alterations of machinery and equipment have to be included in documentation by arrangement, however 6 weeks after final inspection in our plant at the latest.

10.2 Circuit diagram

- 1) The circuit diagram must be clearly structured and numbered in accordance with **DIN EN 61346-2**. It must correspond in all details with the installation.
- 2) The circuit diagram documentation must be created on a CAD system for electrical equipment (EPLAN).

The circuit diagram documentation must include the following items on one or more cover sheets:

- ▶ Name or brand of manufacturer
- ▶ Machine type or catalogue number
- ▶ Year of construction
- ▶ Serial number
- ▶ Nominal voltage or nominal voltage range
- ▶ Current rating and back-up fuses
- ▶ Nominal power
- ▶ Connected load
- ▶ Current type, frequency
- ▶ Project-specific wiring colors
- ▶ Number of circuit diagram with version indication
- ▶ Table of contents
- ▶ Wiring diagram
- ▶ Numbering systematic of electrical machinery and equipment explained in legend
- ▶ Graphical symbols for diagrams in accordance with **DIN EN 60617**
- ▶ Necessary electrical power parameters of machinery and equipment must be indicated.
- ▶ Line wiring of fieldbus systems is to be documented by its order, addressing and length indication
- ▶ Same potentials get the same identification
- ▶ Power circuits not separated by the main switch, must be identified in the documents
- ▶ The designation of components is supplemented by respective cross references
- ▶ Equipment and equipment combinations can be represented as block diagram with connection designation
- ▶ Cross references to interfaces of purchase equipment
- ▶ Parts lists
- ▶ Terminal diagrams/plug diagrams
- ▶ Cable lists (upon agreement with orderer) **N54 B2**

11 Inspection, acceptance

11.1 Inspection

11.1.1 General provisions

Inspection report (in accordance with **DIN EN 60204-1**, Chapter 18) must be available for acceptance at the manufacturer.

11.1.2 Continuous connection of protective conductor system

- ▶ Visual inspection
 - Connection of all bodies
 - Identification of conductor and connection point
 - Control for firm connection
- ▶ Inspection “Voltage drop in the protective conductor system” (inspection of the most remote consumer is mandatory)

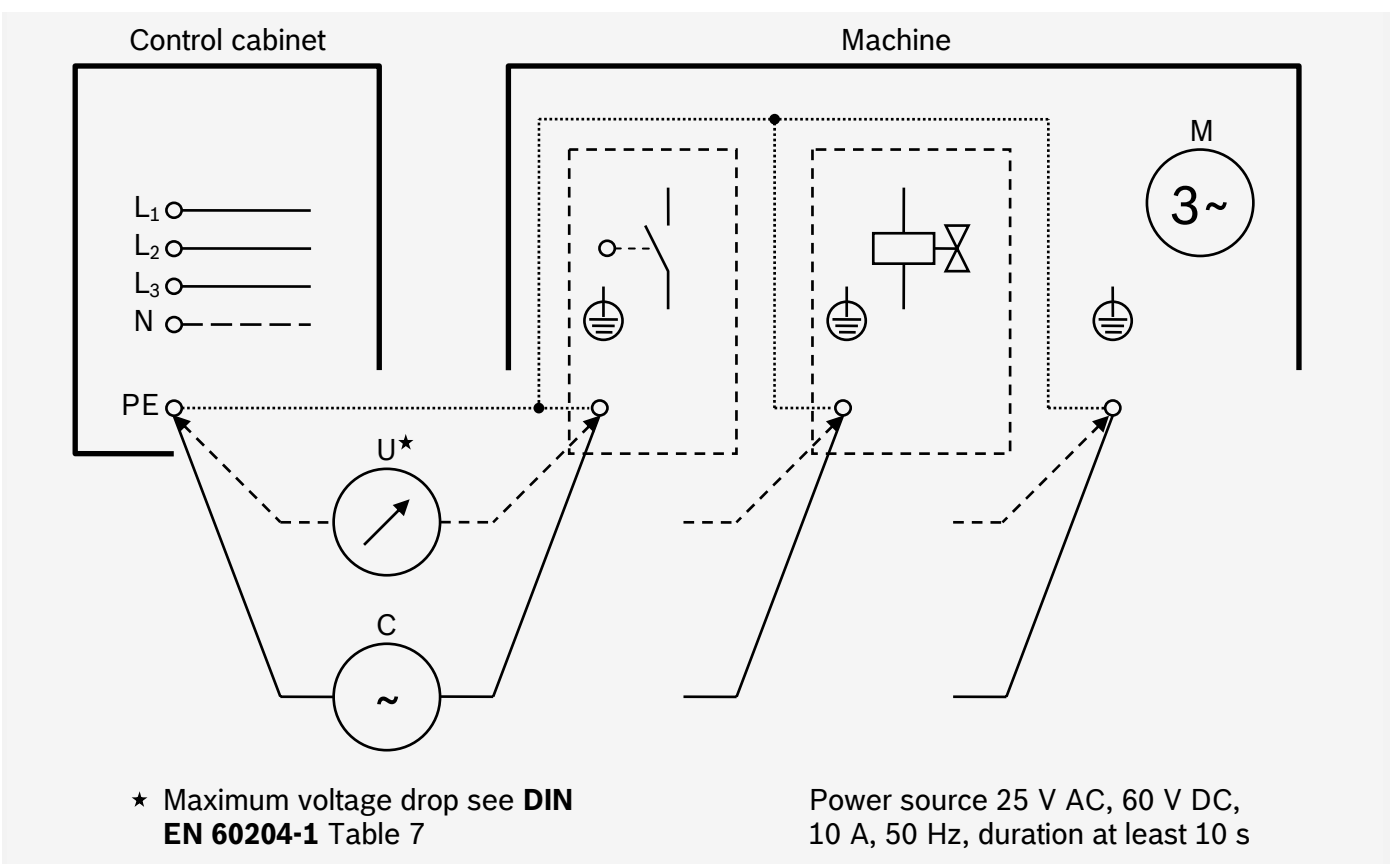


Figure 7 Inspection “Voltage drop in the protective conductor system”

11.1.3 Inspection of insulation resistance

Inspections of insulation have to be performed in accordance with **DIN EN 60204-1** Chapter 18.3 in an adequate manner.

It is the duty to evaluate when and to which extent the inspections have to be performed. The inspection must not cause any additional faults. Inspections that require disassembly, disconnection and reassembly with new connection of machinery and equipment are considered very critical.

11.1.4 Voltage test

Voltage tests have to be performed in accordance with **DIN EN 60204-1** Chapter 18.4 in an adequate manner.

It is the duty to evaluate when and to which extent the inspections have to be performed. The inspection must not cause any additional faults. Inspections that require disassembly, disconnection and reassembly with new connection of machinery and equipment are considered very critical.

12 Information on supply sources

- 1) Special design, types to be discontinued or spare part types may only be used after consultation.
- 2) Mounting and connection of the listed parts must be performed according to the recommendations of the manufacturer and must not impair indicated properties, e.g. protection class, cooling etc.
- 3) For machine groups and manufacturing stations belonging together, similar brands and types must be used and agreed with the orderer (operating elements, components, drives etc.).

13 Reference list N54 B1 – DIN EN 60204-1

Table 8 Reference list **N54 B1 – DIN EN 60204-1**

General target specification N54 B1		DIN EN 60204-1 (2006-06)	DIN EN 60204-1 (1998-11)
1	Instructions		
2	Control cabinet, power supply		
2.1	Control cabinet	11	12
2.1.1	General provisions	11.1	12.1
2.1.2	Arrangement of equipment	11.2	12.2
2.2	Power supply	5.1 / 5.2	5.1 / 5.2
2.2.1	General provisions	5.1 / 5.2	5.1 / 5.2
2.3	Performance	5.1 / 5.2	5.1 / 5.2
3	Main switch, emergency stop and protective equipment		
3.1	Main switch (switch disconnecter)	5.3	5.3
3.1.1	Requirements	5.3.3	5.3.3
3.1.2	Performance	5.3.3	5.3.3
3.1.3	Installation	5.3.3	5.3.3
3.2	Emergency stop	10.8	10.8
3.3	Protective equipment, key switch	9.3 / 9.4	9.3 / 9.4
4	Controlling, computer system		
4.1	Controlling concept	10	10
4.2	Voltage supply	13	14
4.3	Software	no information	11.3

General target specification N54 B1		DIN EN 60204-1 (2006-06)	DIN EN 60204-1 (1998-11)
4.4	Diagnosis	no information	no information
4.5	Representation of diagnosis in clear text using symbolism	no information	no information
4.6	Computer	no information	no information
4.7	Protection through automatic interruption of supply in the current circuit	7	7
4.7.1	Circuit diagram	17	18
4.7.2	Measures	8	8
5	Control, command and detection systems		
5.1	General provisions	10	10
5.2	Default colors	10.3	10.3
5.3	Colors of push-button actuators	10.2	10.2
5.4	Colors for indicator lights (signal beacon)	10.3	10.3
6	Cables, lines, installations		
6.1	Protective measures/protection of installations	6	6
6.2	Cables and lines	12.0	13.0
6.2.1	General provisions	12.1	13.1
6.2.2	Colors	12.2	13.2
6.2.3	Designation	12	13
6.2.4	Installations before the main switch	5.3.5	5.3.5
6.2.5	Current circuits that are not disconnected by the main switch	5.3.5	5.3.5
6.2.6	Power circuits for supply and locking between control cabinets	13.1.3 / 13.2.4	14.1.3 / 14.2.4
6.3	Installations (general provisions)	13.4 (11.3)	14.4 (12.3)
6.4	Terminal boxes (see also Chapter 9.3)	13.5	14.5
6.5	Plug and terminal equipment	13.4.5	14.4.5
6.6	Fieldbus installations	no information	no information
7	Electric motors, electrical drives		
7.1	General provisions	14 / 14.1	15 / 15.1
7.2	Installation	14.4 / 14.5	15.4 / 15.5

General target specification N54 B1		DIN EN 60204-1 (2006-06)	DIN EN 60204-1 (1998-11)
7.3	Winding layout and starting conditions	no information	no information
7.4	Special motors	14.3	15.3
8	EMC-conform design		
8.1	General provisions	4.4.2	4.4.2
8.2	Electricity feed	4.4.2	4.4.2
8.3	Arrangement of control cabinet	4.4.2	4.4.2
8.3.1	Mechanical arrangement of control cabinet	4.4.2	4.4.2
8.3.2	Arrangement of equipment and components	4.4.2	4.4.2
8.3.3	Electrical arrangement of the control cabinet	4.4.2	4.4.2
8.4	Cable ducts	4.4.2	4.4.2
8.5	Installation	4.4.2	4.4.2
9	Identification		
9.1	Identification of control equipment	11 / 16	12 / 17
9.2	Identification inside control cabinets	11	12
9.2.1	Identification of machinery and equipment in accordance with DIN EN 61346-2	16	17
9.2.2	Line identification	13.2	14.2
9.2.3	Identification of equipment, components and lines in the control cabinet	16	17
9.3	Identification during installation and inside the terminal boxes (signal, adjustment and drive elements)	16	17
9.3.1	Line and strand identification of machinery and equipment	13.2.4	14.2.4
9.3.2	Line and strand identification in the terminal box	13.2.4	14.2.4
9.3.3	Terminal box	16	17
10	Documentation of machinery and installation		
10.1	Documentation	17.1	18.1
10.2	Circuit diagram	17	18
11	Inspection, acceptance		
11.1	Inspection	18	19
11.1.1	General provision	18.1	19.1

General target specification N54 B1	DIN EN 60204-1 (2006-06)	DIN EN 60204-1 (1998-11)
11.1.2 Continuous connection of protective conductor system	18.2	19.2
11.1.3 Inspection of insulation resistance	18.3	19.3
11.1.4 Voltage test	18.4	19.4

14 Additionally applicable documents and referenced Bosch-Norms and external standards

- ▶ N51M M20 (2006-07)
- ▶ N51M M23 (2007-08)
- ▶ N54 B2 (2007-10)
- ▶ N54 B3 (2007-10)
- ▶ N54 D4 (2007-03)
- ▶ N54 D6 (2006-07)
- ▶ N93 I3.9.2 (2006-03)
- ▶ N93 I3.9.3 (2006-03)
- ▶ N93 I3.9.4 (2006-03)
- ▶ 98/37/EG (1998-06-22)
- ▶ 73/23 EWG (1973-02-19)
- ▶ BGV A 3 (1979-04-01)
- ▶ DIN 8659-2 (1980-04)
- ▶ DIN EN 1088 (1996-02)
- ▶ DIN EN 50262 (2005-05)
- ▶ DIN EN 60204-1 (2006-06)
- ▶ DIN EN 60447 (2004-12)
- ▶ DIN EN 60617 (1997-08)
- ▶ DIN EN 61131 (2003-12)
- ▶ DIN EN 61346-2 (2000-12)
- ▶ DIN EN ISO 12100-1 (2004-04)
- ▶ DIN EN ISO 12100-2 (2004-04)