Wieland-Werke AG
Corporate Function Global Engineering
Graf-Arco-Strasse 36
89079 Ulm
Germany
Phone +49 731 944-0
www.wieland.com

Section B – Electrical engineering

Part 1: Electrical equipment for machinery and plants

The following delivery specifications of Wieland-Werke AG form part of the contract.
Any deviating specifications are to be agreed upon between the supplier/contractor and Wieland, and documented.

Created by: **Mr. Stadler**
Phone: +49 731 944-2707
Email: lv.elektrotechnik@wieland.com

Table of contents

Summary of changes (based on revision of January 2019)

Section	Change
Header	Department identification and contact person updated
1.3	500 V supply voltage deleted
2.2.6	Slide-type terminal blocks replaced by test disconnect terminal blocks
3.5.7	Reference to part 6 of LvE when measuring Profinet wiring
3.5.10	Cable ties must be selected to suit the environment Example modified to the EPLAN designation Labelling colour in consultation with the electrical department
3.8.1	Additional device identifier on cable deleted
4.1.3	Efficiency requirements for drive systems updated
4.2.3	Energy meter requirements updated
4.3.2 & 4.3.3	Three-phase motor feeders and motor dimensioning updated
4.4.4	Requirements for the networking of frequency converters updated
4.7.2 & 4.7.4	Safety passwords must be supplied
4.8.2.3	SCL programming language may be used if necessary subject to prior consultation with the planning electrical department
4.11.3	Successor model for Comfort Panels, section updated
4.13.5	Requirements for PROFINET added (tree topology, occupancy of switches, line depth)
4.13.6	Requirements for DRIVE-CLiQ added
5	Device selection updated and standardised
7	PLC program is delivered as TIA project
7.5	Preferably EPLAN as CAE system
7.11.1 & 7.11.7	Document password list in circuit diagram
7.16	The cable length must be specified in the cable list

1 General

1.1 Standards and regulations

In accordance with applicable laws, the current VDE regulations are stipulated as the state of the art for the execution of electrical equipment. These delivery specifications state the requirements resulting from the VDE regulations more precisely in line with our concerns and requirements.
All supplies, components, assembly work and other services must conform to the latest editions of the relevant standards, regulations and laws, such as:

- DIN standards, EN standards, VDE regulations
- EU Directives:
  Low Voltage Directive 2014/35/EU
  Machinery Directive 2006/42/EC
  EMC Directive 2014/30/EU
- EMC: Recommendations of Deutsche Gesellschaft für EMV-Technologie e.V. (DEMVT “EMV gerechter Schaltschrankaufbau” (“EMC-compliant switch cabinet construction”))

Conformity of the electrical equipment with EU Directives as well as any other relevant regulations must be confirmed with the Declaration of Conformity and CE marking.

1.2 Environmental conditions

1.2.1 Scope of application

The delivery specifications for electrical equipment (LvE) apply for the plants
- Ulm, Vöhringen, Langenberg and Villingen

1.2.2 Altitude of site

Ulm plant:	475 m above sea level
Vöhringen plant:	495 m above sea level
Langenberg plant:	80 m above sea level
Villingen plant:	704 m above sea level

1.2.3 Ambient temperatures

External temperatures:

Max.:	+35 °C
Mean:	+10 °C
Min.:	-20 °C

1.2.4 Room temperature

Relative humidity: 30 ... 80%
Room / production area temperature: max.: + 40 °C
The devices must be functional in the temperature range between +5 °C and +35 °C.

1.3 Electrical supply network

The mains voltage to be provided and the short-circuit currents to be taken into account at the connection point must be agreed with our planning electrical department.

1.3.1 Ulm plant

Medium voltage:	3 x 10 kV, 50 Hz (IT system)
Low voltage:	3 x 400/230 V, 50 Hz (TN-S system)
Lighting:	3 x 400/230 V, 50 Hz (TN-S system)

1.3.2 Vöhringen plant

Medium voltage:	3 x 20 kV, 50 Hz (IT system)
Low voltage:	3 x 400/230 V, 50 Hz (TN-S system, without N conductor)
Lighting:	3 x 400/230 V, 50 Hz (TN-S system)

1.3.3 Langenberg, Villingen plant

Medium voltage:	3 x 10 kV, 50 Hz (IT system)
	3 x 20 kV, 50 Hz (IT system)
Low voltage:	3 x 400/230 V, 50 Hz (TN-S system)
Lighting:	3 x 400/230 V, 50 Hz (TN-S system)

1.3.4 Voltage fluctuations

It must be possible to operate devices with effective values between 90 and 110% of their rated connection voltage.

1.3.5 Harmonics

Due to the line-commutated converters connected to our system, deviations from the sine shape and short-term dips in the mains AC voltage are possible.
However, harmonics in our system fall within the limits according to EN 50178 (VDE 0160) and EN 61000 (VDE 0838) Class 2.
Electrical and electronic equipment must satisfy these requirements.

1.4 Protective measures

In all cases, the protective measures against direct and indirect contact according to VDE 0100, 0101, DGUV Vorschrift_3 and similar must be provided:

- 400/230 V mains with earthed neutral point (TN system)

1.4.1 Efficacy of the protective measures

The efficacy of the protective measures must be proven and documented by inspections, tests and measurements in accordance with VDE 0100. In fixed electrical installations these are, for example, the insulation condition and loop impedance.

1.5 Electromagnetic compatibility (EMC)

In our plants, there are extensive cable networks with high power densities. Consequently, there is a risk of conducted disturbance being coupled into neighbouring systems.
Special attention must therefore be paid to electromagnetic compatibility (EMC) in the design, construction and assembly of systems. Faults and malfunctions in system components or in already existing systems in the vicinity which are demonstrably due to improper EMC planning by the contractor shall be remedied by the contractor.

1.6 Training of maintenance personnel

When delivering technically extensive systems, the contractor must provide training and instruction for our maintenance personnel.
The contractor shall draw up a proposal for the training programme and agree it with our planning electrical department in good time, with e.g. the following content:

- Design and function of the system
- Components and software used
- Structure and explanation of the documentation, etc.
- Measures when replacing devices (setting up, fine-tuning)

The time required for this depends on the size and complexity of the plant equipment. If the contractor offers general introductory courses for a particular technology, which support the required introduction in a preparatory way, then information about this should be provided during the bidding stage.
The required training documents (e.g. operating instructions, maintenance documents, programming explanations, etc.) shall be prepared and supplied by the contractor.

1.7 Notes on the task and definition of the scope of supply

In addition to this delivery specification, the project-specific requirements for the scope of services and supply according to the requirement specification / functional specification and the component list must be fulfilled.
All points that cannot be fulfilled by the contractor are to be specified before work begins and coordinated with our planning electrical department.

Responsibility for the design and execution of the scope of services and supply lies with the contractor for the electrical equipment. We assume that the contractor is familiar with the technological task, the manner of operation and production of the plant and has the know-how to implement the technical solution.
The required modes of operation, qualities or times, power reserves for the control dynamics and mass acceleration, as well as required control and regulation procedures shall be taken into account in the design of the electrical equipment by the contractor in order that the agreed scope of services and supply can be fulfilled on schedule and materially.

Unless specified otherwise, the scope of supply shall begin with the connection to a power supply located on our premises. All required intermediate voltages, auxiliary voltages, control voltages, excitation voltages and their distribution from this power supply shall be included in the scope of supply of the electrical equipment.
For assembly, commissioning, optimisation and acceptance, all tools, instruments and other aids shall be provided by the contractor.

The contractor of the electrical equipment is required to provide a functional and complete installation in accordance with the current state of the art. This also includes equipment parts that are not expressly mentioned in the specification or component list, but are necessary and required for the operation of the plant.

With regard to the increasing requirements for energy efficiency, the contractor must propose control concepts that enable the automatic shutdown and restart (switch-off or power reduction) of the larger energy consumers in the installation.

The quantity structure listed in the functional specification or in the component list corresponds to the respective clarification and planning status of the project.
The further detailed planning will result in a change in the quantity structure.
Therefore, according to the size of the project, an appropriate degree of change must be included in the scope of supply of the electrical equipment, without this leading to additional costs being charged.

2 Design of switch cabinets, consoles, control panels, enclosures

2.1 Design of switch cabinets

2.1.1 Enclosure execution

Sturdy sheet steel construction

Mounting plate execution:	Galvanised sheet steel
Coating:	Supplier standard, RAL 7035 (light grey)

2.1.2 Transportation units, transport lugs

Unless otherwise defined, switch cabinets must be divided into groups of no more than 3.6 m in length for transportation.
Transport lugs are to be provided on the tops of each switch cabinet group to allow the attachment of ropes.
A seal must be fitted between the individual cabinets of the cabinet rows.

2.1.3 Current load of busbars

Busbars may only be loaded with current to such an extent that, taking into account the permissible cabinet / switching room temperature, a temperature increase at the busbars of max. 30 K results, but the maximum temperature of 60 °C is not exceeded.
The busbars must be dimensioned for the rated operational short-circuit current (I_{CS}) and for the short-circuit breaking capacity (I_{UC}).

2.1.4 Power sockets

230 V power sockets must be installed at an interval of approx. 2 m along the switch cabinet row. Power sockets in luminaires do not fulfil this requirement! These power sockets must be wired in such a way that the power to them can be supplied independently of the system supply. The feed terminals must be accommodated in a separately fitted and covered terminal strip (terminal designation –XF). The connection within the cabinets must be made with orange sheathed cable (not individual conductors).

2.1.5 DIAZED fuses

Only fuses of the DIAZED system may be used. NEOZED fuses are not permitted.

2.1.6 Equipotential bonding, EMC

Equipotential bonding of movable or removable parts such as lids, doors, panels, covers etc. must be carried out by means of flexible copper braids and large-area contacting. Mounting plates arranged in a row must be connected at the top, middle and bottom with fine-stranded copper braids.

2.1.7 Protective covers, protection against accidental contact

Protective covers larger than 0.5 m² must be equipped with quick-release fasteners and handles.

2.1.8 Switch cabinet and machine labelling

For the labelling of the switch cabinets for a machine, the machine short designation is to be affixed to the incoming supply panel by means of a sign 200 x 80 mm; designation and labelling in consultation with our planning electrical department.

2.1.9 Location designation on the switch cabinet

For switch cabinets, the location designation is to be affixed to the top right of each panel, on a sign approx. 100 x 50 mm, with plain text stating the field contents.

Example:

+C1.E1
Power supply, 400 V

2.1.10 Name plate, CE marking

In accordance with EN 61439 and EN 60204-1, all switch cabinets and enclosures with their own power supply must be provided with a name plate containing the following information. Conformity with the applicable Low Voltage Directive is to be indicated on the switch cabinets by means of the CE mark.

Design suggestion, e.g. supply panel:

wieland

CE

Bearbeiter:	
Baujahr:	
Anlagenbezeichnung:	
Auslegungsdaten für:	
Netzsystem:	
Bemessungsspg/Freq:	
Steuerspannung:	
Bemessungsstrom:	
Volllaststrom:	
Kurzschlussauslegung:	
Norm:	
Schaltplankennung:	

Zuleitungsdaten

Verteilung:	
Standort:	
Zuleitungsquerschnitte:	
Absicherung:	

Legend:

DE	**EN**
Bearbeiter:	Contact person:
Baujahr:	Year of construction:

Anlagenbezeichnung:	Plant designation:
Auslegungsdaten für:	Design data for:
Netzsystem:	Mains system:
Bemessungsspg/Freq:	Rated voltage / freq.:
Steuerspannung:	Control voltage:
Bemessungsstrom:	Rated current:
Volllaststrom:	Full load current:
Kurzschlussauslegung:	Short-circuit rating:
Norm:	Standard:
Schaltplankennung:	Circuit diagram identifier:
Zuleitungsdaten	Power supply data
Verteilung:	Distribution board:
Standort:	Location:
Zuleitungsquerschnitte:	Supply cable conductor cross-sections:
Absicherung:	Fuse protection:

2.1.11 Switch panels for installation in enclosed electrical rooms

2.1.11.1 Execution

.. without doors, with back and side walls, with a red safety barrier made of electrically non-conductive material fitted at a height of approx. 900 mm.

2.1.11.2 Dimensions:

- Height:		max. 2200 mm incl. base
- Depth:		600 mm
- Width:	pitch	600, 800 or 1200 mm

2.1.11.3 Ventilation

The switch panels must be open at the bottom if ventilated through the (cable) floor, or, if ventilated from the front, sealed at the bottom by means of a cover plate and foam rubber seal.

2.1.12 Switch cabinets for installation in the workshops

2.1.12.1 Design, protection class

IP rating: IP54
For installation in acidic/alkaline environments: Stainless steel version

2.1.12.2 Dimensions:

Floor-standing cabinets	Height:	max. 2200 mm incl. base
	Depth:	max. 600 mm

2.1.12.3 Switch cabinet cooling, air-conditioning

In order to save energy, the switch cabinet interior temperature of the air-conditioning units must be set to a sensible value, e.g. 35 °C. The cooling must be dimensioned in such a way that at 40 °C ambient temperature, the maximum permissible heat values for the installed devices are not exceeded. Open-circuit ventilation, even with a filter, is not allowed because of the risk of fouling. Required switch cabinet air-conditioning units must be installed in the cabinet door or side wall with quick-change frames.
Only units with optimum efficiency may be used as air-conditioning units.
Air conditioning units are to be of the condensate evaporator type. The model and manner of installation are to be agreed with our planning electrical department. An intelligent fan control system, e.g. Rittal Eco-Mode, is to be provided for demand-based energy use by the units.
During installation, attention should be paid to suitable air ducting, heat dissipation and possible condensate routing.
A switch cabinet heater must be provided for ambient temperatures below 10 °C.

2.1.12.4 Switch cabinet doors

- shall be equipped with a comfort handle, double bitted lock and slide-rod closure.
- must have an opening angle of at least 120 °C.
- must not be impaired in their stability as a result of the installation of equipment. If necessary, additional mechanical stabilisation measures must be implemented.
- PLC cabinets must be provided with a fold-out shelf on the inside of the door.

2.1.12.5 Storage pocket for documentation

Made of metal, screwed to the inside of a door, suitable for holding circuit diagrams. This door shall be marked on the outside with a black “P” on a yellow background.

2.1.12.6 Cable entry

Standard cable entry from below via cable glands (20% spare holes, must be sealed), or via a cover with foam rubber seal. Special cases with cable entry from above must be agreed with our planning electrical department.

2.1.12.7 Lighting:

Each switch cabinet must be equipped with lighting. This must be switched on via door limit switches or integrated motion detectors.
Power supply and wiring as in section 2.1.4.

2.1.13 Control panels

2.1.13.1 Console cover

… must be fitted with an automatic latch.

2.1.13.2 Coating

Outer surfaces as agreed, mounting plate: Galvanised sheet steel

2.1.13.3 230 V power sockets

… to be provided if programmable devices or (decentralised) PLC modules are installed. Power supply and wiring as in section 2.1.4.

2.1.13.4 Service unit in the console side wall

A service unit consisting of a 230 V AC power socket and
PG Ethernet connection (e.g. Murr Elektronik) is to be installed in the console side wall.

2.1.13.5 Pushbutton housing (combinations)

Housing execution: Metal, protection class IP54

2.1.13.6 Identification plate

An identification plate with the location designation of the console is to be affixed to consoles. Example: (+B4.P1).

2.1.14 Housings, distribution boxes and intermediate terminal boxes

2.1.14.1 Execution

- Sheet steel housing, protection class IP54
- Coating: unless specified otherwise, standard colour, RAL 7035
- With double bitted lock and cover holder
- With sturdy hinge for housing larger than 200 x 300 mm
- In problem areas (wetness, aggressive environment) made of plastic or stainless steel
- Terminals must always be fixed in place (even in small connection boxes)
- Cable ducts fitted on both sides of the terminal strip.

2.1.14.2 Identification plate

An identification plate with the location designation of the terminal box shall be affixed to the housing cover / terminal box cover. Example: +B1.M1.

2.1.14.3 Installation of switching devices

Installation of switching devices in terminal boxes only after consultation with our planning electrical department.

2.1.14.4 Cable entry

Via cable glands with strain relief from below (20% reserve holes sealed, required)

2.2 Installation of devices

2.2.1 Spare space

The available mounting spaces may only be occupied up to max. 80% per individual cabinet or enclosure, so that a space reserve of 20% is available in the cabinets.

2.2.2 Accessibility

All devices must be accessible after opening the door and, where applicable, removing the covers.

Devices on which adjustment, switching or maintenance operations have to be carried out (fuses, motor protection switches, time relays, measuring instruments) must be at least 0.4 m and max. 2 m above access level.

Device carriers and cover plates with modules and devices installed on the front side must also be accessible from the connection/plug side (swivelling or hinged design).

A distance of at least 40 mm must be maintained between the outside of the housings or the connection terminals of the installed devices and terminals, and the wiring ducts.

Device mounting

- on cabinet side walls is not permitted (except main switch)
- on top hat rail DIN EN 60715
- of heat-radiating devices in the upper part of the cabinet
- of switching devices such as contactors, relays must be in coherent functional groups in accordance with the circuit diagrams
- in control panels, except for display and operating elements, is not allowed without the approval of our planning electrical department.
- No devices, e.g. relays, fuses etc., may be installed between terminals.
  Additional electronic parts (resistors, capacitors etc.) must not be connected “flying” to terminal blocks, but must instead be connected to fixed support points.

Each device must be labelled twice with its device identifier:

- 1x on the device
- 1x in a fixed position on the mounting plate or switch cabinet door

Identification plates on cable duct covers are not permitted.

Designation of control devices and signal units:
Control devices, signalling devices, display devices and measuring devices are to be provided with a plain text labelling plate (e.g. 15 x 50 mm, Resopal white or aluminium, black lettering (4 mm)), stating the function in German and the device identifier. The device identifier must also be indicated on the back of the mounting plate.
The available labelling possibility on the switch plate can be used.

2.2.3 Main switch

- For open switchboards and frontal actuation, a well adjusted door coupling is required. For closed switch cabinets, side installation is preferred.
- Must not be installed in doors (except for switching handle)
- Must be lockable in the “off” position with 3 padlocks, in accordance with EN 60204 (VDE 0113)
- Must not be included in a door interlocking system
- Actuation height approx. 1200 mm

2.2.4 Supply line

The supply line is connected directly to the main switch without intermediate terminals. The corresponding main switch terminals must be covered to prevent accidental contact.

2.2.5 Device identification for excluded circuits

All components and switching devices that are still live despite the main switch being switched off must be arranged separately in the switch cabinet, covered and marked with warning signs.

2.2.6 Terminals

Incoming and outgoing connections must in principle be routed via terminals or equivalent separating devices.

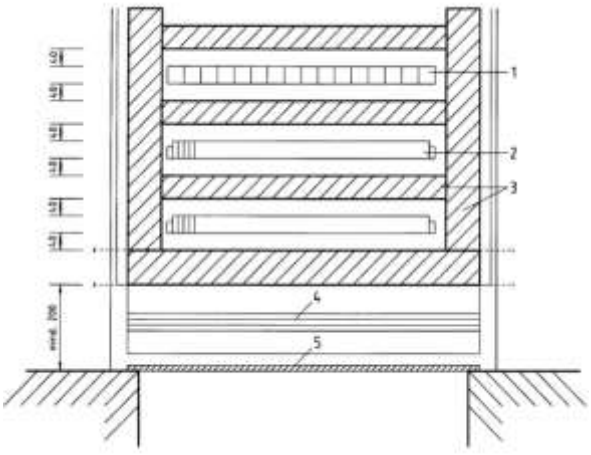
Exception:

- Supply line directly to main switch
- Sensitive measuring leads with very low signal level directly to built-in amplifier
- Themocouple leads via thermocouple terminals or directly to amplifier
- Bus cables
- Use of ET200S modules
- If the cable type does not allow intermediate terminals

Preferably terminal blocks should be used in accordance with section 5.1; if space is very limited, multi-level terminals can be used.
Installation terminals (luster terminals) are not allowed.

All terminals must be easily accessible and in principle fixed in place.

Terminal strips and cable support rails shall be installed as shown in the following drawing:



1. Contactors, relays etc.
2. Terminal strip
3. Cable duct
4. Anchor rails for cable fastening
5. Unscrewable floor panel with cable glands

For horizontal installation, an inclination of up to 30° upwards is permissible. A maximum of 2 terminal strips may be installed one above the other.

Intermediate terminal strips in the cables to devices fitted in doors must in principle be located on the stationary part; the terminal strips must have their own designation and be entered in the circuit diagrams. The same applies to disconnect terminal strips at cabinet separation points.

The secondary connections of current transformers must be connected via test disconnect terminal blocks (see 5. Device selection).

Terminal labelling must be carried out using the labelling system specified by the terminal manufacturer. Handwritten labels are not allowed.

For each protective earth connection, a separate green/yellow PE terminal must be provided, and for each motor feeder a PE terminal must be provided next to the phase terminals.

Only 1 conductor may be clamped in each terminal connection.

2.3 Wiring

2.3.1 Plastic ducts and protective tubes

Wiring is to installed in plastic ducts, which may be filled to no more than 2/3rds full. For the wiring ducts, only designs with continuous slots that allow the wires to be inserted from above may be used.
Protective tubes may only be used to protect moving cables.
For this purpose, plastic tubes without an inserted wire spiral are to be used, which are fastened at both ends with tube fittings and/or Stauff clamps in accordance with the manufacturer's specifications.

2.3.2 Connections to movable parts

Connections from fixed to movable parts (e.g. switch cabinet door) must be routed in plastic tubes and executed in such a way that the conductors are not subjected to tensile or bending stress (S-shaped arrangement). The protective tube and the conductors must be fixed on each side.

2.3.3 Conductor type

… exclusively flexible H07V-K (NYAF), LiYCY

The minimum cross-section for power conductors is 1.5 mm².
The connection technology must be matched to the conductor cross-sections and the type of conductor (fine-stranded, stranded, single-core). The connection ends of fine-stranded / stranded conductors must be terminated with gas-tight crimped wire end sleeves or cable lugs.

Conductors whose fuse protection does not correspond to the cross-section prescribed for the fuse used are to be installed as short-circuit-proof single wires.

2.3.4 Colour coding of conductors (single wires)

2.3.4.1 Wiring colours for individual conductors

- In main circuits AC and DC	:	black
- In auxiliary circuits for AC power	:	red
Without control transformer; N conductor	:	red with blue identification ring on the end of the conductor
- In auxiliary circuits for DC power	:	dark blue
- Interface between system controller and central control system	:	brown
- Measurement circuits (e.g. current transformers)	:	grey
- External voltages (e.g. light power supply)	:	orange

2.3.4.2 Protective earth and neutral conductor:

Bare busbars as protective earth and neutral conductor shall be colour-coded according to their function.
The PEN conductor shall be marked green/yellow+blue, the connection from PEN to N light blue.

2.3.4.3 Assignment of protective earth conductors

The assignment of protective earth conductors to the cable or connection point must be recognisable by marking with the device identifier, the cable number or by spatial assignment.

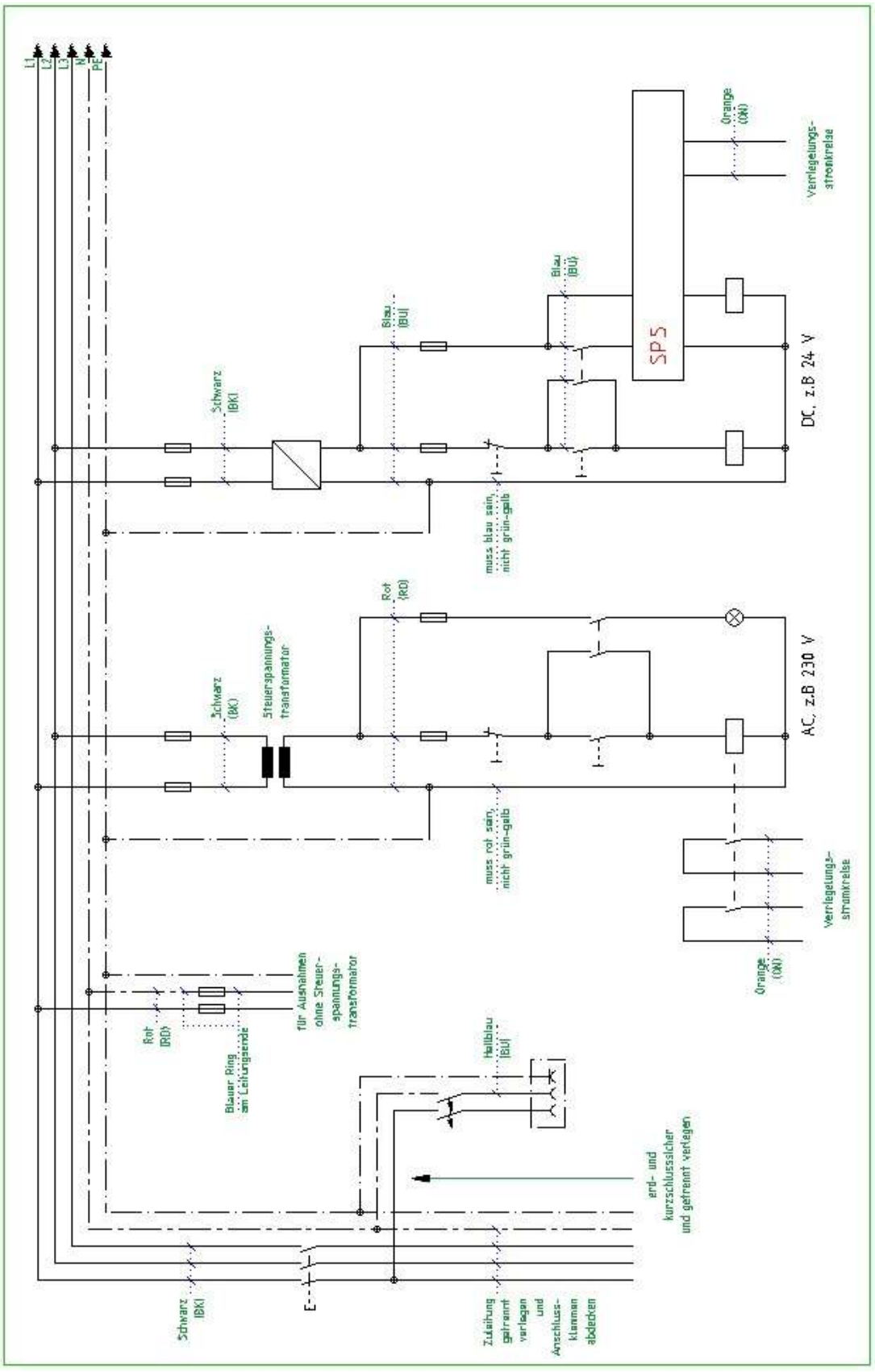
2.3.4.4 Circuits before the main switch

Circuits that are connected before the main switch (i.e. are live when the main switch is switched off) constitute a potential hazard. For spatial separation and identification, the entire length of conductors with a voltage greater than **50 V AC or DC** must be placed in a dark yellow protective tube or spiral wrap, or installed as a dark yellow multi-core cable. Black is to be selected as the default conductor colour. This also applies to routing within wiring ducts. Single conductors connected before the main switch must be short-circuit-proof.

2.3.5 Edge protection

To protect insulated cables and conductors, edge protection must be provided in the vicinity of metal edges.

Example: Wiring colours



Legend:

DE	**EN**
Schwarz	Black
Zuleitung getrennt verlegen und Anschlussklemmen abdecken	Route supply line separately and cover connection terminals
erd- und kurzschlusssicher und getrennt verlegen	Route separately and in a short-circuit proof and earth fault proof manner
Rot	Red
Blauer Ring am Leitungsende	Blue ring on the end of the conductor
für Ausnahmen ohne Steuerspannungstansformator	for exceptions without control voltage transformer
Hellblau	Light blue
Orange	Orange
Verriegelungsstromkreise	Interlocking circuits
muss rot sein, nicht grün-gelb	Must be red, not green/yellow
Steuerspannungstransformator	Control voltage transformer
muss blau sein, nicht grün-gelb	Must be blue, not green/yellow
Blau	Blue
AC, z.B 230 V	AC, e.g. 230 V
SPS	PLC
DC, z.B 24 V	DC, e.g. 24 V

3 Machinery and equipment installation

3.1 General

3.1.1 Protection class of components

All electrical equipment and field devices must have at least IP54 protection.

3.1.2 Direct interconnections

Direct interconnections between field devices are not allowed; circuit connections must be made in the switch cabinet or in terminal boxes.

3.1.3 Connections in ducts/pipes

Terminals are not allowed inside cable and wiring ducts or pipes.

3.1.4 Switchboard containers and control rooms

When installing switchboard containers and control rooms, anchorage points shall be provided on the roof for fall protection during maintenance work.

3.2 Installation of electrical equipment

3.2.1 Accessibility

All devices such as motors, brakes, couplings, solenoids, sensors must be installed in such a way that they can be inspected and serviced without obstruction.

3.2.2 Proximity switches

As standard, rectangular proximity sensors are to be mounted using the mounting brackets provided by us. The details are to be agreed with our planning electrical department in good time.

3.2.3 Function marks and name plates

Function marks (direction of rotation arrow, OPEN/CLOSED etc.), name plates of motors etc., must be recognisable and readable without removing coverings.
If this is not possible, a duplicate of the information must be affixed so that this requirement is met.

3.2.4 Vibration measurements on motors

For motors of frame size 250 and up, verification of conformity with the vibration values must be carried out and documented after commissioning. Limit values and further details according to delivery specification part C) Mechanics, proactive maintenance. Any necessary rework shall be at the contractor's expense.

3.3 Cable routes

3.3.1 Cable racks and trays

Cable racks and trays are to be designed according to the load, but must be at least the medium-duty type with perforation (1.5 mm material thickness).
If more than 3 cables are required, cable racks or installation trays with removable cover (with rotating clip lock) are to be installed.

3.3.2 Fastening of cable routes

Fastening to masonry using bolt guns is not permitted.
Fastenings to existing steel structures on site may only be carried out by clamping or welding (obtain permission). Drilling or gluing is not allowed. For welding work an appropriate welding certificate must be presented; the execution must be coordinated with our welding experts.
Cable racks are to be fastened on one side at intervals of 1.5 m by means of wall brackets, ceiling supports/hangers or similar. Temporarily attached wire fastenings and supports are to be removed once installation is complete. The fastening material must have two coats of primer or a galvanic coating. After installation, a finish coat is to be applied.

3.3.3 Occupancy of cable routes

Cable racks and trays may only be up to 50% occupied (spare space). The temporary fixing of the cables by means of cable ties is to be removed once installation is complete.
The wiring is to be laid in an orderly manner on racks or similar, but without fastening.
If single-core cables are used, our planning electrical department must be consulted.

3.3.4 Chemically aggressive ambient conditions

Stainless steel installation materials must be used in acidic/alkaline areas.
Plastic pipes or ducts including such fastenings are not allowed.

3.3.5 Vertical cable ladders

Cables and wires on vertical cable ladders must be fastened using clamps and counter-troughs (shells). Tying (e.g. using plastic straps) is not allowed. Ensure suitable rung spacing in accordance with VDE 0289-300.

3.3.6 Steel pipes

Type: Galvanised protective pipes in open armoured steel installation
Grommets must be provided at the ends of the steel pipes. The pipe diameter should be chosen so that there is at least 30% spare space.
Elbows and T-pieces must not be used.
Fastening must be done by means of metal clamps (because of inclusion in the equipotential bonding) at the pipe ends with a maximum fastening interval of 1.5 m.
Cut-out sections in pipes to lead out wires are not allowed.
After approx. 9 m, a possibility for pulling in the cables must be provided.

3.3.7 Wall and floor feed-throughs

Floor feed-throughs must be executed with protective steel pipes (D = 1.5 x cable diameter), or protective covers made of sheet steel must be installed. Height of protection up to 1.5 m above floor
Cable feed-throughs through walls and ceilings without fire protection requirements must be sealed with non-combustible materials (VdS guideline).

3.3.8 Cable protection conduits

Only protective conduits made of plastic may be used instead of pipes to protect moving cables and for fixed installation in difficult locations. Metal reinforcements or inserts in the conduits are not allowed.
The ends of the conduits must be reliably fastened and closed using suitable fittings that prevent the ingress of liquids or foreign bodies.

3.3.9 Cable drag chains and cable hangers

There must be a separate guide chamber for each individual cable or multiple cables in one chamber must be separated by dividers. If the chambers are vertically above one another, the cables between the dividers must not touch each other. If the cable length before or after the drag chain and connection point is more than 3 m, an intermediate terminal box must be installed in each case. Exception: Profibus cables; these must be executed as trailable cables over the entire length (without interruption).
When installing cable hangers, the cable manufacturer's instructions must be followed. Electric cables must not be tied to hydraulic hoses.

3.3.10 Cable feed-throughs, edge protection

Cable routes or machine parts must be provided with edge protection so that the cables are reliably protected against damage.

3.3.11 Maintenance openings on machine parts

Openings, e.g. commutator covers or for sensor adjustments, must not be restricted by cable routes.

3.4 Switch cabinets, distribution boards, terminal boxes

3.4.1 Switch cabinet fastening, installation

Switch cabinets shall be fixed to the floor at their place of installation by means of base frames or bases. Where equipment parts are not fixed directly to the floor, a distance of at least 200 mm from the floor must be maintained for cleaning work.

3.4.2 Terminal boxes

Terminal boxes are to be used when
- cables are branched
- a transition between different conductor types is required (e.g. solid to flexible)
- parts of the cable that are subject to high wear and tear have to be replaced more often and replacement of the entire cable length is too costly.

Specifications for the arrangement
- Easy accessibility must be guaranteed
- If possible, outside of safety areas
- Opening in a vertical plane
- Opening must be possible without dismantling other machine parts
- Bottom edge at least 400 mm,
- Top edge not more than 2000 mm above access level

3.5 Cables, wires and installation

3.5.1 Approved cable and wire types

3.5.1.1 Cables for 400 V AC power circuits, cross-section at least 1.5 mm². For cable lengths greater than 80 m, a minimum conductor cross-section of 2.5 mm² shall be used.

Fixed installation:
- NYY, NYCY, NYCWY in industrial areas and machine installations
- H07 cable and cable according to VDE with rated voltage U0/U = 600/1000 V
- NYM in office areas

Flexible installation:
- HO7RN-F
  Highly flexible cables according to VDE, rated voltage U0/U = 600/1000 V
- Motor supply cables for frequency converter drives EMC-suitable connecting cable in accordance with section 3.5.6

3.5.1.2 Control circuits for control voltages 24 V DC and 230 V AC:

- H05VV-F and cable according to VDE

3.5.1.3 The following cables are not permitted

- H05 ... for power circuits (see above)
- H03 …
- single-core cables laid in pipe

3.5.1.4 Environmental conditions

Cable/wire types must be selected according to the environmental influences. (Acids, alkalis, oil, emulsion, UV exposure, temperature, etc.) For example, PUR-insulated cables should be used in an oil-laden environment. Special cases must be agreed with our planning electrical department.

3.5.1.5 Voltage levels in the cable

In each case only one voltage level may be carried in the same cable, with the exception of system cables.

3.5.2 Control cables

Control cables with more than 12 cores must have at least a 25% reserve. The ends of reserve cores must be either connected to earth on terminal blocks or isolated with end terminals in the cable connection compartment.

3.5.3 Shielding

At the cable ends, the shield must be short and placed in a shield connection clamp so as to make contact over a large surface area, and connected to the mounting surface.
Shields may only be set back a short distance from the connection terminals (no pigtails).

3.5.3.1 Analogue signal lines

Analogue signal lines generally have to be earthed at one end, usually on the switch cabinet or amplifier side. The opposite end must be carefully insulated.

3.5.3.2 PROFINET / PROFIBUS cables

The shields of bus cables are connected at both ends through the devices to the equipotential bonding. To avoid equipotential bonding currents via the shields (shield currents), a sufficiently dimensioned superfine stranded (low impedance) equipotential bonding wire should be installed parallel to the bus cable. The shield and the equipotential bonding wire must be connected so as to ensure proper contact at the switch cabinet entry and exit points.

3.5.4 Moving cables

Cables that are moved during operation must be designed to be highly flexible. Cables in drag chains must be trailable and have PUR insulation. Special cases must be agreed with our planning electrical department.

3.5.5 Profibus cables

With regard to EMC, attention must be paid to the maximum permissible cable length per segment as well as to the suitable selection of the transmission medium.

Plastic fibre optic cables are not permitted, copper cables only up to a segment length of max. 100 m;

All bus cables must be at least 1 metre long.

The minimum bending radii specified by the manufacturer must be observed.

Cables for functional equipotential bonding must be connected so as to make good contact over a large surface area.

Only one cable type may be used per segment.

If a trailable bus cable is required for a subsegment, the whole segment must be designed to be trailable.

3.5.6 AS-Interface bus cables

Only the cable types specified in section 5. (Device selection) are permitted.

When installing single wires, ensure wires are routed in twisted pairs; ideally, the standard profiled cable should be used.

Without measures to increase the range, the cable length must not exceed 100 m.

All cable sections must be labelled, see cable designation.

All ASI bus devices must be labelled with address labels.

Only one type of cable is to be used in one segment.

For terminal connections, terminals must be used in which parallelism is maintained (e.g. two-tier terminals).

The ASI cable must be laid separately from power cables.

3.5.7 PROFINET cabling

Only cables certified for PROFINET are to be used in automation systems (manufacturer's specification). The cables used must be suitable for the FastConnect (FC) fast installation system.

The cable shields must be integrated into the earthing and equipotential bonding in a suitable manner, see also the notes in the installation guidelines (8071) of the PI user organisation.

Patch cables may only be used for structured cabling for connection to a socket or to a patch field. Plastic fibre optic cables are not permitted.

Test measurements must be carried out on the PROFINET cabling itself (without end devices) and documented. The measurements must be carried out with FLUKE measuring instruments (e.g. FLUKE DTX-1800 cable analyser) (cf. delivery specification B part 06 section 3). The measurement results must be provided as part of the documentation (see section 7.26).

The cable-specific NVP values required for the measurement of the installed PROFINET cables must be specified in the cable lists. The NVP value is absolutely required for later measurements of the Profinet cables.

(Nominal Velocity of Propagation: ratio of the signal speed on a line to the speed of light in a vacuum in percent).

3.5.8 Motor connection cables for frequency converter drives

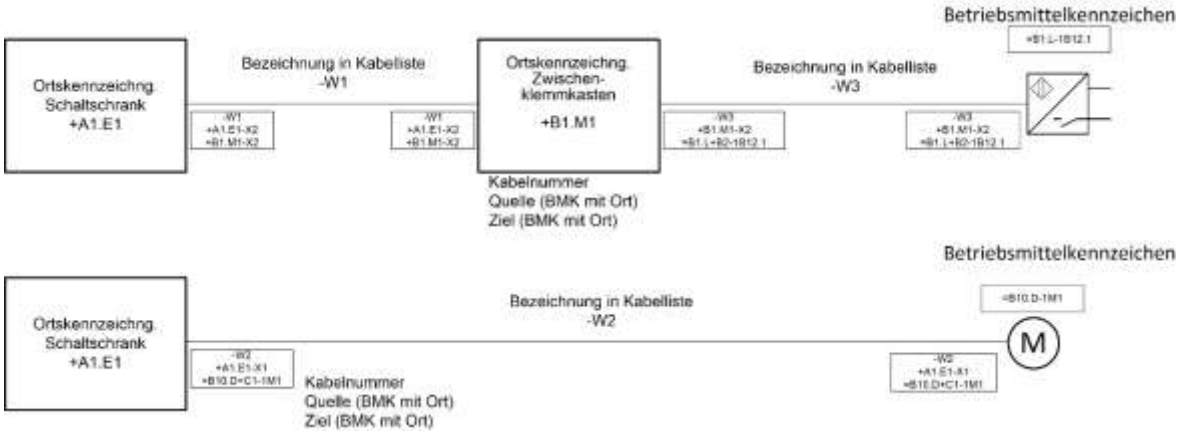
To reduce EMC interference levels, use EMC-suitable cables, i.e. low mutual capacitance and shield capacitance, low coupling impedance, greater (double) shielding and increased (at least 2-fold) dielectric strength. If possible, cables with symmetrical core structure should be used. Accordingly, in the case of large drives that are supplied via single cores connected in parallel, the cable routing and the RF-suitable protective earth or equipotential bonding conductors must also be executed symmetrically.

3.5.9 Cable and wire routing

Bus cables, signal and control cables and power/motor cables must be laid separately from each other with sufficient spacing to prevent inductive and capacitive coupling. Fibre optic cables must be laid separately from other cables (e.g. separate protective pipes) so that no mechanical damage/stress is caused by other cables.

3.5.10 Cable designation

Each cable must be labelled at the ends with the cable number and the designation of the source and destination respectively (see example below).
The labelling must be oil and UV resistant.
Standard version: engraved or lasered label
In acidic or alkaline environments, the material of the cable labels must be suitable for the environmental conditions.
Fastening: By means of S-hooks and UV-resistant, if necessary acid-resistant cable ties, lettering colour in consultation with our planning electrical department.
The above specifications also apply to fibre optic cables.



Legend:

DE	**EN**
Betriebsmittelkennzeichen	Device identifier
Ortskennzeichng.	Location designation
Schaltschrank	Switch cabinet
Bezeichnung in Kabelliste	Designation in cable list
Ortskennzeichng.	Location designation
Zwischenklemmkasten	Intermediate terminal box
Kabelnummer	Cable number
Quelle (BMK mit Ort)	Source (device identifier with location)
Ziel (BMK mit Ort)	Destination (device identifier with location)

3.6 Plug/socket combinations

Plug/socket combinations for different voltages, types of current or systems must be of a noninterchangeable design. Only 1 conductor may be connected to each pin of a plug/socket. Three-phase sockets must have a clockwise rotating field and, from 63 A, be provided with a built-in switch, with which the plug/socket combination is interlocked.

3.7 Connection of electrical equipment

3.7.1 Cable entry points (cable glands)

must always have strain relief (normal cable glands do not fulfil this requirement).
In metal enclosures they must in principle be made of metal (in exceptional cases, after consultation with our planning electrical department, alternatively plastic), in plastic enclosures they must be made of plastic.
Only 1 cable may be routed through each gland – except where multi-cable seals are used.
Shielded motor cables must be fed in at the motor terminal box with an EMC cable gland.

3.7.2 Entry openings

Unused cable entry openings or cable glands must be sealed.

3.7.3 Length of connecting cables

The length of connecting cables must be dimensioned in such a way that the devices can be replaced easily.
If there is more than 0.4 m of free cable length to the devices, the cable must be properly fastened.
For devices that are installed in containers, e.g. thermometers, level probes and suchlike, the connecting leads must be long enough to allow the device to be removed while connected. The excess cable length should be rolled up near the device and held together with cable ties.

3.7.4 Connection systems

The connection technology must be matched to the conductor cross-section, the type of conductor (fine-stranded, stranded, single-core) and the device's connection compartment. The ends of fine-stranded / stranded conductors must be terminated with gas-tight crimped wire end sleeves or cable lugs.

3.7.5 Protective earth connection for auxiliary voltages

In general, for devices supplied with auxiliary voltages (e.g. 24 V, 48 V, 60 V, 230 V), the protective earth conductor must also be connected. (Exceptions: SELV and PELV)

3.7.6 Equipment on rubber mountings

Equipment (e.g. motors) on rubber mountings must be connected via flexible cables or wires, if necessary via intermediate terminal boxes.

3.8 Designation of electrical equipment

Each electrical device must be labelled with the corresponding device identifier in a fixed position and on the cable. Bus components must also be marked with the bus address.

3.8.1 Identification plate

Standard version: Engraved/lasered metal tag or engraved plastic tag
The identification plate must be oil and UV resistant.
Lettering colour: black on light-coloured background
In acidic or alkaline environments, the material must be adapted to the environmental conditions.
The identification plate must be attached safely and reliably to the fixed machine part, in the immediate vicinity of the devices (not on the devices).

3.8.2 Inaccessible devices

For devices that are not directly accessible, the identification plate must also be affixed to the outside of the casing/enclosure.

3.9 Protective measures, protective equipotential bonding

3.9.1 Earthing; protective equipotential bonding

Attention must be paid to the EMC-compliant execution of the equipotential bonding.
All earthed points and components must be connected directly, with good conductivity, to the system's main earthing bar (star-topology earthing system).
All machine units that are connected to each other in a nonconductive manner must be earthed via equipotential bonding conductors or round conductors (steel, galvanised, 10 mm) in a star configuration to the main earthing bar via connection points that make contact over a large surface area. The looping through of earthing conductors via various machine units is prohibited.
The main equalisation conductors must be made of copper, min. 25 mm². For connecting field devices, the cross-section can be reasonably reduced, but must be at least 10 mm². By means of "additional protective equipotential bonding measures", external conductive parts must also be included in the equipotential bonding, e.g. safety fences at intervals of approx. 20 m. The contact resistance of the protective equipotential bonding must be verified at suitable points and documented.

3.9.2 Cable racks and pipes

Metallic cable racks, distribution boards, distribution boxes and cable protective pipes must be included in the protective measure.

3.9.3 Parasitic currents in motors:

No harmful stray currents shall arise via machine parts, e.g. shaft, bearings, gears etc. To this end, special attention must be paid to the EMC-compliant design of the equipotential bonding (RF-suitable connections) and motor cabling (symmetrical / low capacitance cabling).

We will check compliance with the limit values for larger machines by carrying out measurements. If the limit values are exceeded (e.g. bearing currents Iss > 0.35 A/mm²) then the supplier must take remedial action.

4 Project planning specifications

4.1 General

4.1.1 Approved devices

Only standard products of the electrical industry in accordance with our device approvals may be used. Devices not listed or deviations require consultation and our written confirmation.

4.1.2 Load on power feeds and load feeders

The operational load on power feeds and load feeders, i.e. transformers, power supplies, switchgear and power tracks, must not exceed 80% of the rated load of these devices.

4.1.3 Efficiency requirements for drive systems (PDS: Power Drive System)

When designing drive systems (motors, frequency converters), the efficiency requirements according to EU Regulations 640/2009 and amendment 2019/1781 must be observed, i.e.

- Induction motors with at least efficiency class IE3
- Frequency converters with at least efficiency class IE2

4.2 Power supply and energy application

4.2.1 Main power supplies

The power supply must in principle be designed as a TN-S system without an N conductor.
In the case of single wire installation, the PE conductor must also be laid in parallel. Timely consultation with our planning electrical department is required.
For the dimensioning of the line fuse on the feed cable, the specified short-circuit current rating of the supplied switchgear (main switch, busbars) is required.

4.2.1.1 Connected load less than 400 kVA

If the connected load of a system is less than 400 kVA, the power is fed directly via the 400 V mains. The supply limit is the input terminals of the main switch.

4.2.1.2 Connected load greater than 400 kVA

If the connected load of a system exceeds 400 kVA, it must be fed via a medium voltage transformer. The design of the transformer must at least conform to EU Regulation 548/2014. The dimensioning and the connection to our supply network (protection, remote control, evaluation etc.) must in each case be coordinated with our planning electrical department.
Supply limits: Primary terminals of the transformer
Scope of the electrical supplier: Transformer, transformer protection, remote control of the circuit breaker in our station, circuit diagrams.

Medium voltage transformer – technical characteristics

- Cast resin transformers
- “Reduced loss” type
- Ambient temperature max. 40 °C
- Temperature sensor for warning and switch-off
- Primary voltage: 10 kV or 20 kV ± 5%, 50 Hz
- Connection symbol: Dyn5 as standard
- Surge arrester primary side
- Surge arrester secondary side with connected current converter load
- Protection class IP23 (internal arc tested protective enclosure in accordance with IEC 62271-200
  with I = 16 kA / 1 s; IAC: FLR) or IP00 if installed in separate rooms
- Transformer coils: Copper conductor material, in fully encapsulated design
- Cable connection on primary and secondary side from below
- Primary side voltage display with integrated capacitive display system in accordance with IEC 61243-5
- Earthing switch, alternatively fixed earthing points:
  - Phase and earth: Ball stud diameter 25 mm

- Transport with forklift, i.e. U-shaped iron cores must be matched to the width of the forklift
- Castors with locking device
- Minimum transformer distance from wall or other transformer: 600 mm
- Doors with double bitted lock
- If installed in a workshop: Doors with cylinder lock, lock cylinder provided by us

4.2.2 Main switch

Main switches that serve as an EMERGENCY STOP device must have a red actuator and yellow background in accordance with EN 60204 (VDE 0113).
Main switches without an EMERGENCY STOP function only serve to isolate the mains (e.g. in subsystems) and should be coloured black or grey. In all cases, main switches must be lockable by means of several padlocks.
If the main switch is located in a locked switch room, it must be possible for the operating crew to switch it off via a remote release (undervoltage release) and switch it on via a motor drive. In addition, it must be possible to operate the main switch manually on site at the switch.
The remote release is carried out via a 25 A main switch, which must be equipped with a mechanical switch lock via padlocks. For the electrical function of this remote release, see section 4.7.6 – Definition of stop conditions for production systems.

4.2.3 Energy meters

Every production facility with a machine data collection device or connected load > 20 kW and its own main switch must be equipped with an energy meter (see 5. Device selection).

The energy meter must be supplied with power before the main switch.
Current transformers must always be connected via special test disconnect terminal blocks (see 5. Device selection), which enable short-circuiting of the transformer secondary side by a simple switching operation – example implementation measurement instrumentation.
The power terminals should generally be equipped with test jacks.

Electric heat consumers of 10,000 kWh/year or more must be recorded separately with their own officially certifiable energy meter.

The energy meter must be integrated into the plant automation via PROFINET. A data block for the energy data must be created in the PLC. The data block must contain at least the following information in this order:

- Total active power (data type “Real”, unit kW)
- Total reactive power (data type “Real”, unit kW)
- Total apparent power (data type “Real”, unit kVA)
- Total power factor (data type “Real”, no unit)
- Total energy (data type “LReal”, unit kWh)

4.2.4 Branches for battery chargers

According to VdS guidelines, supply branches for battery chargers must be protected with a residual current circuit breaker (R) with a maximum rated differential current of 0.3 A.

4.2.5 Power sockets for accessories and lighting

Power socket circuits for the connection of equipment such as power tools, measuring instruments, lights, etc. must be protected by an additional residual current device (RCD) type B, response value 30 mA.

4.3 Motor feeders for drives with constant speed (without current converter)

4.3.1 Direct switching on of three-phase motors

Three-phase motors up to the following values can be switched on directly:

Vöhringen plant:	200 kW
Ulm plant:	75 kW
Langenberg plant:	30 kW
Villingen plant:	22 kW

Beyond that, soft start devices are to be used in consultation with our planning electrical department.

4.3.2 Three-phase motor feeders

Motor feeders consist of motor protection switches with downstream power contactor. Motor protection relays are not accepted (exception: heavy starting).
For the dimensioning of motor feeders, the increased starting currents of IE3 and IE4 motors must be taken into account.
If the short-circuit breaking capacity of the motor protection switches is exceeded, line fuses must be installed; grouping is permitted.
Reversing contactor combinations must be protected via mutual interlocking contacts, especially also when controlled from a PLC!

4.3.3 Motor dimensioning

Drives must be optimally dimensioned according to the required power and ambient conditions. A reasonable standardisation of sizes as well as the use of special motors must be agreed with our planning electrical department.
For motors with belt output, from frame size 100 and up the bearing of the drive side must be designed for increased transverse forces, and a relubrication device must be fitted.
Braking operations by means of phase reversal are not permitted.

4.3.4 Temperature monitoring

For three-phase motors of 30 kW and up, a temperature monitoring system for warning and shutdown by means of PTC thermistors is required.

4.3.5 Repair switches

In systems where protection against unexpected start-up of individual drives cannot be reasonably implemented via the central main switch, repair switches (main switches) must be fitted on site in the main circuit in the power range up to 90 kW. The switches must be equipped with auxiliary switches to signal the switching position and be lockable via padlocks or keyswitches. The colour distinction between emergency stop and mains isolation must be observed.

4.4 Variable-speed drives

All variable-speed drives are to be implemented in AC technology as standard.
When planning the project, a 20% power reserve in respect of the maximum value and the sensible standardisation of device sizes must be taken into account.

4.4.1 Supply voltage for frequency converters

Frequency converters are to be designed for 400 V supply voltage.
The connection to the supply shall be made directly on the 400 V TN system.
For power > 100 kVA in the Ulm, Vöhringen plants
> 30 kVA in the Langenberg, Villingen plants
consultation with our planning electrical department is required.

4.4.2 Installation of frequency converters

Each infeed line module or frequency converter is connected to the mains via fuses, main contactor and commutating choke.
The installation/arrangement of the frequency converter / inverter modules in the switch cabinet must be carried out according to the sequence of the technological function.
Switching or protective devices may only be installed between the frequency converter and motor in special cases – consultation with our planning electrical department is required.
Motor cables are to be connected directly to the frequency converter / inverter output.
For main drives, multi-motor drives, positioning drives and drives with technological functions, frequency converters type Siemens Sinamics S120 series are to be used.
For auxiliary units, such as pumps, fans, etc., frequency converters with a lower (standard) range of functions can be used.
Where sensible, devices must be equipped with built-in energy-saving functions.
Decentralised drive concepts should generally be avoided.

4.4.3 Instrumentation of drives

Where several inverters have a common DC link busbar, the DC link voltage shall be displayed on a separate display instrument.
A standard operating device shall be used on each frequency converter or control unit of an inverter group.

4.4.4 Networking

Frequency converters shall be connected to a higher-level automation system via Profinet.
Where several frequency converters are used, it must be possible to operate them from a central location (configuration, programming, commissioning, service, data backup).

4.4.5 Project planning and configuration

If a higher-level Step7 or TIA project exists, all engineering data should be integrated into this project. All current converter devices shall be supplied with an MMC card to store the device parameters and software settings.

4.4.6 Power regeneration, DC link coupling

In order to exchange energy between individual drives, a DC link coupling between these drives shall be implemented wherever appropriate.
Chassis-type inverter modules must be coupled to the DC link via separately installed (external) fuse elements.
Power regeneration is only required if braking energy from the drive system occurs cyclically or frequently. For sporadic cases, the braking energy can be dissipated via braking resistors (e.g. for emergency stop).

4.4.7 Mains feedback / EMC

Mains feedback must be kept within compatibility limits according to EN 61800-3, 2nd environment, by means of standard EMC measures (basic disturbance suppression).
Suitable output and mains chokes, output filters and shielded motor cables are to be used based on the project planning documents.

4.4.8 Technological drive functions

According to the dynamic requirements and future expandability, technological functions, e.g. master setpoint formation, diameter calculator, synchronisation controls, compensation of disturbance variables, etc., are to be implemented in the higher-level automation or as drive-related control tasks in the drive CU as a DCC or Simotion solution. Only so many objects may be processed in the individual drive CUs that the sampling times set in the plant do not have to be reduced. The standard modules that are available ready from Siemens should preferably be used. Know-how-protected function blocks are not permitted.
The use of a SIMOTION P system is not permitted.
Details of execution are to be agreed with our planning electrical department.

4.4.9 Three-phase motors

Where three-phase standard motors are used, at least efficiency class IE3 must be provided. For motors with belt output, from frame size 100 and up a drive-side bearing for increased transverse forces, and a relubrication device, must be provided.

Insulated bearings:	Servo motors	from frame size 180 and up
	Standard motors	from frame size 225 and up

All motors operated on frequency converters must be equipped with winding temperature monitoring by KTY or Pt1000 (corresponding evaluation in the frequency converter). In the case of a group feed for several motors, the temperature monitoring shall be carried out via the system controller. Unless specified otherwise, the air direction on the motor is from the non drive side (fan side, non drive end (NDE)) to the drive side (shaft side, drive end (DE)). For forced-ventilated motors, air filters shall be provided whenever possible.

4.5 Supply of auxiliary voltages

4.5.1 Auxiliary voltages

Auxiliary voltages shall be generated by transformers with separate windings. Primary side connection: 400 V AC
The transformers must be protected against short circuit and overload. The transformers must be provided with taps that allow the secondary voltage to be changed by ± 5%. Voltmeters must be installed for supply powers > 1 kVA.
If there are several control transformers within a system, the AC voltages must be in phase on the secondary side.

4.5.1.1 Power supplies

The output voltage of power supply units must generally be monitored.
This can be done either via the built-in device circuit breaker or by external monitoring. The input and output side of power supply units must be galvanically isolated (potential-free) according to VDE.
In addition, the devices must have a short-term buffer capability or 1-phase failure safety.

4.5.1.2 PLC power supply

The power for the power supply module is tapped off before the main switch via a separate transformer or supplied by a separate UPS.
The cables tapped before the main switch must be installed in accordance with the requirements for excluded circuits, i.e. spatial and colour separation, covering and labelling of live parts.
Exceptions must be agreed with our planning electrical department.

4.5.2 Control voltages

The following control voltages are to be used:

24 V, DC:	PLC inputs/outputs; power contactors controlled directly from PLC; system peripherals, valves, brakes, clutches and cross-connections between systems (or system parts) with their own main switch
24 V, AC:	Permitted only in exceptional cases and after prior consultation with our planning electrical department.

Parallel connection of solenoid coils is not permitted. If several solenoid coils are switched by the same function, each coil must be controlled by its own contact or separate PLC output (exception: safety-related circuits).

4.5.3 Fuses

The connected loads must be divided into sensibly subdivided circuits. A circuit breaker shall be provided for each circuit, which is monitored via signal contacts.
The supply for PLC input modules and 0.5 A output modules should be divided up according to the mounting location, wherever possible.
For 2 A output modules, a maximum of 32 outputs may be combined into one circuit.
Where power is supplied via switched-mode power supplies, it must be ensured that the protective circuit breaker switches off reliably and selectively (electronic circuit breaker).

4.5.4 Earthing of control voltages

All control and auxiliary supply voltages must be earthed on one side (protection in the event of a fault). The earthing must be executed detachably and clearly visibly with a green/yellow wire colour:

- for AC voltage directly on the transformer
- for DC voltage directly at the rectifier / power supply unit output.

In complex signal processing systems, in which the reference potentials of various supply systems are routed in isolation and connected together in a star configuration at a central point, this star point must be clearly visibly connected to the common earth. The earthing must be documented in the circuit diagrams.

4.6 Control functions

The following control functions must in principle be implemented with contact components (contactors, relays).

4.6.1 Controller on/off

Switching on or off is performed at the main control panel or switch-on point for central equipment by means of pushbuttons or keyswitches. The detailed design shall be specified in the individual case by our planning electrical department. Switching off the controller must not result in an operating state in which persons or system components are endangered.

4.6.2 Control of system functions

Limit switches must not be connected in series.
All actuators in the system (motors, valves, solenoids, etc.) must be capable of being operated individually in manual mode. Manual and jog functions must be performed via discrete control elements or via a screen in combination with discrete control elements.

4.6.3 Control of electrically operated safety doors

The control system and design must conform to current guidelines for power-operated liftable gates, e.g. safety switch strips, automatic reversing, overtravel protection, etc.
The control system is to be provided by the supplier of the safety door.

4.7 Safety equipment and controllers

4.7.1 Operator control of safety functions

The requirements and specifications in accordance with EN 60204 part 1 and DIN EN 13850 apply in full. The operating devices for emergency stop (category 0 or category 1) must be force opening (closed-circuit current principle) and of self-monitoring design.
The concept for emergency stop (category 0 or category 1) and the form of emergency shutdown (stop category 0 or 1) must be the result of a risk assessment.

To avoid the risk of confusion, only one control element for an emergency (red/yellow marking) may be located at an operating point (in one operating area). Several control elements for an emergency, even if they have different effects, are not permitted at one location. If a main switch is used for the emergency stop function, this must also be marked red/yellow. In all other cases, the main switch is considered to be the mains disconnection device, in black or grey colouring.

4.7.2 Control and switching devices

Control of safety functions must be implemented via a safety PLC (failsafe CPU). If the safety program (failsafe program) is password-protected, this password (safety password) is part of the documentation (see 7.11.7) and must also be supplied by the supplier.
Safety relays can be used for smaller scopes of application.
Where safety scanners, safety light curtains, safety light barriers etc. are used, evidence must be provided showing how the clearance distances have been calculated.

4.7.3 Safety interlock switches

Normally, safety interlock switches must be designed so that they are open when de-energised. Exceptional cases, such as coasting axes, which based on the risk analysis require a guard locking device in the de-energised state, must be coordinated with our planning electrical department.

4.7.4 Safety functions for controlled drives

The safety functions (e.g. Sinamics Safety Integrated) available in the frequency converter are to be used as far as possible. If safety-related settings or program parts are password-protected, this password is part of the documentation (see 7.11.7) and must also be supplied by the supplier.

4.7.5 Device selection for safety functions according to EN ISO 13849-1

Taking EN ISO 13849-1 into account, it must be ensured when selecting components that the determination of the service life TM and operating time T10d results in a value of at least 20 years (operation 365 days/year and 24 h/day). Deviating cases must be coordinated with our planning electrical department.

4.7.6 STOP conditions table

4.7.6 Definition of STOP conditions on production facilities (does not apply to casting and smelting furnaces)

No.	Description Function	Trigger by	Trigger Actuating element	Trigger Location	Possible causes	Functional sequence	Remarks
1	Operating stop (for movements) Operating stop (other functions)	Manual	Red pushbutton	Control panels, local control units	-----	- Drive controls guided by master setpoint - Deceleration ramp selected so that all operating values such as speeds, tensions, etc. remain within tolerances - Stop category 2	
		Automatic	From system controller	-----	e.g. Strip end Strip length reached		
2	Fast stop .. for systems with controlled drives for material transportation	Manual	Yellow mushroom button	Control panels, local control units	e.g. Loading operations Slight production disturbances	- Drive controls guided by master setpoint - Deceleration ramp shortened Tolerances can be exceeded, material breakage must not occur - Other system functions unaffected - Stop category 2	
		Automatic	From system controller or auxiliary unit (e.g. material testing)	-----	e.g. Material tolerance exceeded, Component defect after reaction time has elapsed		
3	Emergency stop .. for systems with controlled drives	Manual	Red mushroom button, with yellow background, latching, not lockable Safety devices, Monitoring limit switches, Emergency trip wires, Footswitches	Control panels, local control units Local control units, machine	- Serious production faults - Danger to people or equipment	Drive controls with fastest possible ramp (internal) brought to a standstill e.g. Braking at current limit, resistance braking, mechanical brakes on After standstill or braking time exceeded Feed switch before current converter off - Hydraulic/pneumatic movements or technological drives off immediately - Switch off three-phase main drives - Switch off all supply voltages for contactor coils and PLC outputs where necessary for safety reasons. - Stop category 1	Any required emergency supplies following consultation. After the fault has been rectified, it must be possible to restart the system in the normal way.
		Automatic	Safety conditions, process monitoring devices		e.g. Electric component defect, Motor protection switch tripped Fuses blown, Overspeed, Hydraulics failed		
4.1	Emergency stop main switch	Manual	Main switch, red handle, yellow background, multiple lockable Red mushroom button, with yellow background, latching	Switch cabinet Distribution station	Danger to people or equipment. Escaping media, electrical dangers, etc.	Switch off electrical power supply in case of emergency. All power supplies off (CPU supply after consultation) All media supplies off - Stop category 0	
4.2	Emergency stop .. if emergency stop point 3 does not apply, e.g. independent thermotechnical systems	Manual	Red mushroom button, with yellow background, latching, not lockable	Control panels, local control units	Safety switch for machine repair or fault	Switch off electrical power supply - All power supplies off (CPU supply after consultation) - All media supplies off - Stop category 0	Any required emergency supplies following consultation.
4.3	Main switch for mains isolation (in addition to 3. and 4.2)	Manual	Main switch black actuator, grey or black background, multiple lockable	Switch cabinet supply	Required for maintenance work and operational shutdown	Isolation of all downstream electrical equipment from the mains when the system is at a standstill Stop category 0	The system must have been shut down beforehand via other measures, operating stop, fast stop, emergency stop
5	Fire (machine, mechanical basement)	Manual	Pushbutton	Control panels	Fire	- Fast stop point 2 then emergency stop point 4.2	
		Automatic	Automatic fire alarm	Local			

4.8 Programmable logic controllers

4.8.1 Automation devices

- For standardisation reasons, consultation with our planning electrical department is required for the hardware specification. The racks must have a 30% slot reserve.
- The I/Os are preferably to be designed as decentralised peripherals
  Approx. 20% of the equipped I/Os must be removable (per station)
  Approx. 10% of the I/Os used are equipped, wired and labelled as a reserve.
- After saving the application program in the corresponding memory module, approx. 50% reserve must still be available.
- An Ethernet connection possibility (company network) must be provided.
- For security reasons, there is a network separation between plant networks (Fieldbus level) and our company network. If a CPU cannot provide this network separation by itself, the PLC may only be connected to the company network via an additional Ethernet CP.
- For security reasons, web server functionalities of the S7 controller must not be used for productive plant functionalities (e.g. HMI replacement for plant operation). By default, the web server must be switched off.
- Technology modules must be coordinated with our planning electrical department.
- The shield support elements and shield termination elements are to be used on the analogue modules.
- The frame of the automation devices must be earthed with at least 10 mm² Cu conductor.

4.8.2 Software development

4.8.2.1 Engineering software

The version of the engineering software used must be agreed with us before the software development begins (preferably the latest version).

4.8.2.2 IT security

Case 1: Permanently installed computer
Hardware and software must be agreed with Wieland. After activation of access to our plant Ethernet, the anti-virus software is installed and updated via the plant network.

Case 2: Temporary programming device and removable storage device
All external devices must be checked by Wieland to ensure that they are free of viruses before they are connected to our plant Ethernet.

4.8.2.3 Specifications for programming

- Logic and bit processing: in Function Block Diagram (FBD)
  Computation function: in FBD or Statement List (STL), Structured Control Language (SCL) only after prior consultation with our planning electrical department
- Clear program structure by means of structured programming, analogous to the structure of the circuit diagrams. The structural program design must be submitted to Wieland for approval at the start of project planning.
- All program comments must be in German.
- Digital outputs and flags may only be set at one point within the application program.
- All inputs, outputs, flags, etc. must be documented in the symbol table.
- For step-by-step control sequences, the program must be programmed as a sequential control in Graph 7. All steps must be monitored with optimised runtime supervision. In the event of a fault

in the step chain, the sequence must stop and a clear message and transition condition (clear reference to peripherals) must be generated in the human-machine interface (HMI).

- Missing conditions for starting automatic operation must be displayed in the HMI. The step chain sequence must be displayed.

- Operating modes are:
  - Setup/emergency operation – manual – automatic
  - Automatic stop-start
  - Starting position 0 - start

- Referencing position-controlled axes (preset)
  For referencing the axes, the machine supplier applies markings to the moving and fixed parts of the machine which are designed for positioning accuracy and a corresponding reproducibility (notches, punch mark, scribe lines, arrows, plates, etc.)

  The preset function of the absolute encoders must only be accessible via access authorisation (e.g. card reader). Operating functions must be provided in the system HMI:
  - Axis selection
  - Select “Operation – Service”
  - Encoder “Preset”

- Program parts that are not required must be removed.

- Software protection (know-how protect) is not permitted.

- No conflicts may occur during the component consistency check.

4.8.2.4 Module designation

Designation of each module by the module title. The function of the module and the meaning of the input/output parameters must be described in the module comment field. Documentation of all networks by the network heading and possibly the network comment.

4.8.2.5 Designation of signals and variables

All inputs and outputs are to be documented with a cross-reference to the circuit diagram. Strict attention must be paid to text consistency with the circuit diagrams.
Flags, counters, times, modules are to be named and commented unambiguously and consistently throughout.
The verbal designation in the comment must refer to the Logic 1 signal.
The “Programming style guide for S7-1200/S7-1500” from Siemens must be used.

For examples see sections 7.21.5 and 7.21.6.

4.8.2.6 Description of data blocks

For data blocks, the individual data words and bits must be documented by means of line comments.

4.8.2.7 Standard FBs/FCs

If standard function blocks (FBs) / functions (FCs) are used, detailed documentation must be provided. In the case of self-developed FBs/FCs, the function must be described in the comment field and each STL program line must be commented.

4.8.2.8 Miscellaneous – STEP7

The load/transfer commands with data must always be executed with completely addressed access:
Example: L DB1.DBB 8

- Each STL line must be commented
- No jumps across network boundaries are allowed
- Local data may only be symbolically addressed.

4.8.2.9 CFC and SFC programs

- The program must be configured with block width “wide”.

- Cross-references to the circuit diagrams must be indicated at the I/O interfaces (output to ET-200 or via special connectors of interface cards) of the CFC program; including device identifier.
- Block connections must be commented.
- Clear, unique, comprehensible and consistent signal designations must be used on the CFC blocks (e.g.: coil car south forwards, swivel on coil opener, swivel down folding table, folding table swivelled down). In this way, the respective function can be seen within a plan page and also on the edge bar. The signal designations must match in the CFC program and in the circuit diagrams.
- The correct chronological sequence of the blocks must be observed.
- When using virtual connections, the name must be identical on the sender and receiver side. The name must clearly indicate the sender and receiver.
- If a cross-reference to the hardware is not possible when using SFC step chains, a reference must be provided in the CFC plan stating the plan name, block and connection.
- The CFC program must be commented throughout (stating the functions realised in the plan, specification of normalisations, commenting of plan containers, information on recipients of broadcast / all telegrams).

  Commenting of CFC plans by means of a table of contents:
  - On subplan A1: Brief description of the plan content (function)
  - On subplan A6: Description of the subplans

  “Plan-in-plan” CFC plans must also be commented (overall function, contents of the subplans, input/outputs, …)

- Execution of a cross-system interface (e.g. FM458 ↔ S7):
  Data exchange via data blocks, S7 side with standard FB
  The coupling partner should be identifiable from the telegram name, e.g. “AB1S7S.70” means: AB1 → decoiler 1; S7S → send to S7 (E for receive); 70 →record no.
  (Parameters on the S7 receive module);

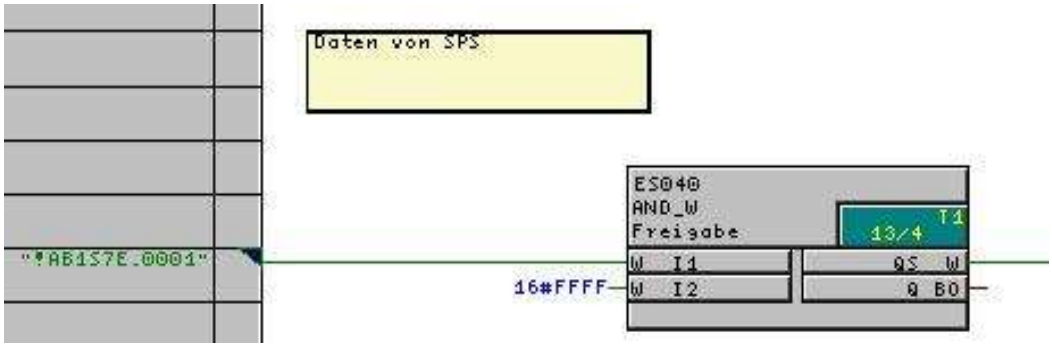
Legend:

DE	**EN**
Abhaspel 1	Decoiler 1
S7-Empfangs DB	S7 receiving DB
Sendebaustein P	Sending module P
GV CTS	GV CTS
S AT	S AT
S MOD	S MOD
BO EN	BO EN
CRT GV	CRT GV
QTS BO	QTS BO
YEV W	YEV W
YTS W	YTS W

The individual words of a record set are to be numbered consecutively; this address is to be entered in the DB as a symbol.

E.g. 1AB1S7E.0001 means: Coupling partner Decoiler1 from S7 receive (in the FM)
the first word

CFC:



Legend:

DE	**EN**
Daten von SPS	Data from PLC
Freigabe	Enable

Coupling data block: The “Send_” part here refers to the point of view of the S7.

+28.0	Empf_AB1S7S_0008	REAL	0.000000e+0	
+32.0	Empf_AB1S7S_0009	REAL	0.000000e+0	
+36.0	Send_AB1S7E_0000	WORD	W#16#0	Steuerbit
+38.0	Send_AB1S7E_0001	WORD	W#16#0	Steuerbit
+40.0	Send_AB1S7E_0002	REAL	0.000000e+0	Durchmesser Setzwert
+44.0	Send_AB1S7E_0003	REAL	0.000000e+0	Bandbreite [mm]
+48.0	Send_AB1S7E_0004	REAL	0.000000e+0	Zugsollwert [N]

Legend:

DE	**EN**
Steuerbit	Control bit
Durchmesser Setzwert	Diameter set value
Bandbreite [mm]	Strip width [mm]
Zugsollwert [N]	Tension setpoint [N]

4.8.2.10 Device name hardware configuration – STEP7

The device name in the hardware configuration must contain the device identifier from the circuit diagram and have the following structure:

Device identifier-device number-device type-[other-…], e.g.

D3S1B1-63-TrCEV65m-encoder-decoiler-pressure roller-coil diameter

B12A1A1-2-HMI-exit-control panel

Only the hyphen is used as a special character. Except for the use of lower case letters, this also complies with the naming convention for PROFINET.

4.9 Systems for recording and controlling process variables (except PLCs)

Electronic systems shall be selected in consultation with our planning electrical department.

4.9.1 Measured variable acquisition, analogue

Actual value signals of physical variables (temperature, pressure, etc.) with very low potential are to be converted into a standard signal via signal converters: 4…20 mA (preferred), 0…20 mA, 0...10 V. Measurement circuits with impressed current must be ungrounded and provided with disconnect

terminals.
The signal converters must be installed as close as possible to the measuring point.

4.9.2 Multiple assignment of measurement signals

If the measurement signal from one sensor is connected to multiple devices, signal distributor modules must be used for this purpose. In the case of pulse generators, corresponding pulse distributor modules must be used.

4.9.3 Actual value acquisition, sampling times

The sampling rates for the actual value sensors, the transmitting bus systems and in the automation system must be configured and set in such a way that no corruption of the measured value or control quality in the automation system results. If necessary, suitable signal processing, e.g. actual value smoothing, linearisation, etc., shall be provided.

4.10 Messaging system

4.10.1 General

The messages for operating states and malfunctions must be uniform in presentation and mode of operation.
If an HMI system is used, the messages (fault messages, warnings) must be marked as received, gone and acknowledged, and assigned to areas. The messages shall be selectively stored in a message archive (e.g. error messages, warnings, danger messages, step chains, etc.) The message archive can be evaluated via filters / sorting criteria.
The layout of message lines shall be defined in consultation with our planning electrical department.

4.10.2 Operating messages, operator diagnostics

Operating messages show the operator system statuses that can assume several states during operation, and which influence the operational readiness of the system (e.g. safety guard closed, temperature, pressure of a medium reached).

All statuses must be displayed which
- are a precondition for subsequent operating steps,
- occur due to a manual control command and cannot be clearly determined by the corresponding switch position (e.g. pushbutton function with memory).

4.10.2.1 Display of operating messages

The following control functions must be checked for missing or incorrect switching/operating actions and execution conditions:
- Ready for operation entire plant / part of the plant
- Startup of the respective plant section
- Movement sequences (semi-automatic operations)
- Limit values overrun/underrun

Operating messages must always be displayed in plain text and should define the reported status as clearly as possible (e.g. rinsing water temperature reached). When the reported status is reached or left, the message must cancel itself without acknowledgement.

4.10.2.2 Pivot switches / indicator lamps

Pivot switches that trigger a stored switching state must be equipped with indicator lamps to indicate the operating state (flashing light, continuous light).

4.10.3 Fault messages

Taking the following conditions into account, the following trigger events must be reported:
- Tripping of all automatic circuit breakers, motor protection switches and fuse monitoring devices.
- Faults in power supply devices, where these are equipped with corresponding monitoring and messaging devices.

- EMERGENCY STOP triggering, differentiated according to tripping by equipment malfunction or manually. If triggering is possible from different control points, the triggering control point shall also be indicated.
- Monitored safety devices must be reported individually.
- Triggering of all limit values and monitoring devices.
- Detection of abnormal conditions, (e.g. “SLIDE VALVE OPEN and CLOSED” actuated simultaneously).
- All faults from current converter devices as individual messages in plain text or as output fault message number from the device.
- All faults from encoders and sensors, if available.
- For bus systems (Profibus, Profinet, AS-Interface), bus faults and failures must be signalled.

4.10.3.1 Display of fault messages

Fault messages must be displayed in plain text. Non-relevant fault messages that occur e.g. when switching on and off and when the system is switched off (message shower) must be suppressed. Every individual message must be displayed on the screen. The messages must contain the following detailed information:
Message text, message type, plant section, device identifier, cross-reference to the program (e.g. flags).
Messages may be cleared (deleted) from the display once the cause has been eliminated and after subsequent acknowledgement. Generally, warning messages do not cause a system standstill; if operation continues the warning leads to a fault and to a shutdown.

4.10.3.2 Danger signals audible/visual

If attention is to be drawn to a hazard state or system state at a greater distance, appropriate audible and/or visual signals shall be used:

- Audible e.g. horns, bells, to avoid confusion with other higher-level Wieland internal signals, may only emit continuous signals; acoustic interval signals are not permitted.
- Visual e.g. flashing or strobe light, lamps, rotating beacons. The identification colours and markings in accordance with EN 60204, Part 1 shall be used.

4.10.3.3 Audible collective alarm

An audible collective alarm for system malfunctions shall only be provided by order of our planning electrical department. In this case, it must be possible to cancel the acoustic signal with the manual command “horn off”. Further incoming messages must trigger the acoustic signal again.
The use of electronic or motor sirens is generally prohibited, as these may only be used to alert our workforce in the event of a disaster.

4.10.3.4 Fault value processing

- After the elimination of a fault that has caused a system shutdown, the system must not restart automatically.

- A fault message must remain in effect even after the fault has been eliminated, until it is cleared by an “ACKNOWLEDGE FAULT” command.

Depending on the severity of the fault, actions are to be evaluated and triggered in the controller, such as

- Signalling only
- Preventing restarting (after completion of a work step)
- Triggering normal stop, fast stop or emergency stop

4.11 System visualisation

Following consultation with our planning electrical department, one of the display types listed below or a combination of them is to be implemented.

4.11.1 Individual indicator

Colour of indicator lamps for fault and operation indication in accordance with EN 60204-1 and EN 61310

Brief summary:

RED:	Danger or alarm (fault indications, command to stop machine immediately, ...)
YELLOW:	Caution (advance warning, permissible overloads, ...)
GREEN:	Safety (status indication, enabling, ...)
BLUE:	Special meaning (indication for remote control, ...)
WHITE:	General information (main switch on, direction of rotation selected, ...)

A lamp testing system must be installed for all fault and operation indicator lamps.
A separate lamp testing system must be provided for each control panel.
All indicator lamps shall be LEDs.
If more than 5 fault and operation indicator lamps are needed at one location, an LED fault indicator panel must be used. The above colour coding must be observed as far as possible.

4.11.2 System signal lamp

A multicoloured system signal lamp must be provided for each system/subsystem. The functions shall be determined in consultation with our planning electrical department, e.g.

- Fault incoming/acknowledged
- Production operation ready/running
- Material request, etc.

4.11.3 Visualisation with SIMATIC HMI operating devices (panels)

The use of a panel must be agreed in advance with our planning electrical department.
Preferably, Unified Comfort Panels from Siemens must be used.

4.11.3.1 Software

SIMATIC WinCC (TIA Portal) must be used for project planning.
Software protection (know-how protect) is not permitted.

4.11.3.2 Project planning

The concept for the picture tree and picture layout must be submitted to our planning electrical department for approval, further specifications according to 4.11.5 Representations in HMI systems.

All system pictures must be integrated. The function keys they contain must be provided with descriptions in the help text.

All data in the data block must be provided with comments.

The password list must be documented separately, so that the passwords can be entered again after reloading (hard reset).

A user logout via “logout time” (automatic) and “logout dialogue” (manual) must always be configured.

At least the indicator must be activated for the initial value detection of error messages.

A message archive must be created. In the message structure, the second line contains the device identifier or the message bit.

The date and time setting for the panel must be password-protected and it must be possible to set the date and time without leaving the runtime.

A manual must be created with the configured pictures; the manual must contain and describe the operating and fault messages.

4.11.4 Visualisation with WinCC

4.11.4.1 System software

The versions for the operating system, WinCC Basic package and the WinCC web navigator must be agreed with our planning electrical department. For expansions, approx. 30% license reserve (number of external variables) must be provided.
If other software packages are required for the creation or operation of the HMI system, their use must be coordinated with our planning electrical department.

4.11.4.2 Programming specifications

- Where possible, standard tools are to be used; no C applications.
- Pictures and picture object functions are not to be created using the WinCC wizard (generation and C scripts).
- Tooltip texts are to be provided with information for the maintenance staff following consultation with our planning electrical department.
- Variable names are to receive a corresponding function reference.
- No use of WinCC external objects or controls (OLE, OCX, ASP, .Net, etc.) without consultation with our planning electrical department.
- When opening standard applications such as the calculator, the possibility of opening multiple instances must be prevented.
- Software protection (know-how protect) is not permitted.

4.11.5 Representations in HMI systems

4.11.5.1 Functional specification document

Before the realisation of the system visualisation, the supplier shall work out and specify all aspects, such as

- User interface – screen layout, font and size, representation of objects
- Operating concept – picture hierarchy, operating philosophy, magnifying glass pictures, user permissions, permitted keys, etc.

Our planning electrical department will coordinate this functional specification with all parties involved, suppliers, production and maintenance.

4.11.5.2 Representation specifications

Operating philosophy picture tree
The structure is based on the functional groups of the plant, e.g. inlet, processing, exit, etc.
Starting from a basic schematic, it should branch out into the following picture hierarchy:

- Overview pictures:
  Summary of larger technological plant areas with display of the most important characteristic values and statuses; plant overview form
- Area pictures:
  Summary of messages, statuses and characteristic values from subsystem areas;
  Operating mode selection.
- Group pictures:
  Plant units, summarised into smaller technological groups
- Detail pictures:
  Display of messages, statuses and characteristic values relating to units.

All system components with all electrical equipment must be shown; their status is to be signalled by means of a colour change.
As standard, pictures for Fieldbus diagnostics, colour chart, service functions and safety devices must be included in every project.

Requirements and functions must be covered in the visualisation, e.g.

- On-screen representations according to the plant/unit arrangement, as viewed from the main operating station.
- Colour definitions for messages, limit values, statuses, lettering, etc.,
- according to specifications in EN 60204-1 and EN 61310
- Messaging and archiving procedures, diagnostics and message screens
- Recipe administration with a standard database
- Enter / modify roller diameters for automatic speed adjustment of controlled drives
- Access to the recipe database from WinCC via Global Script.
- Service functions (status, control, online functions)

The operating manual is stored in the system as a PDF file and can be accessed from any display (via a button).

Detail pictures are opened by clicking on them in the general overview. The devices, with their sensors and drives, of the individual system parts are then shown.
Detail pictures contain the following information, for example:

- Sensor status
- Drive on / off / fault (with fault number)
- Positions of displacement sensors
- Roller data

Movements and positions moved to must be displayed and signalled in the visualisation.

Flow diagrams
Active pipes must be marked by a change of colour.
Variable values, e.g. level, temperature, pressure, displacement etc. must be displayed in the flow diagrams and numerical values.

System limit values, entering setpoints, machine data, etc.
The system values must be displayed and saved in the visualisation. When setpoints are entered, they must be plausibility-checked against the system limit values.
It must be possible to transfer the system values stored in the visualisation system back into the controller upon manual request (operating button) (e.g. after restarting the controller).

4.12 IT infrastructure and IT solutions

4.12.1 General

In the course of preparing the proposal, the supplier shall prepare a computer and networking concept that is to be coordinated with our planning electrical department.

The following objectives shall apply:

- Use of the standard Wieland IT solutions (in particular the use of the hardware and of the operating system)
- To implement measures to protect the systems against malware and unauthorised access
- To establish the extent to which the devices are to be procured by Wieland-Werke
- To specify protection of the systems against network failure

An operating system is to be used that is currently supported by the manufacturer and is preferably already in use at Wieland. The installation of the latest security fixes for the operating system must not impair the functions of the application programs.

The installation processes must be geared towards automatic software distribution and described in the system documentation.

The activation of a replacement system and/or the handling of replacement components must be demonstrated in the course of putting the system into operation in accordance with the documentation (in clear process steps).

4.12.2 Network Access Control (NAC) for unsecure systems

For all systems that are connected to the company network but do not meet the security requirements, such as

- No operating system with current support from the manufacturer
- No timely regular installation of security fixes
- No active virus scanner (real-time)

detailed regulation of network communication is required. This is to prevent, as far as possible, any threat to all other devices in the Wieland IT network.
With the NAC solution, communication between systems is specifically defined on the basis of IP addresses and ports, and all other data traffic over the network is prevented (system hardening).

Based on a communication matrix of the connected systems, targeted enabling must take place in the course of initial setup. The specifications for this are to be prepared by the system supplier, e.g.

Application	Client	Server	Remark
Internet Explorer	192.168.1.2:80	192.168.100.2:80	http (terminal server)
Step7	192.168.1.2:102	192.168.100.3	PLC

4.12.3 Virus scanner

The virus scanner used by Wieland must be used. The installation files and the corresponding configuration will be provided by us. Exceptions to this are only possible following consultation with our planning electrical department.

4.12.4 Data backup

The supplier must provide a backup/recovery solution if the operation of the computer generates data to be backed up. Alternatively, a possible Wieland IT solution can be agreed with our planning electrical department.

4.12.5 Remote maintenance access (only if required)

Remote maintenance access represents a security risk and must therefore undergo a risk assessment. Each time that remote maintenance access is required, the supplier must apply to our planning electrical department in good time, and this application must be checked and approved by us. The company carrying out the remote maintenance must ensure that the access capability is used only by a restricted group of persons named in advance. It must be ensured that the remote clients used are equipped with the latest protection mechanisms.
The connection data and login attempts via remote maintenance access are logged in our systems.

In the plant and machinery environment, the following types of remote maintenance access are permitted in our IT environment:

4.12.5.1 Remote access

By means of two-factor authentication: A plugin is installed on the remote client and the virus scanner is checked on dial-in to ensure it is up to date.

4.12.5.2 Web access

By means of two-factor authentication: A Citrix plugin is installed on the remote client. The Citrix session is restricted in functions, i.e. clipboard locked, no file transfer possible.

4.12.5.3 Site-to-site VPN

Based on IP addresses and is not suitable for sporadic service deployments.

4.12.5.4 Dial-out VPN router

Access is via a supplier-specific component and can be activated from the system/machine. In principle, no radio, mobile phone network, telephone modem or DSL-based solutions are permitted. The components used for remote maintenance may only be used for this purpose and must not be mixed with other functionalities. Remote maintenance components which are installed as standard, but are not used, must be expressly reported to our planning electrical department and must be safely switched off. The device configuration must be documented and made available to us.
In the aim of achieving the highest possible level of security, the supplier is required to install the latest updates and patches on the remote maintenance components used. Each respective update is only to be carried out following prior consultation with the relevant electrical department.

4.12.6 Software licenses

Any type of software required as part of the procurement project must be correctly licensed. Software without a valid license certificate must not be used or installed.

All Microsoft products used by us are audited at regular intervals.
Their use must be notified by the supplier in good time in order to reconcile them with the license agreements applicable to us. All proofs of license, including those attached to devices, must be provided in original and digital form (jpeg photo). The relationship to the installed device must be

obvious from the supplied proofs of license (photo with serial number, PC name, invoice with serial number, etc.)

4.13 Bus systems and networks

4.13.1 General

4.13.1.1 Networking concept

The networking concepts in the plant automation and the link to the company network are set out in the separate project specification (functional specification) and must be coordinated with our planning electrical department before the work is carried out.
In principle, the plant networks are to be set up in accordance with the Siemens network installation guidelines.
Standard-compliant installation, equipotential bonding and the functioning of bus systems and networks must be verified by measurements under the responsibility of the supplier. For plant-related communication systems, the transmission times are to be measured and documented. The corresponding test documents and certificates form part of the electrical documentation and are a requirement for system acceptance.
If necessary, a specialist company should be engaged for this task.
As standard, only wired transmission media are permitted. Radio or wireless transmission technologies (Wi-Fi, mobile phone networks, etc.) can affect each other or existing installations and require the approval of our planning electrical department.
The addresses to be used for the implemented communication networks will be specified following consultation with our planning electrical department.

4.13.1.2 Standards

The cabling standards EN 50173, ISO/IEC 11801, EIA/TIA 568 are the basis for cabling. The basis for the testing of the installation is (VDE) DIN EN 50174-1 Information technology – Cabling installation – Part 1: Installation specification and quality assurance.
DIN EN 50346 Information technology – Cabling installation – Testing of installed cabling.

4.13.1.3 Fibre optic connectors

For fibre optic connectors, where technically possible, ST connectors with ceramic ferrule (BFOC) should be used, otherwise the type is determined according to the technical requirements and in consultation with our planning electrical department.

4.13.1.4 Communication networks

The following communication networks are to be used in the plant automation.
Other systems require the approval of our planning electrical department.

4.13.2 Company Ethernet

Communication between equipment and machinery takes place via the company Ethernet. The connection is specified and approved by our planning electrical department.
One system or machine is to be regarded as a functional cell. To achieve the desired cell protection, communication via Ethernet must be limited to what is necessary. All access must be secured with a suitable firewall functionality (gateway with firewall, CP with firewall, NAC at the switch port, etc.), the configuration of which is managed centrally.
The number of accesses must be reduced to a necessary minimum. Independent functions (remote access, internal communication) require separate accesses.

4.13.3 PROFIBUS DP

4.13.3.1 Standards and guidelines

The following applicable standards and guidelines must be observed: IEC EN 61158/61784 standards, PNO (PROFIBUS User Organisation) guidelines, Siemens manual for PROFIBUS networks.

4.13.3.2 Protocol type:

Only the DP (Decentralised Peripherals) protocol version is permitted; the use of FMS or PA must be approved by our planning electrical department.

4.13.3.3 Transmission rate

The permitted transmission rate is 1.5 Mbps. Deviations upwards and downwards must be discussed with and approved by our planning electrical department, stating the reasons. The entire wiring, the infrastructure components, the bus modules, etc. must always be designed for a maximum transmission rate of 12 Mbps.

4.13.3.4 Masters per bus segment

For performance reasons, there may only be one master per bus segment.

4.13.3.5 Active RS-485 termination element

The termination of a segment shall be ensured independently of the power supply for the terminal devices.
An active RS-485 termination element must always be installed at the Profibus segment ends where the Profibus master is not the segment end.
An active RS-485 termination element consists of a Profibus connector with switchable terminating resistor and PG/diagnostics socket and an active measuring adapter (see “Device selection”), which must be supplied with power.
At the same time, the connectors at the segment ends serve as measuring points for the bus communication.

4.13.3.6 Profibus measurements after installation

After installation and commissioning of the Profibus, it is the supplier’s responsibility to carry out and document acceptance measurements
- Generation of an error report on installation and assembly errors
- Shield current measurement at full load between all devices
- Detailed Profibus network verification
  (signal ratios, topology determination, online monitoring, etc.)

If necessary, a specialist company should be engaged for this task.

4.13.3.7 Earth connection

Only Profibus components with an earthing connection option may be used.

4.13.4 AS-Interface

The system is to be used as standardised in EN 50295 and IEC 62026-2. Only AS-i products certified by the AS-International Association may be used. Tests or certifications ensure that devices from different manufacturers will work together.

4.13.5 PROFINET

4.13.5.1 PROFINET guidelines and standards

In addition to the manufacturers’ descriptions, the applicable guidelines and specifications of the PI user organisation and the applicable standards IEC 61158 and IEC 61784-2 must be observed.

4.13.5.2 PROFINET “flavour” and Conformance Class

The PROFINET IO “flavour” is permitted; in our automation systems, it must at least comply with Conformance Class B.

4.13.5.3 PROFINET addressing

Unless agreed otherwise, the following applies.
Default address range 192.168.0.1 to .254

Default address for a gateway 192.168.0.1
Default address for a portable PG (IO Supervisor) 192.168.0.2
Default address for the PLC (IO Controller) 192.168.0.10
Default addresses for switches starting from 192.168.0.253, assigned downwards.

Automatic addressing by means of target topology must be used.

4.13.5.4 PROFINET performance considerations and topology

The notes from the PI user organisation planning guidelines (8061) must be taken into account.

Every switch and every device between a controller and an IO device causes a delay in the data transfer. Therefore, especially in time-critical applications, a large line depth must be avoided. To keep the line depth as small as possible, the CPU must be connected directly to a switch. The transmission times must be tested.
The line depth must not exceed 7; deviations are only possible in consultation with our planning electrical department.
The PROFINET must be implemented in a tree topology. To this end, functionally connected system parts are combined in a star point with a switch. The star points in turn are linked to each other in a star topology. For more details, see the planning guidelines of the PI user organisation.
For diagnostic purposes and future expandability, switches must not be completely occupied. At least one free port must be provided on each switch.
The influence of standard applications on the network load (video cameras or data services, for example, are critical) must be taken into account.
Decisions (settings, device selection, transmission methods, topology) which are made on the basis of performance considerations and therefore are not obvious must be suitably documented and communicated to us.

4.13.5.5 PROFINET network components

Managed switches shall be used, which enable PROFINET diagnostics and topology support, among other things.

4.13.6 DRIVE-CLiQ

Only certified/approved DRIVE-CLiQ cables are to be used (no patch or Ethernet cables). If a larger number of drives with DRIVE-CLiQ interface are installed in the system, the number of connections should be reduced by using DRIVE-CLiQ hubs (DME20). The maximum cable length must be observed during project planning.

4.14 Interfaces with higher-level and external systems

4.14.1 Plant automation

WWAG standard interfaces have already been implemented for linking the automation technology to the plant management computer and to the machine data collection system. Details of execution must be agreed with our planning electrical department.

4.14.2 Link to Wieland Factory Suite (WFS)

The data transmission method and the variables to be defined must be agreed with our planning electrical department before implementation begins.

4.14.3 Link to machine data collection (MDC)

The interface includes signals such as production, UB1, quantity 1, quantity 2, which are transmitted from the PLC to the MDC device via separate optocouplers. The program for controlling the signals is plant-specific and must be coordinated with us. The optocoupler outputs are connected to a separate terminal strip.

For further details, see sample circuit diagrams / design examples

4.14.4 Link to central control system (CCS) – Ulm, Vöhringen plants

If a data link is required (e.g. monitoring of energy and media supply), the following specifications must be observed:

4.14.4.1 Conventional data link

- Provide disconnect terminals
- Terminal strip designation for messages: ZLT-X7
- Terminal strip designation for measured values: ZLT-X8
- Fault messages in closed-circuit principle via floating contacts
- Operating messages in open-circuit principle via floating contacts

4.14.4.2 PLC data link (H1/L2/Ethernet)

- The following specifications must be agreed with Wieland:
- Hardware
- Selection of link PLCs
- Coupler function block numbers
- Specification of system names

5 Device selection

5.1 Approved devices and components

Only products from the following manufacturers may be used.

Devices	Manufacturers
Absolute encoders	T & R, FRABA
Control devices and signal units	Siemens ACT, EAO Lumitas series 04, 22.5 mm, with LED
CNC controls	Siemens
Speed encoders	Hübner
Pushbutton panels	Siemens
Pressure switches	Herion, Hydac, IFM
Flow transmitters	Endress & Hauser
Mechanical limit switches	DIN/EN standard
Frequency converter - Standard applications	Sinamics G120, G130
Frequency converter - Technological controls	Sinamics S120
Fill-level sensors / level sensors	Endress & Hauser, VEGA
Gear motors	DIN/EN standard
Main switch	Eaton, Siemens, Schneider
Pulse encoders	Balluff, Heidenhain, Hübner, Lenord & Bauer, Stegmann, T & R
Pulse counters	Hengstler, IVO
Industrial relays	ComatReleco, OMRON
Insulation monitors	Bender, Eberle, Siemens
Cables	DIN/EN standard
Cable racks	OBO-Bettermann
Cable glands	Pflitsch-UNI Zug, Lapp Skintop with strain relief
Terminals	Phoenix Clipline
Air-conditioning units	Efficiency-optimised units, e.g. Rittal Blue e
Laser measuring systems up to 300 m	Sick, DME 5000
Conductivity measuring equipment	Endress & Hauser
Wires	DIN/EN standard
Luminaires	Regiolux, Siemens
Light barriers	IFM, Keyence, Sick, Turck, Balluff
Linear position measuring systems	Balluff, Heidenhain, Sony, T & R
Linear position measuring systems (ultrasound)	Balluff, MTS (Temposonics), Siemens
Annunciator	Pötter

Devices	**Manufacturers**
Energy meters: PROFINET module: PROFIBUS module:	Siemens SENTRON PAC 3220 7KM3220-0BA01-1DA0 (230 V AC) 7KM3220-1BA01-1EA0 (24 V DC) 7KM9300-0AE02-0AA0 7KM9300-0AB01-0AA0 In addition, the following energy meters can be used in the Villingen plant: Janitza: UMG96…. ProfiNet: …RM-PN Ethernet: …RM-E RS-485: …RM Officially certified: …RM-PA MID+
Test disconnect terminal blocks	Phönix Contact PTME 6-Set Power – Starter kit - 3035991
Signal converters	ABB, Siemens, PR electronics
Three-phase motors	Standard motors efficiency class IE3 or IE4
DC motors	Siemens
Motor protection switches	Siemens SIRIUS
Proximity sensors - EN and DIN compliant - Visual indicators (LED) to indicate covered (obligatory) supply voltage present (desirable) - short-circuit and reverse polarity protected	Pepperl- u. Fuchs, ifm, Balluff
Cam switch	Kraus & Naimer with metal switch shaft
Panels	Siemens
PCs	Dell, Siemens, HP
pH measuring equipment	Endress & Hauser
Regulators (process variables)	ABB, Siemens
Switch cabinets	Rittal, Häwa
Electronic loggers	E&H, Jumo
Contactors, main	Siemens, SIRIUS
Contactors, high-current	HOMA, Schneider-Elektrik
Contactors, auxiliary	Siemens, SIRIUS
Servo drives	Siemens
Servo-drive frequency converters	Siemens
Automatic circuit breakers	ABB, Siemens
Switched-mode power supplies for 24 V DC	Siemens

Devices	**Manufacturers**
Circuit breaker, electronic	For voltage feeders after switched-mode power supplies: ETA ESx10-114 or ESx10-S114 with individual signal messaging, Siemens SITOP PSE200U selectivity module with status signal for each output
Fuses, cabinet	Only DIAZED
Signalling devices, visible, audible	Siemens, Werma, Pfannenberg (in LED technology)
Fuse-switch disconnectors	ABB, Rittal, Siemens
Control panels	Häwa, Rittal, Rose
Control switches	ABB, Kraus & Naimer, Siemens
Current converter devices DC	Siemens
Keyboard cable extensions (PC)	ATEN
Transformers ≥ 400 kVA	HTT
Valve connectors Mating connectors (plugs/sockets), metric thread Colour: black LED modules for valves Valves 24 V AC/DC Valves 230 V AC/DC	 Hirschmann Type A type GDM 3016 / order no. 934 395-100 Murr Type A type VBS / art. no. 3124033 Type A type VBS / art. no. 3124049
Intermediate terminal boxes	Rittal, Häwa

5.2 Safety equipment

Devices	**Manufacturers**
Safety light barriers	Sick
Safety laser scanners	Sick
Safety light curtains	Sick
Safety switches, mechanical	Schmersal
Safety switches, non-contact	Pilz PSENcode cs3.1p or cs1.1p

Devices	**Manufacturers**
Safety switches with mechanical guard locking	Schmersal (for doors): Closed-circuit principle: AZM201Z-SK-T-1P2PW Open-circuit principle: AZM201Z-SK-T-1P2PW-A Actuator for left-hinged doors: Sliding doors: AZ/AZM201-B1-LT Hinged door without escape release: AZ/AZM201-B30-LTAG1 Hinged door with escape release: AZ/AZM201-B30-LTAG1P1 Actuator for right-hinged doors: Sliding door: AZ/AZM201-B1-RT Hinged door without escape release: AZ/AZM201-B30-RTAG1 Hinged door with escape release: AZ/AZM201-B30-RTAG1P1 Exception Ulm plant additionally EUCHNER MGB possible -> Consultation with the planning electrical department Euchner (for flaps): Switch de-energised locked: CET3-AR-CRA-CH-50X-SG-110906 (Order no.: 110906). Switch energised locked: CET4-AR-CRA-CH-50X-SG-111684 (Order no.: 111684). Actuator: CET-A-BWK-50X (Order no.: 096327). Fortress Interlocks (Heavy Duty): Switch de-energised locked including actuator ATLOK024024, 24V AC/DC
Safety switch with electromagnetic guard locking	Pilz PSENslock
Safety hinge switches	Schmersal
Key transfer systems	Fortress Interlocks
Pressure sensitive safety mats, bumpers, safety switch strips with evaluation unit	Mayser (Ulm), Haake
Safety switching devices for emergency stop, guard doors, light curtains	Pilz PNOZsigma (preferably S4 and S5)
Safety-related drive functions	Siemens SINAMICS safety functions
Safety-related PLCs	Siemens S7-1500F
Speed, standstill monitors	Pilz PNOZ S30

5.3 Programmable logic controllers – Siemens

The following components are permitted:

5.3.1 SIMATIC S7-1500

Power supply	System power supply PS 60W	6ES7507-0RA00-0AB0
CPU standard	CPU 1513-1	6ES7513-1AL02-0AB0
CPUs failsafe	CPU 1513F-1 PN	6ES7513-1FL02-0AB0
	CPU 1515F-2 PN	6ES7515-2FM02-0AB0
	CPU 1516F-3 PN/DP	6ES7516-3FN02-0AB0
	CPU 1517F-3 PN/DP	6ES7517-3FP00-0AB0
Digital input module	DI 32xDC 24V	6ES7521-1BL10-0AA0
Digital input module F	F-DI 16x 24VDC	6ES7526-1BH00-0AB0
Digital output modules	DQ 32xDC 24V/0.5A HF	6ES7522-1BL01-0AB0
	DQ 8xDC 24V/2A HF	6ES7522-1BF00-0AB0
Digital output module F	F-DQ 8x 24VDC 2A	6ES7526-2BF00-0AB0
Analogue input modules	AI 8xU/I HS	6ES7531-7NF10-0AB0
	AI 8xU/I/RTD/TC ST	6ES7531-7KF00-0AB0
Analogue output module	AQ8xU/I HS	6ES7532-5HF00-0AB0
Interface module for ET 200MP	IM 155-5 PN ST; PROFINET	6ES7155-5AA01-0AB0

5.3.2 ET 200 SP

Preferably use the bus adapter BA 2xRJ45.

Interface module for ET 200SP	IM 155-6PN/2; PROFINET	6ES7155-6AU01-0CN0
Digital input module	DI 8x 24VDC	6ES7131-6BF01-0BA0
	DI 16x 24V DC (only in control panels)	6ES7131-6BH01-0BA0
Digital input module F	F-DI 8x 24VDC	6ES7136-6BA00-0CA0
Digital output modules	DQ 8x 24V DC/0.5A	6ES7132-6BF01-0BA0
	DQ 4x 24VDC/2A	6ES7132-6BD20-0BA0
Digital output modules F	F-DQ 8X24VDC/0.5A	6ES7136-6DC00-0CA0
	F-DQ 4x24VDC/2A	6ES7136-6DB00-0CA0
Analogue input modules	AI 8xRTD/TC 2-wire	6ES7134-6JF00-0CA1
	AI 4XU/I 2-wire	6ES7134-6HD01-0BA1
	AI 2x U/I 2-,4-wire	6ES7134-6HB00-0CA1
	AI 4xRTD/TC	6ES7134-6JD00-0CA1
Analogue output module	AQ 4XU/I	6ES7135-6HD00-0BA1

Base Units	Type A0; P16+A0+2D; new load group	6ES7193-6BP00-0DA0
	Type A0; P16+A10+2D; new load group	6ES7193-6BP20-0DA0
	Type A0; P16+A0+2B; bridged to the left	6ES7193-6BP00-0BA0
	Type A0; P16+A10+2B; bridged to the left	6ES7193-6BP20-0BA0
	Type A1; P16+A0+2D/T; new load group	6ES7193-6BP00-0DA1
	Type A1; P16+A0+2B/T; bridged to the left	6ES7193-6BP00-0BA1
	Type B0; P12+A4+0B; bridged to the left	6ES7193-6BP20-0BB0
	Type C0; P6+A2+4D; new load group	6ES7193-6BP20-0DC0
	Type D0; P12+A0+0B; bridged to the left	6ES7193-6BP00-0BD0
	Type F0; P8+A4+0B; bridged to the left	6ES7193-6BP20-0BF0

5.4 PROFIBUS network components

- Bus connector RS-485
- Approved up to 12 Mbps
- Switchable terminating resistor
- PG/diagnostic connection socket
- For cable type A (EN 50170), diameter 8 mm

The corresponding connector types from Siemens are approved.

5.4.1 PROFIBUS cables RS-485

Cables type A (according to EN 50170) approved for fast installation system PROFIBUS FastConnect.

Preferred types:

Siemens PROFIBUS FC Standard Cable	6XV1 830-0EH10
Siemens PROFIBUS FC Robust Cable For use in environments exposed to oil, chemicals or mechanical loads.	6XV1 830-0JH10 (PUR cable)
Siemens PROFIBUS FC Trailing Cable, trailable	6XV1 830-3EH10

Active RS-485 termination element
Order no. 010 516 (only the adapter without connector)

Indu-Sol measuring adapter PBMB IP20

5.5 AS-Interface network components

5.5.1 AS-Interface cables

AS-i profiled cables according to the AS-i specification must be used that are oil-resistant and suitable for drag chains. Suitable strain-relieving and sealing cable glands must be used for these profiled cables.

Preferred types:

Siemens, AS-i shaped cable, PUR, yellow	3RX9 01x-0AA00
Siemens, AS-i shaped cable, PUR, black	3RX9 02x-0AA00

5.5.2 AS-Interface power supply unit

Siemens AS-i power supply unit, IP20, input voltage AC230V	3RX9 50_-_____

5.5.3 AS-Interface master

The masters used must support at least the AS-Interface specification 3.0.

5.5.4 Communication processor

Siemens CP 343-2P AS-Interface	6GK7 343-2AH11

5.5.5 PROFIBUS DP / AS-Interface network transitions

Siemens DP / AS-Interface Link 20 E	6GK1 415-2AA10
Siemens DP / AS-i LINK Advanced (single master)	6GK1 415-2BA10

5.6 ASIsafe

5.6.1 ASIsafe safety monitor
(as bus-based safety relay)

Extended safety monitor, with screw terminal, two enabling circuits	3RK1105-1BE04-2CA0

5.6.2 Safety-oriented PROFIBUS DP / AS-Interface network transition
(In conjunction with F-PLC and bus-based safety technology)

Siemens DP / AS-i F-Link, with screw terminals	3RK3 141-1CD10

5.7 AS-Interface slaves
Only products certified by the AS-International Association are permitted, as this ensures that devices from different manufacturers work together.
Preferably, devices made by Siemens should be used.

5.8 PROFINET

5.8.1 PROFINET network components
Siemens SCALANCE X switches, managed.

5.8.2 PROFINET cables (copper)
Certified for PROFINET and suitable for the FastConnect fast installation system.

Preferred types:

Siemens IE FC TP Standard Cable	6XV1840-2AH10
Siemens IE FC TP Robust Flexible Cable	6XV1841-2B
Siemens IE FC TP Trailing Cable	6XV1840-3AH10

6 Handover and acceptance

The dates for handover and acceptance are specified in the contract dates or the project schedule.

6.1 Requirements for handover to production and maintenance

6.1.1 General

The training of the operating and maintenance personnel has been carried out.
Spare parts lists exist and spare parts quotations are available.
Installations and switch rooms must be cleared of installation and commissioning remnants.
Proof that all computers and data carriers are free of viruses – virus check reports.

6.1.2 Electrical engineering documentation

The documentation must be complete and up to date – handwritten entries and additions are permitted.
There must be no other copies of technical documentation in the plant area.
All invalid plans must be removed.
Devices that have become inoperative during commissioning (switches, limit switches, valves, contactors as well as program parts) must be completely removed.

6.1.3 CE marking, machine safety

The system must comply with the relevant regulations and must have been tested. CE conformity has been established and CE marking has been provided. If necessary, provisional equipment and functions must be documented and instruction given with a corresponding risk assessment.

6.2 Requirements for acceptance

Following a stable trial operation, the acceptance procedure takes place. For this purpose, an acceptance programme shall be agreed with the contractor in advance, taking into account the applicable contractual guarantees. The acceptance programme shall be documented by an acceptance report.

6.2.1 Processing of open points

Functional and performance-limiting defects existing at the time of handover, as well as those identified during the trial operation, have been eliminated. The remaining open points are documented in a list (annex to the acceptance report). The open points are to be scheduled in consultation with Wieland and dealt with by the supplier within a short period of time.

6.2.2 Documentation and software

Availability of the complete documentation and software in final form and scope in accordance with the present delivery specification of Wieland Werke. If necessary, to check the program versions we may request a transfer of the data into the PLC controller or an offline/online code comparison.

6.2.3 Functional test and performance characteristics

Proof of all performance features agreed in the scope of services and supply, and successful completion of system tests, if necessary with subsequent fulfilment of previously failed acceptance tests. Successful completion of these tests is part of the acceptance programme.

7 Documentation

7.1 Scope of documentation

As a preliminary version for the handover and final version for the acceptance, the following scope of documentation shall be delivered to Wieland in each case:

		Handover	Acceptance	Paper DIN A4	Data carrier Single
1.	Circuit diagrams	X	X	Single	CAE, DXF, PDF
2.	Control plans, control overviews	X	X	Single	CAE, DXF, PDF
3.	Cabinet / console layout plans	X	X	Single	CAE, DXF, PDF
4.	PLC device configuration	X	X	Single	CAE, DXF, PDF
5.	Terminal diagrams, connection diagrams	X	X	Single	CAE, DXF, PDF
6.	Device location plan	X	X	Single	CAE, DXF, PDF
7.	Operating and service manuals	X	X	Single	Word, PDF
8.	Data sheets, device descriptions	X	X	Single	Word, PDF
9.	Construction details, installation drawings		X	Single	CAE, DXF, PDF
10.	Parts lists and equipment lists		X	Single	Excel
11.	PLC program including GSD files	X	X	--	STEP7, TIA, etc.
12.	Software and licenses for programmable devices	X	X	--	Original
13.	Machine safety documentation		X	Single	Word, Excel, PDF
14.	Documentation for computers and panels		X	Single	Word, Excel, PDF
15	Software deliveries and licenses for computers/panels	X	X	--	Original
	Test reports (verification documents)				
16.	Parameters lists for devices and components	X	X	Single	Original
17.	Setting values for sensors	X	X	Single	Excel, PDF
18.	Reference/fixed points in the system for encoders	X	X	Single	Word, Excel, PDF
19.	Measurement reports for bus systems	X	X	Single	PDF
20.	Proof that computers are free of viruses	X	X	Single	PDF
21.	Plant safety test report	X	X	Single	Word, PDF
22.	Conformity certificates		X	Single	PDF
23.	SISTEMA calculations		X	Single	Original, PDF
24.	Initial test before commissioning (VDE 0100-600)	X	X	Single	PDF
25.	Measuring equipment test certificates		X	Single	PDF

7.2 Overall design of the documentation

If a system consists of components from several contractors or subcontractors, the main contractor is required, vis-à-vis Wieland, to integrate their documentation into the overall designation system. The must be no duplication of designations.

7.3 Nomenclature

The nomenclature must be consistent with that of the machine manufacturer. It is the contractor's responsibility to ensure that the nomenclature is consistent. The plant designation as well as the designation of assemblies, functional units and components must be kept the same throughout all documents (drawings, descriptions, lists, etc.)
The designations used in the circuit diagrams must correspond to the labels on the system, e.g. the labelling of operating elements.

7.4 Designation system for electrical equipment

The designation system for the electrical equipment (system function designations, location designations, …) must be agreed with our planning electrical department as early as possible.

7.5 CAE system

Circuit diagrams for Wieland are to be created using the electrical CAE system EPLAN (preferably) or ELCAD. Exceptions are only possible with the approval of our planning electrical department. The project name in the CAE system is in principle assigned by Wieland.
For the EPLAN system, the general structure and settings are provided and specified by us via a base project. In addition, the notes on using the EPLAN base project must be observed (Annex C).
Annex A of this delivery specification applies to the creation of circuit diagrams using ELCAD. The Wieland-specific ELCAD environment data are available from the Wieland ELCAD program manager.

Circuit diagrams created with ELCAD/EPLAN are to be supplied in electronic form as an ELCAD project or as an EPLAN project backup (zw1 file).
ELCAD project data can be saved in a packed state (ZIP format).

Circuit diagrams created with other CAD/CAE systems are to be supplied in electronic form in DXF and PDF format. The original project must be delivered with all used system files, text fonts and any image files integrated into the plans. Texts in the DXF files must not be displayed as lines or graphics, they must be editable as text.

7.6 Language

All documentation shall be submitted in German. This also applies to descriptions of series production devices.

7.7 Components used

The electrical documentation may only contain installed components. Series variants that are not installed must be removed from the documentation or marked as not installed.

7.8 Tables of contents

Each folder of the system and software documentation must be provided with a table of contents.

At least one directory in each case shall be created for the following types of documentation:
- Circuit diagrams
- Data sheets, descriptions
- Other documentation

7.9 Submission for approval

The following documents must be submitted by the contractor in a checked state by the specified times (if no other dates have been specified) to our planning electrical department for approval:

- Drafts/concepts for the circuit diagrams	At the beginning of the detailed engineering
- Device lists, spare parts quotations	At the end of the detailed engineering
- Circuit diagrams as a preliminary ELCAD/EPLAN project	3 weeks before the start of switch cabinet production
- Safety assessment (SISTEMA)	3 weeks before the start of switch cabinet production
- Concepts for application programs	At the beginning of software development
- Functional specification (preliminary)	At the beginning of software development

7.10 Circuit diagrams

7.10.1 Title block

All circuit diagrams must contain the title block below with the corresponding information

Legend:

DE	**EN**
Aenderung	Changed
Datum	Date
Name	Name
Erstellt am	Created on
Geplant	Planned
Gefertigt	Completed
WWAG	WWAG
Hr.	Mr.
Allgemein	General
400V AC Einspeisung	400 V AC Power Supply
Stromlaufplan	Circuit diagram
Musterprojekt_2013	Musterprojekt_2013
Blatt	Sheet
Bl	sheets

1. Designation block “contractor”: Company name [logo]
2. Designation block: “plain text”:
   The content usually consists of the higher-level function group designation, the higher-level function subgroup designation and the type of diagram (obligatory in the third line).
3. Designation block “Wieland project name”
4. Designation block “system function designation”: =AN.AN
5. Designation block “location designation”: +AN.AN
6. Designation block “sheet”
7. Designation block “revision designation”
8. Designation block “plan creation”
9. Designation block “special notes”
10. Designation block “drawing number”
11. Designation block “Wieland logo”

7.10.2 System function designation =AN.AN

Each sheet in the circuit diagrams must be clearly identifiable by the system function designation. For terminal diagrams, the designation block “sheet” can be consulted.

At Wieland, the electrical device identifier consists of the system function designation, the identifier for the device type and the device counting number.

7.10.3 Location designation +AN.AN

Before project planning begins, a project-specific location designation should be agreed with our planning electrical department. On each sheet of a circuit diagram, the location designation must be entered that applies to most of the equipment shown.

7.10.4 Number of sheets for a system subgroup

In the circuit diagrams, it must be possible to determine on each sheet whether this is the last sheet in a system subgroup (=AN.) or whether there are more sheets following. This is done by marking in the designation block “sheet”. The last sheet is marked with a minus sign, all preceding sheets with a plus sign. Alternatively, the system function designation of the preceding and following sheet of the system subgroup is to be entered on each sheet. For terminal diagrams, this specification may be deviated from.

7.10.5 Connection to other plants

References are to be entered with the Wieland project name, sheet (system function designation) and current path. For handover, after completion of commissioning, all other references such as “old installation” or “customer” must be replaced.

7.11 Connection diagram types

For Wieland, connection diagrams shall be subdivided into the following types of diagrams:

- Overview plans
- Circuit diagrams
- Control plans
- Layout plans
- Terminal diagrams
- Cable lists

The following diagram types are to be subdivided by the system function designations as follows:

	“System function designation”	
Diagram type	**Higher-level function group identifier**	**Electrical function group identifier**
Overview plans	=A	.A
Circuit diagrams - General - Project-specific groups	=B =C ... X	.A ... Z .A ... Z
Control plans	=Y	.A
Layout plans	=Z	.A

7.11.1 Overview plans =A

- Cover sheet	See sample circuit diagram	=A0.A0
- System function designation	See sample circuit diagram	=A1.
- Location designation	See sample circuit diagram	=A2.
- Terminal strip designation	See sample circuit diagram	=A3.
- Plant layout	See sample circuit diagram	=A4.
- Technology scheme		=A5.
- Single-line overview plan	See sample circuit diagram	=A6.
- Bus/automation/visualisation overview	See sample circuit diagram	=A7.

- Equipotential bonding See sample circuit diagram =A8.
- Password list =A9

7.11.2 Plant layout (floor plan) =A4.

The following information must be included:

- Location coordinates corresponding to the “location designation”
- Higher-level function group designation (press, loop pit, furnace) stating the group identifier (=C, =D, =E).
- Location of switch cabinets, intermediate terminal boxes, control panels and their designation

7.11.3 Technology scheme =A5.

Technological relationships must be shown if a system is made up of several groups that form a self-contained functional unit in themselves but nevertheless are functionally linked to each other (e.g. material cycles).
If the depiction of process equipment is required for technological understanding, symbols according to DIN 19227 shall be used.

7.11.4 Single-line overview plan =A6.

with the following scope

- Feed data, supply cables (cores, cross-section), clear designation of the mains system (e.g. TN-S)
- Power supply with main switch, fuses and metering equipment
- All load feeders including consumers such as motors, heaters
- DC motors supply with current converter and motor

The following must be specified for all consumers:

- Complete device identifier
- Power, speed if applicable
- Function in plain text (e.g. hydraulic pump)

Consumers that form a functionally independent unit (e.g. welding equipment) can be shown as a block. If necessary, a separate overview diagram must be created for this purpose.

7.11.5 Bus/automation/visualisation overview =A7.

All bus systems such as ETHERNET, PROFINET, PROFIBUS, DRIVE-CLiQ
ASI, peer-to-peer bus, MPI, USS bus etc. with the following information:

- Device identifiers of all components
- Location designations of all components
- Component types
- Cable types used
- Cable length between the devices
- Total cable length of the respective segments
- Bus address
- Set terminating resistors
- Stub lines
- Available PG/diagnostic interfaces
- All visualisation components

7.11.6 Equipotential bonding =A8.

Overview plan with the following information
Supply/connection points (neutral point, foundation earth electrode)
Equipotential bonding busbar with location designations / device identifiers, size and cross-section details
Cross-sections and lengths of the equipotential bonding lines

7.11.7 Password list =A9.

All passwords used must be documented in the password list with the purpose of use and, if applicable, the user. The passwords to be documented include the safety password in the Tia Portal, passwords for the visualisation.

7.12 Circuit diagrams =B. to =X.

The project-specific groups (higher-level function group identifiers =C ... X) in the circuit diagrams are to be defined by the contractor with our planning electrical department before the start of project planning.

7.12.1 Signal flow representation

either	from top to bottom	(preferred for power and control engineering)
or	from left to right	(preferred for measurement and feedback control systems)

7.12.2 Grouping of signal lines

The grouping of signal lines that have the same course (e.g. data lines) for single-line representation is permitted, although the identification of each individual line at the source and destination must be maintained.

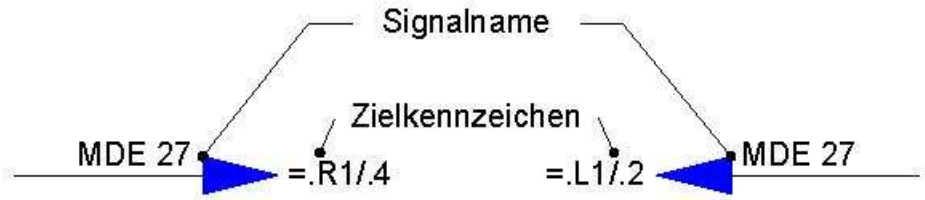
7.12.3 Representation of devices

The technical relationships shall be represented by interruption points or cross-references (e.g. at contacts).
Combination devices with independent functional units (e.g. indicator panels) may be shown either as a complete unit on a common sheet, or in parts on several sheets, although all parts must bear the device identifier of the complete device.
Furthermore, it must be evident on which sheets further parts are shown.

7.12.4 Signal lines (point-to-point connections)

Within the entire set of plans, a signal name may only ever be used for the same signal of the same polarity. Signal names should preferably indicate the signal function in short form (Example: v*,n-act,n).

Interruption points of signal lines must be executed as follows at the source and destination point:



Legend:

DE	**EN**
Signalname	Signal name
MDE 27	MDE 27
Zielkennzeichen	Destination identifier

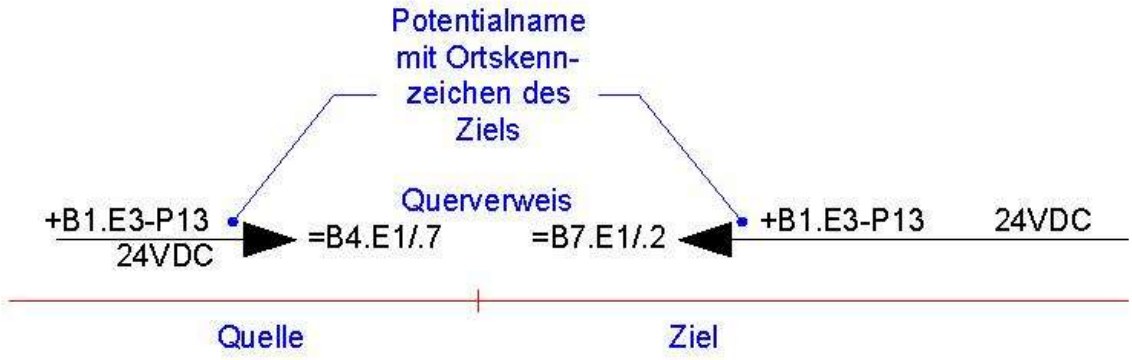
7.12.5 Potentials

Within the entire set of plans, a potential name may only ever be used for the same potential of the same polarity.

In addition, a potential must be marked on every sheet with the voltage (V) and the voltage type (AC or DC).

If a potential is distributed to mounting locations with different location designations, the destination location designation shall precede the potential name.

Potentials and their interruption points must be marked as follows:



Legend:

DE	**EN**
Potentialname mit Ortskennzeichen des Ziels	Potential name with location designation of the destination
Querverweis	Cross-reference
Quelle	Source
Ziel	Destination

7.12.6 Representation of reference potentials

For systems with several reference potentials (earth and equipotential bonding connection, 24 V control, ±15 V controller supply, shield connection, etc.) that are routed isolated from each other and earthed together at a central point, this connection must be documented in the circuit diagrams in the functional group =.E... , with indication of the corresponding switch cabinet location designation.

7.12.7 Multifunctional assemblies

If assemblies (e.g. electronic boards) are installed in the plant which contain several freely usable functional units (e.g. operational amplifiers), an overview plan shall be drawn up of each assembly showing whether and, if so, at which place (indication of the sheet and current path no.) each functional unit is used.

7.12.8 Unused potential and signal connections

Potential and signal lines as well as contacts that are routed to terminals or similar connecting elements, but are not further used from there, must be marked as having no function. This does not apply to connections that end on the perimeter line of compact devices.

7.12.9 Information in the circuit diagrams

The following information shall be provided for every device:

- Identifier for device type in accordance with DIN 40719, Part 2, supplemented by a counting digit. The counting digit is derived from the current path number in which the device is drawn (example –Q1). The current path rule does not apply to devices connected to the inputs/outputs of a PLC.
- Function in plain text
  referring to the switched-on state for contactors/relays or the actuated state of contacts or indication of the respective reference value.
- Type designation (except motors, actuating elements, valves, terminals)
- Technical data:

Machines:	Power, voltage, current, rotary speed
Tachogenerators:	Rated voltage / rated speed
Measuring converters:	
- Incremental:	pulses per revolution, mechanical units per pulse
- Absolute:	steps per revolution; mechanical units per step total angle/displacement
- Analogue:	mechanical units per electrical unit (e.g. 100 mm 10 V)
Safety equipment:	Response value (where technically meaningful)

For adjustable devices:
- Realised values such as slider position,
  (potentiometer, DIP switch position, amplification factor, switching points, switches, amplifiers)

Measuring instruments:	Normalisation for full-scale deflection (e.g. 0 ... 10 V 0 ...100 m/min)
Profinet devices:	IP address, I/O range, device name and number from the Step7 project

7.12.10 Internal circuitry of compact devices

(e.g. compact current converters, instrumentation amplifiers, controllers, monitoring devices)
This can be shown in full detail or in a simple block diagram, as long as the function of the unit can be recognised.

7.12.11 Signal normalisation

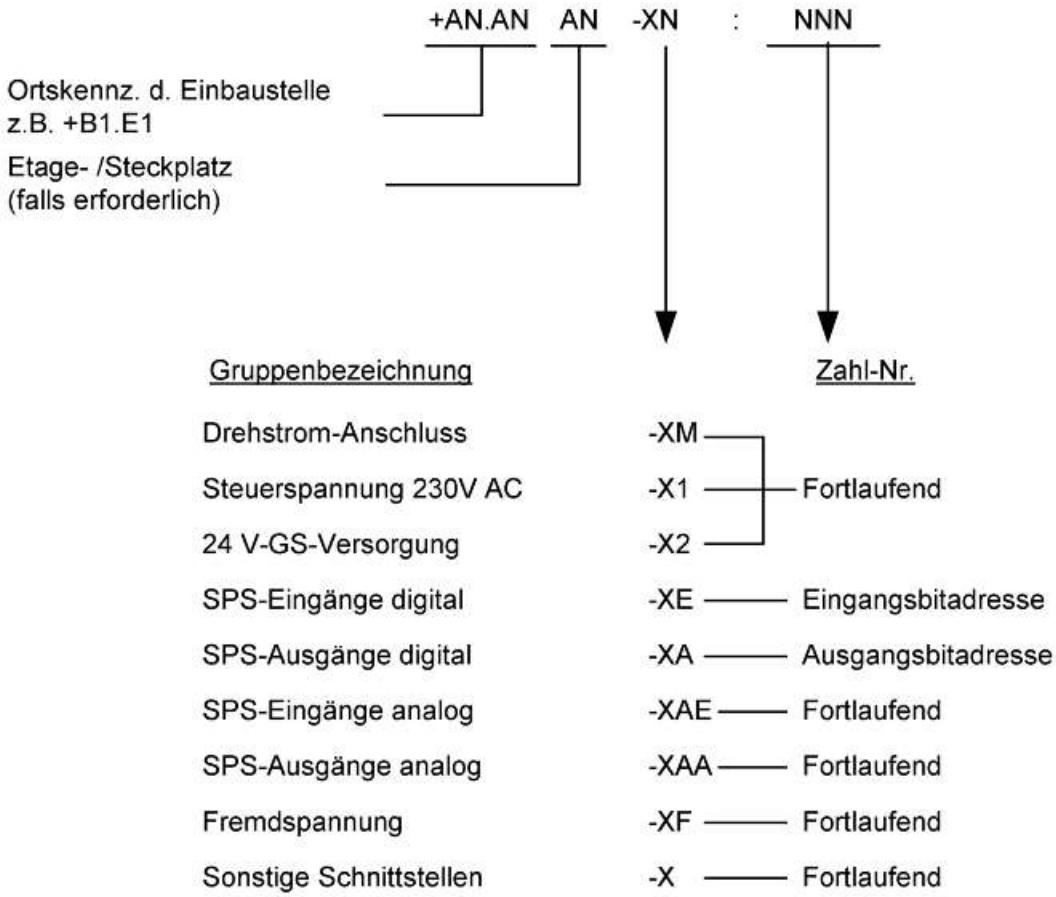
In analogue measurement and control circuits, normalised information about the signal level being measured must be provided for all quasi-stationary operating states (e.g. 10 V 100 m/min).

7.12.12 Wiring cross-sections

Wire cross-sections deviating from the standard 1.5 mm² cross-section must be indicated in the circuit diagrams.

7.12.13 Terminal organisation

Terminals shall be grouped into separate groups according to the different operating and control voltages.
Each group is given its own designation, which is composed as follows:



Legend:

DE	**EN**
Ortskennz. d. Einbaustelle	Location designation of the installation point
z.B. +B1.E1	e.g. +B1.E1
Etage- /Steckplatz	Floor/slot
(falls erforderlich)	(if required)
Gruppenbezeichnung	Group designation
Zahl-Nr.	Count no.
Drehstrom-Anschluss	Three-phase connection
Steuerspannung 230V AC	Control voltage 230 V AC
Fortlaufend	Consecutive
24 V-GS-Versorgung	24 V DC supply
SPS-Eingänge digital	PLC inputs digital
SPS-Ausgänge digital	PLC outputs digital
SPS-Eingänge analog	PLC inputs analogue
SPS-Ausgänge analog	PLC outputs analogue
Fremdspannung	External voltage
Sonstige Schnittstellen	Other interfaces
Eingangsbitadresse	Input bit address
Ausgangsbitadresse	Output bit address

7.12.14 PE terminals

Like all other terminals in a terminal strip, the protective earth terminals receive only a consecutive number as a designation.
In the circuit diagram, they are distinguished from the other terminals by the connection to the protective earth potential or a connection with a protective earth symbol.
In the terminal diagram, the terminals are additionally identified by the protective earth symbol.
Deviating from this, only the protective earth terminal for the mains connection is marked with PE.

7.12.15 PLC representation

The layout and assignment diagram must be designed according to the sample circuit diagram =B11.A… with potential connections drawn in.

Inputs, outputs and associated peripherals are shown according to their functions.

- The counting number of terminals and device identifiers of connected switching devices is identical to the address of the input or output they are connected to
  (e.g. = B12.L2-S5.7).

- Control switches that operate on several inputs receive the lowest address as counting number (e.g. =B12.L2-S5.4).

- Function designations in plain text are always to be defined as “logic 1”; inverted signals are identified by “NOT”, (e.g. NOT EMERGENCY STOP).

7.13 Control plans =Y.

For discretely constructed control loops (hardware controls), overviews must be created from which the control type and the setpoint / actual value flow can be quickly recognised. The input/output interfaces (interface to PLC, analogue inputs, analogue outputs) must also be entered in these diagrams.

In a block diagram, all devices (electronic modules, controllers) must be shown as block symbols with the transmission function drawn in.

Setpoints and actual values must be indicated in normalised form (e.g. V setpoint = 10 V => 200 m/min).
Cross-connections must be entered with source and destination.

7.14 Layout plans =Z.

7.14.1 Console and local control point layout plans

In addition to the dimensions and position of the units to scale, the functional designations and device identifiers must be indicated (see sample circuit diagram).

7.14.2 Cabinet layout and assignment plans

Shown to scale. The components shown must be assigned to the devices.

7.15 Terminal diagrams (connection diagrams)

The terminal diagrams at Wieland must contain at least the following information:
Terminal strip designation, terminal designation and installed terminal jumpers.
Cable name (-W with consecutive number), cable type (NYY, H07, …), number of cores and core cross-section of the connected cables.
Assignment of the individual terminals to the connected cores and target connection points.

7.16 Cable lists

The cable lists must contain at least the following information:
- Cable name (-W with consecutive number), cable type (NYY, H07, …)
- Number of cores, core cross-section, connection destinations of both cable ends
- Installed cable length in metres
- Number of occupied cores and free cores
- For ready-made cables, the length in metres
- For PROFINET cables, the NVP value of the installed cable

7.17 Parts lists, equipment lists

These lists are to be generated from a common database, preferably from the electrical CAE system. The respective list contents are generated by corresponding evaluations of the database and subsequent export into the required XLS format.

The item numbers in both lists must be kept the same.
In the “long text” field, all essential technical features of the equipment shall be listed, and the assignment of all order numbers and data for the features shall be included.

The listing of standard devices such as contactors, operation and indicator elements, measuring instruments may be omitted, provided that the characteristic data are specified in the circuit diagram.

Parts lists:
Output during project planning and for documentation purposes shall be in XLS format.
Details according to the following table format:

Device identifier	Location	Quantity	Short name	Long text	Manufacturer/ supplier	Type designation / order no.	Item no.

Device lists (for spare parts specification):
- Output in XLS format with details according to the following table format.
- Modular devices are to be listed in the device list according to the modules.
- For motors and transformers, the rating plate data and serial number must be entered.

Item no.	Short name	Long text	Manufacturer / supplier	Type designation Order no.	Serial number Motors & transformers	Number fitted in system	Recommended number in reserve	Urgency	Type of component	Delivery time weeks	Unit price [ ]	Total price [ ]

7.18 Data sheets, device descriptions, device manuals

These must be supplied for all installed devices and installations, except for standard switching and operating devices (limit switches, pushbuttons, indicator lamps, contactors).

They must contain the following information (where technically meaningful):

- Specifications and functional descriptions
- Dimensional data
- Connection diagrams
- Installation, commissioning, operating and maintenance instructions
- Internal circuit diagrams

In the case of automation devices and other devices of modular design, this applies to all individual components.

In the case of devices which must be adjusted or parameterised if replaced (zero-point adjustment, basic programming, ...), a precise step-by-step description must be supplied so that replacement can be carried out by technical personnel without special knowledge. The reference points and fixed points (in the installation) of the measuring systems must be documented accordingly.

7.19 Functional specification, service manual

For all projects, in accordance with the size and complexity, the supplier shall draw up a functional specification. The functional specification forms the basis for the technical realisation and contains the contents of the detailed technical clarification (discussion agreements, etc.)

The description of functions and processes are preferably to be presented as flowcharts, contents and structure are to be agreed with our planning electrical department.

During project realisation, sufficient time must be allowed for clarification and coordination of the scope of services with our planning electrical department.

The functional specification shall be continuously updated and revised in accordance with the progress of the project.
With the creation of the final documentation, the functional specification shall then be transferred into the service manual and forms the basis for training the operating and maintenance personnel.

An operating manual must be created for the system operation (visualisation). In this operating manual, the operating steps and functions shall be described on the basis of screenshots.

7.20 Construction detail drawings, installation plans

With representation of the structures and the necessary details for the installation of the electrical equipment, e.g. for electrical rooms, control rooms, control stations, transformers, machines, etc.

These details and plans must show details such as:
- The space required for the installation
- All cut-outs, openings, piping and cable routes required for carrying out the installation are drawn in and dimensioned
- Local loads, static and dynamic foundation loads
- Vibrating parts of the installation or parts that tend to vibrate
- Earthing points

7.21 Documentation for automation functions

7.21.1 Standard FBs/FCs

If standard function blocks (FBs) / functions (FCs) are used, detailed documentation must be provided.

7.21.2 CFC and SFC programs

Cross-references to the circuit diagrams must be entered at the I/O interfaces of the CFC program. The circuit diagrams must contain clear references to the CFC program (plan name, module, connection). A description (preferably online) must be available for each CFC module used.

7.21.3 Additional documentation

- Communication links must be documented via the S7 functionalities.
- A complete upread (backup of all parameters) must be created on data carriers for each programmable device.
- Printout and data carrier of all software programs / parameter lists of programmable devices (e.g. absolute encoders, decentralised peripherals, Sick, frequency converters, etc.)
- Printout of parameters deviating from the factory setting (parameters changed during commissioning) in list form.
- Each sequential control shall be represented in a flowchart in accordance with DIN 40719 (e.g. in accordance with SIEMENS Graph 7).

7.21.4 Presentation of control overviews and function diagrams

For each device, the following documents shall be supplied as a printout, PDF file and original file.

7.21.4.1 Control overview diagrams

For all devices used, overviews must be created from which the control type and the setpoint / actual value flow can be quickly recognised. The input/output interfaces (interface to PLC, analogue inputs, analogue outputs, peer-to-peer connections) must also be entered in these diagrams.
The labelling and structure is analogous to the labelling system for the circuit diagrams.
For systems with multi-motor drives, a control overview shall be drawn up showing the type of control and the interaction of the drives in the line.

7.21.4.2 Control structure diagrams:

A function block diagram shall be created for each completed control system. The labelling and structure is analogous to the labelling system for the circuit diagrams.
All functions realised by software (e.g. ramp function generator, switch, adder, multiplier, controller, etc.) shall be represented as block symbols with the transmission function drawn in.
The signal flow (setpoints, actual values, etc.) must be marked with a thick line or in colour.
Switches must be drawn in the parameterised position and cross-connections must be entered with source and destination.
Parameterised fixed setpoints must be entered in the plans and circled.
Setpoints and actual values must be indicated in standardised form
(e.g. V setpoint = 100% 200 m/min).

7.21.4.3 Recording of actuator/control characteristics

- For technological control loops with special functions

As reference documents for maintenance, typical signal recordings for the actuators (controllers) shall be recorded during commissioning, e.g. friction characteristics, hystereses, step responses, frequency responses, characteristic curves, etc.

7.21.5 Example: Symbol table for Simatic S7

Symbol	Address	Data type	Comments
E1.0 =B1.L1/0 T	E1.0	BOOL	Lifting unit raise Transport unit 1
E1.1 =B1.L1/1 T	E1.1	BOOL	Lifting unit lower Transport unit 1
E1.2 =B1.L1/2 ES	E1.2	BOOL	Lifting unit down Transport unit 1
E1.3 =B1.L1/3 T	E1.3	BOOL	Carriage forwards Transport unit 1
E1.4 =B1.L1/4 T	E1.4	BOOL	Carriage backwards Transport unit 1
E1.5 =B1.L1/5 ES	E1.5	BOOL	Carriage position material loading
E1.6 =B1.L1/6 ES	E1.6	BOOL	Carriage position material unloading
E1.7 =B1.L1/7 MS	E1.7	BOOL	Motor protection carriage Transport unit 1
A3.1 =B1.L1/2 MEL	A3.1	BOOL	Lifting unit down Transport unit 1
A3.2 =B1.L1/3 REL	A3.2	BOOL	Carriage forwards Transport unit 1
A3.3 =B1.L1/4 REL	A3.3	BOOL	Carriage backwards Transport unit 1
A3.4 =B1.L1/6 LM	A3.4	BOOL	Material in position Transport unit 1
A12.0 =B1.L1/0 VEN	A12.0	BOOL	Lifting unit raise
A12.1=B1.L1/1 VEN	A12.1	BOOL	Lifting unit lower
FB 1	FB 1	FB 1	Sequence of the mixing station
FC 44	FC 44	FC 44	Mixing station control, simulation
FC 45	FC 45	FC 45	Organisation of operating modes
FC 70	FC 70	FC 70	Standard FC for S7 Graph
M 6.0	M 6.0	BOOL	Reset sequence
M 10.0	M 10.0	BOOL	Sequence operating mode SETUP
M 10.1	M 10.1	BOOL	Sequence operating mode MANUAL
M 10.2	M 10.2	BOOL	Sequence operating mode AUTO
M 11.1	M 11.1	BOOL	Fault test
M 12.0	M 12.0	BOOL	Start automatic mode
M 12.1	M 12.1	BOOL	Stop automatic mode
M 12.2	M 12.2	BOOL	Move to starting position
M 13.0	M 13.0	BOOL	Operand flag for M13.1
M 13.1	M 13.1	BOOL	Acknowledge edge flag
M 13.3	M 13.3	BOOL	Starting position reached
etc.			

Inputs/outputs specification:

Cross-reference to circuit diagram

- WS Wahlschalter / Selector switch
- ES Endschalter / Limit switch (NS,LS,MS)
- T Druck-, Schwenk-, Fusstaster / Pushbutton, rotary switch, foot switch
- MS Motorschutz / Motor protection
- LM Leuchtmelder / Indicator lamp
- REL Relay (auxiliary or power)
- VEN Ventil / Valve
- MEL Meldung / Message (pressure, temp., level, …)
- DP Signal via Profibus
- LAN Signal via Ethernet

7.21.6 Example: Symbolics for TIA

Beispiel zur SPS-Software-Dokumentation (PLC-Variablen)			
Symbol	**Adresse**	**Datentyp**	**Kommentar**
T_Stoer_quitt	%I0.0	BOOL	Störung quittieren =B1/L1.0
ES_Hubwerk_oben	%I12.0	BOOL	Hubwerk oben =B10.L1/5
MS_Hubmotor	%I0.3	BOOL	Motorschutz Hubmotor =B1.L3/6
VEN_Hubzylinder_auf	%Q45.5	BOOL	Hubzylinder auf =B4.L4/7
M_Stoerung_allg	%M10.0	BOOL	Störung allgemein
			Verweis auf Stromlaufplan:
			z.Bsp. =B1.L1/0
			=B1.L1 Anlagenfunktionskennzeichen
			/0 Strompfad

Agenda Symbol:	
WS	Wahlschalter
ES	Endschalter
T	Taster
MS	Motorschutz
LM	Leuchtmelder
REL	Relais
VEN	Ventil
MEL	Meldung
DP	Signal über Profibus
LAN	Signal über Profinet
M	Merker

Legend:

DE	**EN**
Beispiel zur SPS-Software-Dokumentation (PLC-Variablen)	Example for PLC software documentation (PLC variables)
Symbol	Symbol
Adresse	Address
Datentyp	Data type
Kommentar	Comments
Störung quittieren	Acknowledge fault
ES-Hubwerk_oben	ES-Hubwerk_oben
MS_Hubmotor	MS_Hubmotor
VEN_Hubzylinder_auf	VEN_Hubzylinder_auf
M_Stoerung_allg	M_Stoerung_allg
Verweis auf Stromlaufplan:	Reference to circuit diagram:
z.Bsp. =B1.L1/0	e.g. =B1.L1/0
Anlagenfunktionskennzeichen	System function designation
Strompfad	Current path
Agenda Symbol:	Key to symbols:
Wahlschalter	Selector switch
Endschalter	Limit switch
Taster	Pushbutton
Motorschutz	Motor protection
Leuchtmelder	Indicator lamp
Relais	Relay
Ventil	Valve
Meldung	Message
Signal über Profibus	Signal via Profibus

Signal über Profinet	Signal via Profinet
Merker	Flag
Störung quittieren	Acknowledge fault
Hubwerk oben	Lifting unit up
Motorschutz Hubmotor	Motor protection hoist motor
Hubzylinder auf	Lifting cylinder up
Störung allgemein	Fault general

7.22 Machine safety documentation

7.22.1 Assessment/validation of safety functions

For the validation and assessment of safety-related parts of machinery control systems in accordance with DIN EN ISO 13849-1, the manufacturer-independent software assistant SISTEMA produced by the Institute for Occupational Safety and Health of the German Social Accident Insurance (*Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung,* IFA) shall be used. The assessment/validation is to be submitted together with the circuit diagram to our planning electrical department for review and delivered as part of the documentation as follows:
The original project is to be delivered together with the PDF file, complete printout and signed summary.

7.22.2 Testing and acceptance of safety functions

In the course of the design and program development process, the supplier shall prepare an acceptance procedure and report, which shall serve to demonstrate the safety functions of the installation. For example, details must be taken into account such as
- Overviews showing safety equipment and areas
- Function tables with associated sensors and actuators
- Clearance distances for scanners, safety light curtains and safety light barriers
- Safety functions of drives
- Time diagrams for movements, etc.

The report on the successfully completed safety test must be handed over to us when the system is handed over and is part of the documentation for the issuing of the CE mark.

7.22.3 Acceptance reports for programmed safety-related control systems

Where programmed safety functions are used, a printout of the system-specific acceptance report must be delivered. Due to the length, it is sufficient to provide this as a PDF.

7.22.4 Summary for repeat tests

The information required for carrying out the repeat testing of safety functions shall be supplied in summary form for all safety functions of a system or machine. It is sufficient to provide this in electronic form.

7.23 Initial testing of electrical safety in accordance with VDE 0113-1 or VDE 0100-600

Every item of plant equipment must be tested in accordance with the applicable VDE regulations after completion of assembly yet before commissioning. The test documentation must be delivered together with the system documentation.
The efficacy of the protective measures (RCDs, loop impedances, tripping conditions), as well as of the PE conductor in no-load condition, must be demonstrated by means of measurement and documented.

7.24 Documentation for computers and panels

7.24.1 Scope of supply for documentation

The scope of supply for the documentation includes all original manuals and descriptions of the supplied devices, system software, project planning and communication manuals. The documentation shall be produced entirely in digital format.

7.24.2 Software documentation

Sequence diagrams and/or structured charts of applications shall be supplied as documentation. The implementation must be comprehensible based on these diagrams and/or charts.
A separate functional description in plain text shall be produced for all program parts programmed in a high-level language. The required commentary on the program does not fulfil this requirement.
The documentation shall also include descriptions of how, in the event of process changes, the HMI system, the message systems, the archiving or recipe memories have to be updated in order to continue to be operated.

7.24.3 Service manuals

Configuration
The configuration of all computers used (including backup computers) must be documented. This can be done in the form of a bulleted list. It must contain at least the following items:
Installed components (hardware, software and drivers, hard disk partitioning)
Computer settings
System settings
Network settings (addresses, transmission rates, etc.)
All configured users and passwords
All product numbers and registration codes for software installation and uninstallation.
For application communication, who is communicating with whom, specifying the IP address and the port (socket information).

System installation procedure
The procedure for installing and setting up the system must be documented. Based on the documentation, it must be possible to restore the system e.g. after a crash. In addition, other system procedures such as starting up, shutting down, switching off, restarting after a system error or power failure, starting up the backup system, data backup, error handling etc. must be described and documented.

User manuals
Separate manuals shall be prepared for the operator and the system administrator, which shall also be used as training material. All operating functions of the system shall be described based on printouts of the implemented screens. All error messages shall be documented. Further functions for service personnel shall be documented separately (based on the screenshots).

7.25 Software deliveries and licenses

The scope of supply shall include all software packages used in the electrical equipment with the respective original licenses, original certificates, license conditions and proofs of procurement.
In the case of purchased system programs or application programs, the product manuals and original data carriers must be supplied.
In the case of self-developed application programs, the source code and software descriptions must be supplied.
Development and handling programs for programmable devices and components are to be supplied following consultation with our planning electrical department.

7.26 Test certificates for PROFINET cabling

The measurement results (see section 3.5.7) must be delivered in electronic form as .pdf as part of the documentation. They shall be handed over using suitable data carriers.