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The authoritative and approved version of this company standard is only available on the Broetje-Automation intranet. Hard copies and locally stored copies must be verified as they are not subject to change management. The website of Broetje-Automation "www.broetje-automation.de" serves as an alternative source of company standards for external parties.

1 Electrical Installations

1.1 General information

Amendments or modifications of documents related to electrical installations are subject to company standard BN50.010.

The up-to-date circuit diagram and part lists of Broetje-Automation must be viewed prior to starting any installation!

Attention must be paid that the materials required for the installation are approved by Broetje-Automation and from the end customer!

1.2 Tendering procedure

Attention must be paid that the relevant specialist departments are consulted for technical and/or specific questions during the tendering procedure.

1.3 Guidelines

The installation is in accordance with:

1. Current standards
2. Guidelines of the end customer (after consultation)
3. This guideline

The relevant specialist department must be informed in case of any disagreement or discrepancies.

1.4 Color coding scheme for cables and wires

Wires and conductors are color-coded in accordance with the specifications of the end customer or compliant with DIN standard.

Wires for external voltage are orange. The colors gray or brown can be used for non-standard cables (e.g. analog signals). Use suitable measures to ensure that colored compensating cables are unmistakable (e.g. color or type of sheath, twisted, etc.).

The color white must only be used for single wires after prior consultation, e.g. as neutral conductor for the American market.

The color code must be documented on the cover sheet of the circuit diagram.

1.5 Color coding scheme for cables and wires in intrinsically safe circuits

Intrinsically safe circuits are to be marked by cables with blue sheaths.
Cable ducts must also be blue and may not be used for different electric circuits.
Single cables must also have blue sheaths.

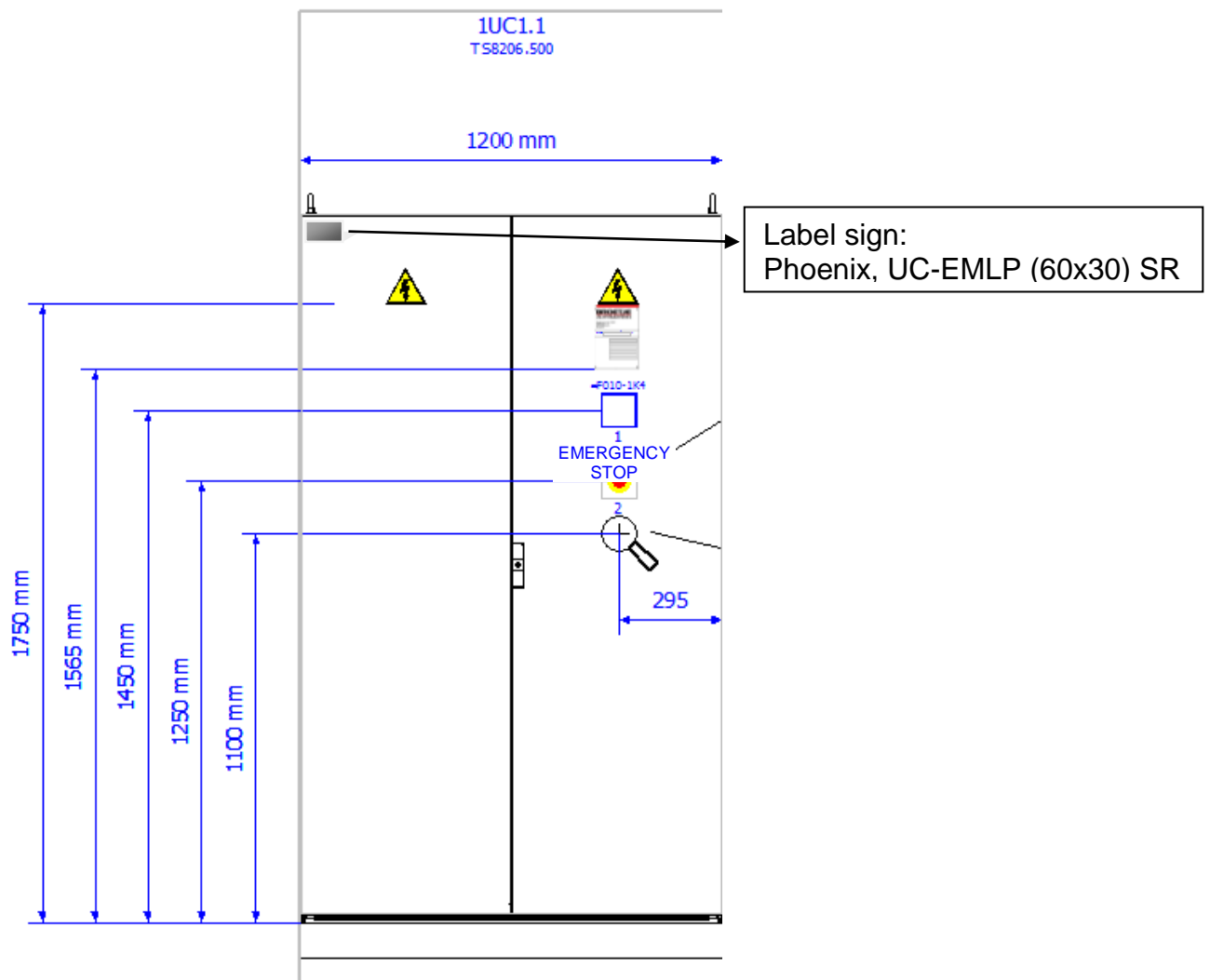
2 Switch cabinet layout and equipment

2.1 Switch cabinets

All switch cabinets must meet protection class IP54 at a minimum.

It must be possible to extend the cabinets by additional housings at any time. Built-in elements in side walls are therefore not permitted (in consultation with Broetje-Automation).

Whenever feasible, switch cabinets by Rittal 2000 x 1200 with 200 mm base are to be used. Main switches, emergency stop switches and flash warning signs must be mounted as specified in the drawings to achieve and maintain a uniform appearance of the overall or partial system.



The following must be observed:

1. The switch cabinet(s) is (are) to be delivered fully assembled, connected, sealed, including side walls, base, lifting eyes, door latches and cooling unit (if required).
2. All required openings and holes must be cut out.
3. A pocket for the enclosure legend must be screwed to the inside of the door, preferably the left one, of the switch cabinet.
4. The switch cabinet must be painted (order-specific color).
5. EMC floor panels are present, if required.

The doors must have a voltage equalization earthing strap with a cross-section of at least 16 mm². When using corresponding switch cabinets, voltage equalization earthing straps on floor panels, side walls, back walls and roofs can be omitted, provided no operating equipment are installed on or in them.

2.2 Switch cabinet layout and arrangement

All installations must be designed as screw-in installations as a matter of principle. Self-adhesive installation techniques are not permitted (use mounting rails).

Wiring ducts are mounted with pop rivets, while label rails may additionally be glued. (e.g. Phoenix marking rail PB-ZB 1051854 or Weidmüller SCHS 2, self-adhesive, black).

All operating equipment must be freely accessible.

Operating equipment must be exchangeable with minimum effort.

Wiring ducts may only be filled up to 70%.

All operating equipment must have sufficient distance from the wiring ducts.

The wiring from the feed to the first fuse element must be inherently short-circuit and earth fault proof.

Operating equipment must be wired so that they can be adequately moved. Control and power lines should be laid separately, if possible.

Heat-generating components should preferably be positioned in upper part of the switch cabinet.

Plug-in card holders must be installed vertically.

Installations in doors, other than control units that are accessible from the outside and sockets, are permitted only after prior consultation of Broetje-Automation.

Rivet nuts must be provided for panel mounting operating equipment with screws > M4.

2.3 Standard switch cabinet equipment

All switch cabinets are to be equipped with the following:

1. Non-halogen wiring ducts with wire clips
2. Non-halogen, fine single wires (exception US orders: UL standard applies).
3. Weidmüller wiring material (terminals, mounting rail labels, terminal angles, etc.).
 4. Only screwless spring-cage terminals are permitted for cross-sections up to 6 mm² (Screw terminals or direct connections for cross-sections of 10 mm² and larger.)
 5. Terminals > 50 mm² are to be installed directly on the mounting plate.
 6. Supply and earthing terminals are to be made of copper.
 7. High-profile support rails are to be used (TS 35/15).
 8. Type plate

Additional protection against contact must be provided for if touch protection is not warranted when the door of the switch cabinet is open.

2.4 Switch cabinet wiring

Manufacturers' guidelines must be observed as a matter of principal.

The wiring sequence specified in the circuit diagram must be adhered for switch cabinet wiring.

A sufficient PE connection on all detachable metal parts in or on the switch cabinet must be provided.

All protective earth cables must be connected as a matter of principal.

Wires from incoming our outgoing cables that are not used must be connected on consecutively numbered terminals or terminal marked as "Res." and subsequently be connected with equipotential bonding. They must be listed in the circuit diagram.

Torque values specified in the manufacturers' component documentation must be observed.

Minimum cross-sections:

Control lines:	0.75 mm ²
Main circuits:	1.5 mm ²
Data lines:	0.34 mm ²
Measuring lines:	0.34 mm ²
Encoder lines:	0.14/0.25 mm ²

Circuits for service sockets, light, undervoltage equipment, measurement equipment, and other equipment, which are connected before the main switch, must be installed separately using cables with yellow sheaths and marked with permanent labels.

After prior consultation, yellow single wires may be permitted.

Only fine wire conductors are permitted for wiring purposes.
Only non-halogen and silicone-free cables and single wires may be used.
All other materials should also be non-halogen to the greatest extent possible.

Wires ends must have wire end ferrules with plastic collars. Crimp-type cable sockets are to be used in case of increased load/stress. Fabricated cables do not require the plastic collar.

A looped-through neutral conductor or a control line must only be connected via one joint cable lug or one joint wire end ferrule. Otherwise, every neutral conductor or the control line must be connected to the terminal strip individually.
Multiple terminal assignment is not permitted.

The cable between the frequency converter and the motor must be shielded (see EU EMC Directive)

Unless otherwise prescribed by the manufacturer of the device, all data lines must be shielded multi-core lines.

2.5 Cooling

All operating equipment must have sufficient distance from the wiring ducts.
Wiring ducts must only be filled up to 70%.

Heat-generating components should preferably be positioned in upper part of the switch cabinet.

Plug-in card holders must be installed vertically.

In case extreme temperature fluctuations inside the switch cabinet are to be expected, for instance due to NC drive controllers, radial flow fans should be installed to ensure an even distribution of the heat.

If more than one cooling unit is used, they must be linked/networked.
This will prevent that the inside of the switch cabinet is cooled by just one cooling unit.

The temperature sensor is to be installed in the upper part of the switch cabinet.
The airflow to the sensor must not be obstructed by cable ducts or devices.

2.6 NC components

Manufacturers' guidelines must be observed as a matter of principal.

Attention must be paid to proper shielding and adherence to EMC guidelines.

The adequately dimensioned protective earth cables are radially connected to the designated terminal strip, e.g. =...=F014+...-1XL1.

The mounting plate must be metallic bright.

The proper tightening torques for screws must be observed.

Components must be easy to replace for repair work.

Power cables/lines and control/data lines must be laid separately (wiring through the back, see chapter "Switch cabinet layout and arrangement")

Devices/equipment and terminals that still hold dangerous residual voltage after disconnection must be identified accordingly (protection against contact with the devices/equipment/terminals must be warranted).

Attention must be paid to sufficient cooling; however, cold air from the cooling units must not blow directly into the modules.

If a specific breadboard is required for mounting, corresponding mounting holes and threads must be provided for future expansions. An expansions of around 30% must be possible without requiring major modifications inside the switch cabinet.

When installing transformers or throttles, it must be kept in mind, that these devices can generate very high surface temperatures.

Provide for sufficient clearance and protection against contact, as needed.

In case extreme temperature fluctuations inside the switch cabinet are to be expected, for instance due to NC drive controllers, radial flow fans should be installed to ensure an even distribution of the heat.

2.7 PLC components

Manufacturers' guidelines must be observed as a matter of principal.

Attention must be paid to proper shielding and adherence to EMC guidelines.

PLC components should be mounted separately and away from power devices/equipment.

If a specific breadboard is required for mounting, corresponding mounting holes and threads must already be in place for expansions at a later time. An expansions of around 30% must be possible without requiring major modifications inside the switch cabinet.

All labels and markings must be complete.

All inputs and outputs must be easy to find. The reference designations of the modules must be visible.

2.8 Grounding / potential equalization

Grounding/potential equalization must comply with DIN /VDE standards. Every protective earth cable must be marked as specified in the circuit diagram.

The potential equalization of the bus subscribers must be connected according to manufacturer specifications.

2.9 Reserve

It is a general requirement that switch cabinets can be expanded by 30% in all areas.

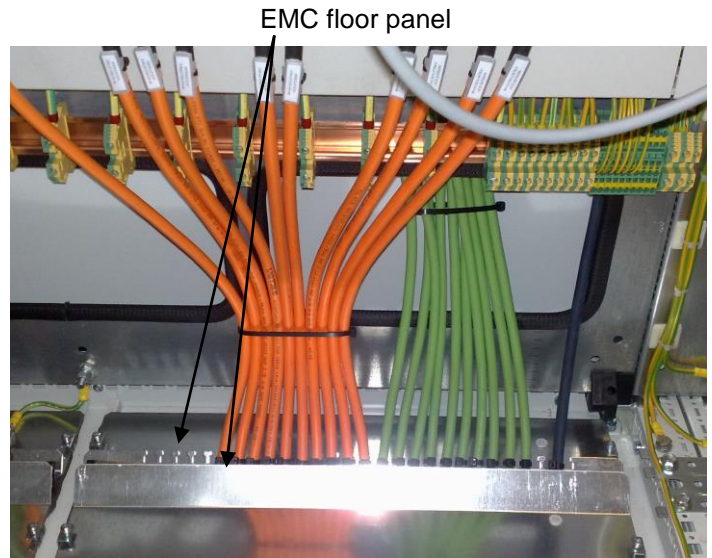
2.10 Cable feed

Cables are always fed into the switch cabinet from the bottom. Exceptions must be agreed with Broetje-Automation in advance.

The EMC floor panels available as accessories have been proven of value as a cable feed point into large switch cabinets.

Alternatively, the threaded “Skintop” glands of Lapp may be used for small switch cabinets. Good accessibility to the threads and sufficient reserve must be warranted.

Allow for sufficient space to insert the cable. No installations may be in the vicinity of the cable feed.



Unless otherwise specified, protection class IP54 must be met.

2.11 Test requirements

The switch cabinet is subject to following tests:

1. Broetje-Automation accompanying checklist
2. Inspection of wiring
(potentials, plug connectors, terminal strips, etc.)
3. Protective earth test
(test record in accordance with VDE 0113 / EN60204-1 / IEC 204-1)
4. Main circuit insulation measurement
(test record in accordance with VDE 0113 / EN60204-1 / IEC 204-1)
5. All adjustable protective devices are set to correct values.

3 Control panel

3.1 Setup

When installing components it must be ensured that all connections are easily accessible. All components must be easy to replace even when access from the back is not possible at the end customer's site.

A connection for a machine control programming device and a network connection, if appropriate, must be available.

If connectors on the side of panel-mounted devices prevent the removal of the devices, the front panel must either be hinged or a service opening on the side must be provided.

Push buttons must be integrated in a removable key panel. The length of connection cables must allow access for service tasks from the front.

3.2 Feed

Control panels are always connected to power supply by means of a 6-pin plug-in connector with following pin assignment:

Wires 1-3	3 x 400 V supply 24 V power supply unit
Wire 4	1 x 230 V or 110 V (end customer's supply voltage) service sockets and lighting
Wire 5	1 x 230 V device power supply (if needed)
Wire 6	Neutral conductor
PE wire	Protective earth cable

3.3 PLC components

Each PLC input and output of the control panel must have its own bus user that may not be used for any other function.

Any other function must be coordinated and agreed with Broetje-Automation in advance.

3.4 Reserve

Control panels must generally have 30% reserved space to allow for future expansions.

4 System installation

4.1 Mounting of electrical and control components

All electrical and control components are mounted only with the accessories provided by the corresponding manufacturer or accessories that are available on the market. Emergency stop buttons must be positioned in such a way that inadvertent actuation is widely excluded.

4.2 System wiring

Non-halogen materials are to be used whenever possible. Cables, in particular, must be non-halogen and silicone free.

Ambient conditions during installation must always be taken into account.

Thus, the arrangement or shielding, respectively, for instance towards hydraulic lines must be observed accordingly.

Control lines (24 V DC) and voltage lines ≥ 110 V AC must be separate cables.

The use of hybrid cables is to be agreed with Broetje-Automation in advance.

Flexible numbered cable is used for system wiring.

Unless otherwise prescribed by the manufacturer of the device, all data lines must be shielded multi-core lines.

Cross-sections must not be adapted by multiplying wires.

Different arrangements may be agreed upon regarding supply lines.

Wires ends must have wire end ferrules with plastic collars.

Crimp-type cable sockets are to be used in case of increased load/stress.

Fabricated cables do not require the plastic collar.

Looping-through of neutral conductors is not permitted for system installation.

Every neutral conductor must be connected separately to terminal strips.

Multiple terminal assignment is not permitted.

Lines connected to moving system components must be highly flexible.

Ölflex[®] ribbon cables or shielded ribbon cables are to be used for trailing cable installations (cable track systems).

If, in justified cases, round cables are used, proof of their mechanical suitability must be provided.

Protective earth cables must be clearly marked in accordance with the circuit diagram.

4.3 Laying and routing of cables

Terminal boxes for operating equipment may only be equipped with the appropriate terminals.

Connecting or looping through other lines is prohibited.

The chapter “EMC guidelines” must be observed.

Components that are not permanently installed or are removed during maintenance work must have plug-in connectors.

Connecting cables that are moved when opening the operating equipment must be flexible.

Only one line may be connected to the individual pins of plug-in connectors.

Suitable measures must be taken to prevent any mix-up in adjacent plug-in connectors. Mechanical coding may be a suitable option. Dimensioning the cable length so that it can only fit into the one proper socket is another suitable measure to prevent an inadvertent mix-up.

All protective earth cables must be connected as a matter of principal.

Wires from incoming our outgoing cables that are not used must be connected on consecutively numbered terminals or terminal marked as “Res.” and subsequently be connected with equipotential bonding. They must be listed in the circuit diagram.

Control cables, power cables and PE cables (protective earth) must be separated by means of space bars or hoses.

The terminal sequence must be adapted to the conditions.

A mix-up of terminals must be avoided by proper labeling or other means.

All cables must be laid in such a way that they are sufficiently protected against damage.

Lines are routed through galvanized metal cable ducts or protective plastic conduits.

Wiring ducts may only be filled up to 70%.

The use of hoses is only permitted after prior authorization.

Armored steel conduits or metal hoses are to be used in areas exposed to fire hazards.

Wall brackets and ceiling profiles must be designed for maximum rail load.

Cable ducts are to be preferred to several parallel conduits or hoses.

All ends of conduits must have end caps / sleeves.

Branch cables and cables through angles and around edges should be laid with a radius of 45°.

Conduits must always be separated at cable exits. Routing cables through the side of bores is prohibited.

Section points should have a width of between 50 and 100 mm to facilitate easy retrofitting.

Cable conduits are mounted with gripper clamps. Conduits, hose joints or hoses subject to mechanical load must be mounted with closed clamps.

Joints between duct and conduit as well as between conduit and hose must be fitted with suitable adapters.

The ends of all cable ducts as well as any cuts into the duct or the lid must be fitted with edge protection or flanged.

Screws penetrating cable ducts must be dulled or fitted with other means to protect the cables.

Cable ducts must always be covered unless the design of the machine prevents any soiling.

All other ducts must be covered.

All devices such as sockets, switches, light fixtures and control devices must be fitted with cable glands or plug connectors and must be connected to the conduits or hoses.

If the manufacturer specified the use of self-sealing grommets or the like, suitable measures must be taken to prevent cables from being pulled out.

Cables run through vertical cable ducts must be secured with reclosable strip ties every 1.5 m for additional pull/strain relief purposes.

Cut-outs in metal floor panels and hollow profiles that are used for cable routing must be beveled and fitted with edge protection.

Lines/cables routed through metal floor panel must be covered across the floor area (slip-resistant design).

Hollow profiles used for routing cables must be fitted with larger screw-on service openings.

Sharp cable tie ends must be beveled.

4.4 Conductor line

The use of conductor lines for power supply requires the prior coordination and agreement of Broetje-Automation.

Any other use of conductor lines is not permitted.

4.5 Cable tracks

Cable tracks, flex hoses or trailing flat cable installations, as required, are to be used to supply moving system components with power.

Strip-wound hoses are prohibited.

All metal parts of moving cable tracks are fitted with potential equalization.

Trailing cable installation must have a head clearance of 2 m.

Only cable tracks which can be opened to facilitate easy retrofitting and/or upgrading are to be used.

There must be sufficient space for all media supply required.

Additionally, all cable tracks must have a reserve of at least 25%.

All trailing cable tracks must be fitted with space bars for cable groups (control lines, power lines, pneumatic and hydraulic hoses) and cables of various diameters.

All lines/cables routed through a cable track must be highly flexible track cables suitable for 3-shift operation (24 h).

The cables must be routed loosely between the studs. If possible, they should be arranged individually in the neutral zone of the track.

Ribbon cables that are routed next to each other (in parallel or horizontally) must always be separated with separating bars. Ribbon and round cables must always be routed separately in the cable track.

A clearance of 10% of the cable diameter must be provided for each cable to facilitate free movement.

Attention must also be paid that every cable has sufficient clearance around bends when routing several layers of track chambers.

Cables must not be twisted. All cables must be taken from the reel and laid down flat before they are routed; pulling off several cable winds from the reel is not permitted.

4.6 Assembly and strain relief of cables inside cable tracks

Manufacturer's specifications apply as a matter of principle when routing and assembling cable tracks.

All cables/lines must be securely clamped to the fixed point and on the driver. It should be noted that the clamping may only cover a large area of the outer sheath. The clamping must ensure that the cables can no longer be moved; however, the single wires inside the cable must not be compressed.

The recommended distance between the end of the bending movement and the fixation is 10 to 30 times the cable diameter.

Cables may not be tied together or attached to the track. They must be allowed to move freely within the entire movement range of the track.

Industrial strength plug-in connectors are to be used in front of and behind moving connections (encoder and measurement cables excluded). These can only be dispensed with if the end points are located close to the connection and the cables can be exchanged easily.

4.7 Assembled cables

The use of preassembled cables is to be preferred to self assembly, whenever possible.

4.8 Connection of mobile components

Mobile components such as mobile control units or confirmation buttons must be connected using fine-stranded PUR cables with fluorescent orange sheath. Cable leads are to be fitted with anti-kink sleeves.

4.9 Test reports

The following test records are to be included with the documentation:

1. Protective earth test
(test record in accordance with VDE 0113 / EN60204-1 / IEC 204-1)
2. Main circuit insulation measurement
(test record in accordance with VDE 0113 / EN60204-1 / IEC 204-1)

5 Designation/labeling

Labels/markings must be uniform even if the system is supplied by different manufacturers.

All devices must be permanently marked in accordance with the circuit diagram. White signs/labels with black lettering are to be affixed to the mounting plate.

The following labeling system should be preferred:

Label rail SCHS 2 by Weidmüller,

or

Phoenix marker strip carrier, PB-ZB METER, and Phoenix marker for terminal blocks, width 16 mm UC-TM 16.

The device is to be labeled with a yellow label (e.g. Phoenix EML 20x8 or Weidmüller THM MT 30x-20/8), black lettering.

Terminal strips are clearly marked (e.g. Weidmüller group marker WAD 8 MC or end bracket marker EM 8/30).

Terminal strips are numbered from left to right and from top to bottom, in ascending order, visible from the front.

All cables (wires) inside the switch cabinet must be permanently labeled with the wire number on both sides, terminal number = wire number. (Wires are labeled by means of sleeves with label inserts, e.g. Grafoplast sleeves with Phoenix UC-WMT 15x4 or Weidmüller TMI 15.)

PLC inputs and outputs are designated in accordance with the diagram.

Drive controllers are additionally marked with the function designation.

(e.g. name of axis).

Components that are still live when the main switch is turned off must be clearly marked with a warning label "live before man switch".

If the designation of terminal strips mounted inside a terminal box deviates from the designation of the terminal box, the terminal strip designation must be listed on the label of the terminal box.

All cables must be marked with the start and end designation.

(e.g. W=1+LD-240XL1/-243S2)

Cable markers by Phoenix are to be used for this purpose:

Type: Cable marker KMK 2, 1005266

Operating equipment outside of switch cabinets and terminal boxes are labeled by means of screwed or riveted aluminum signs, ecru colored sign with black lettering.

Following consultation and approval, adhesive labels may be used if the existing assembly does not allow for the above mentioned permanent attachment of these signs. However, it must be ensured that such adhesive signs are durable and that the lettering will not become illegible from cleaning agents, lubricants or other chemicals used on or with the system

(e.g. Phoenix device marking SR EMLP (27x8) R SR)

6 EMC guidelines

6.1 Basic regulations

All specifications provided by the manufacturer, as well as EMC guidelines, are to be observed as a matter of principle.

If cables of electronic control units are routed next to cables carrying high starting currents (e.g. cable routes), appropriate shielding measures must be taken.

For instance, with:

1. Network and bus cables
2. Control voltage 24 V DC, signal/measurement lines
3. Power/motor cables/power supply/lighting

6.2 Assembly guidelines

The cables of controlled motors must be shielded.

Unless otherwise specified by the manufacturer, the shield must be applied on both sides.

A black insulating sleeve must be used as sheath if the shielding braid is run directly to the connection terminal.

The end of the shield must be secured against unraveling.

Measurement, data and signal cables must be routed separately from control and power cables. The shield is applied on one side starting from the neutral point (supply side).

The outer shield of double-shielded cables is applied to both sides.

The inner shield is applied on one side starting from the neutral point.

7 Bus configuration

7.1 General information

Standards and guidelines for the corresponding bus must be observed.

EMC guidelines must be observed.

Only materials approved for the particular type of bus may be used.
The sequence of the bus users can be found in the circuit diagram.
Bus addresses are to be configured as specified in the circuit diagram.
The MAC addresses must be entered in the circuit diagram.

Circular plugs are to be preferred for the connection of lines.

8 IT networks

8.1 General information

Standards and guidelines for the corresponding network must be observed.

EMC guidelines must be observed.

Only materials approved for the particular type of network may be used.
The sequence of the network users can be found in the circuit diagram.

Circular plugs are to be preferred for the connection of lines.

9 Explosion area

9.1 General information

The installation is in accordance with the current standards and end customer guidelines.

9.2 Chip extraction

If the system is used to process CFRP materials and is equipped with a chip extraction system, all dust-carrying components of the extraction line must be connected to the PE conductor. Please also refer to BN 10.320.

Moreover, you must check whether an “emergency stop” has to be triggered for the system in case of malfunctions of the chip extraction system.

