

TECHNICAL DELIVERY SPECIFICATION

II Technical Equipment Instructions

TA01 Electrical Engineering

Status 07/2015



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Modification Service

Status	Chapter / Page	Description of modification including name of the person responsible	Date
07/2015	4.1.2 / 7 4.2 / 8 5.5 / 8 5.6 / 8 7.1.2 / 9 7.1.5 / 9 8 / 10 11.1.1 / 13 11.1.2 / 13 11.3 / 14 11.1.5 / 15 11.6 / 15 11.8. / 16 11.10 / 16 11.11 / 17 11.12 / 17	<p>Modified: replaced "approved lists" with "approved list"</p> <p>Added: current, changed space reserves of 20% instead of 30%</p> <p>Added: "A failure of the supply voltage must not lead to a loss of data or system failure."</p> <p>Modified: replaced "run the production equipment one cycle more" with "bring the production equipment ahead in the cycle"</p> <p>Added: "For more than 5 motors and/or line safety switches, the responses must be displayed individually or in groups including the location."</p> <p>New chapter: "7.1.5 Pulse circuits Pulse circuits must be designed with semiconductor (e. g. washing machine heating). Safety must remain guaranteed."</p> <p>Added: "The equipotential bonding must be effected according to the relevant standards. When doing so, take into account high-frequency interference signals/currents caused by converters and nonlinear consumers. Depending on the currents' frequency and giving consideration to the skin effect, highly flexible lines/conduction bands may need to be used. All connecting points must be free of lacquer. Threads must not be used as conductors. Toothed disks, snap rings, contact disks with cutting teeth, etc. must not be used as connectors. Also, the earth lug must not be mechanically damaged by toothed disks, snap rings, etc. Corrosion prone areas must be treated with a suitable protective agent."</p> <p>Modified: replaced "Transline 2000" with "Solutions for Powertrain"</p> <p>Deleted: "and programming style"</p> <p>Added: "The applicable versions must be added in the case of modifications. Any necessary licenses and documentation that is required for licensing must be included."</p> <p>Modified: replaced "approved lists are" with "approved list is"</p> <p>Added: "The interface signals must be visualized including their status. The signal designations must be consistent."</p> <p>Modified: replaced "approved lists" with "approved list"</p> <p>New chapter: "11.10 ProfiNet The design shall be coordinated with the Customer and documented. The Profinet must be decoupled from the plant network. This is done using appropriate firewalls."</p> <p>Added: "The Customer will provide an Ethernet connection. The connection type and network topology in the production network shall be coordinated with the technical departments."</p> <p>New chapter: "11.12 Data connection to superordinate computer systems</p>	2014-12-19

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		<p><u>This matter must be coordinated with the Customer's IT departments and the technical department before the system is planned and designed.</u></p> <p><u>The data connection of the PLC S7 model ranges is implemented using the ZF standard connector. The Customer's IT department makes the ZF standard connector available as library.</u></p> <p><u>The Sinumerik PLC components, too, can be connected with the ZF standard connector.</u></p> <p><u>The data connection for other manufacturers must be coordinated individually."</u></p>	
	11.13 / 18	<p>New chapter: "<u>11.13 Remote diagnosis</u></p> <p><u>As a general rule, the connection is established by an employee of the Customer who connects to the machine first and then sets up a web conference with the technician at the manufacturer's site and grants remote access.</u></p> <p><u>Manufacturer-specific remote maintenance solutions (VPN or wireless connections) are not permitted."</u></p>	
	12.3.4 / 20	<p>Modified: replaced "Cooling devices in the form of roof structures are not permitted" with "<u>The Customer shall be consulted about the use of a top-mounted cooling unit.</u>"</p>	
	13.2 / 20	<p>Modified: replaced "must run separately from the other power lines or be adequately protected" with "<u>must be routed according to the manufacturer's installation guidelines.</u>"</p>	
	16.2 / 23	<p>Added: "<u>and be connected before the main switch</u>"</p>	
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1 Scope of Application

The technical instructions described here apply specifically to the machine/machine system's electrical engineering. They supplement the instructions listed in Chapter I General Information of the ZF Technical Delivery Specification and alongside these, are valid for all ZF plants.

2 Normative References

As a basic principle, the agreements listed in Chapter I General Information regarding normative references apply.

They concern the electrical equipment of machines/machine systems and supplement the valid versions of DIN EN 60204-1 and VDA-LVE.

Observe DIN EN 60204-1 (VDE 0113 Part 1) and DIN EN 50178 (VDE 0160), including the target specifications and recommendations contained therein.

3 Definitions

The definitions listed in Chapter I General Information and in VDA-LVE are binding.

4 General Requirements

4.1 Selecting the equipment

4.1.1 Operating materials

The Contractor shall select or design all operating equipment in such a way that it can be connected to the existing local networks - despite any voltage fluctuations and interfering pulses - and is fully functional without any special precautions.

4.1.2 Approved list

Only components and assemblies appearing in the [approved list](#) may be used. They must be in their original condition and without any modifications whatsoever when installed. Deviations must be approved in writing by the respective technical department.

4.2 Electrical engineering setup and installation

Wiring must comply with the [current](#) EMC directive.

Inductive and capacitive interference (e. g. caused by power converters, protection coils, controlled drives, transducers and their power lines, etc.) must not impair the PLC function.

It is important that switch cabinets can be set up near existing cable routes laid by the Customer that are unrelated to the machine.

Shielded cables as specified by the manufacturer are to be used for analog signals, interfaces and bus cables.

The installation guidelines of the system control manufacturer are binding.

Make sure the devices are easy to access. It must be possible to easily replace assemblies and components and also remove covers without requiring the removal of other components.

In the case of special machines, [20%](#) space reserves must be available in the switch cabinet at the point in time of procurement.

5 Electrical Supply and Network Connections

5.1 Line entry

The Customer will connect the feed line to the switch cabinet. Cable glands or cable fittings, including strain relief, as well as any covers are part of the scope of delivery for the machine/machine system.

5.2 Connection to power supply

Terminal blocks must be provided for the power supply connection up to 240 mm². Pay attention to the clockwise phase sequence. An equipotential bus bar shall be provided and connected to the line-side protective ground conductor.

A 5 line terminal (TN-S system) must always be provided. A connection between N and PE in the machine/machine system is not permitted.

5.3 Control circuit grounding

Control circuit grounding is only permitted with a disconnect terminal.

5.4 Main switch

Every machine/machine system must have a mechanical 3-speed lockable main switch.

Door coupling is not permitted; the switch toggle must be fastened to the switch unit.

5.5 Supply voltage

In the event of a power outage, the control unit must turn on automatically when power is restored so that all configuration parameters are re-set without input from the operator and without triggering the actual machine/machine system (processing/motion) to start.

A failure of the supply voltage must not lead to a loss of data [or system failure](#). If a lead-acid accumulator or battery is used to keep data, then its voltage needs to be monitored and visualized.

5.6 Faults

The program must be properly accessible again after power dips and failures or any system disruptions. It must be possible to [bring](#) the production equipment [ahead in the](#) cycle or into home position with the control unit.

5.7 Startup routines

The machine/machine system's technical documentation must include special startup routines after a general reset of the system.

5.8 Plug power supplies

Plug power supplies are not permitted.

6 Protection Against Electric Shock

The conditions defined in DIN EN 60204-1 apply.

7 Equipment Protection

7.1 Overcurrent protection

7.1.1 Overload and short-circuit protection

Up to 32 A, automatic circuit breakers are required (without fuse to protect against overload and short circuit).

Three-pole automatic circuit breakers are required in general three-phase circuits.

Protective motor switches are required for motor electric circuits up to 100 A.

Above a current intensity of 35 A, NH circuit breakers are to be provided.

7.1.2 Switch response

The operator panel must display the response of protective motor switches and line safety switches. For more than 5 motors and/or line safety switches, the responses must be displayed [individually or in groups including the location](#).

7.1.3 Special motors

A temperature monitor is required in the winding for motors used for heavy starting, for a 5x per hour or higher switching frequency or for converter feed.

7.1.4 Feedback

The Contractor must ensure that no incorrect recovery of harmonics occurs in the network.

7.1.5 [Pulse circuits](#)

[Pulse circuits must be designed with semiconductor \(e. g. washing machine heating\). Safety must remain guaranteed.](#)

8 Equipotential Bonding / Screening

Equipotential bonding must converge in a central location and be carried out according to the EMC guideline.

The screening of signal lines must be effected near the device itself and may not be used for equipotential bonding.

A topology plan for the equipotential bonding also needs to be supplied.

[The equipotential bonding must be effected according to the relevant standards. When doing so, take into account high-frequency interference signals/currents caused by converters and nonlinear consumers. Depending on the currents' frequency and giving consideration to the skin effect, highly flexible lines/conduction bands may need to be used. All connecting points must be free of lacquer. Threads must not be used as conductors.](#)

[Toothed disks, snap rings, contact disks with cutting teeth, etc. must not be used as connectors. Also, the earth lug must not be mechanically damaged by toothed disks, snap rings, etc.](#)

[Corrosion-prone areas must be treated with a suitable protective agent.](#)

9 Control Circuits and Control Functions

9.1 Control voltage

The control voltage for PLC, initiators, photoelectric barriers, valves, solenoids, etc., must be 24 DC.

Voltage supply of the measuring equipment must be ensured through separate power supply units.

9.2 Operating modes and functions

The Customer shall be consulted about operating modes and functions (e. g.: manual, stop at cycle end and idling "all units in home position").

9.3 EMERGENCY STOP / Error

9.3.1 Safety equipment harmonization

The Customer shall be consulted about all system safety equipment and the boundaries of the "EMERGENCY STOP" circuits between individual system parts.

In the case of interlinked facilities/machines, the supplier must provide an EMERGENCY STOP concept and must harmonize it with the Customer.

9.3.2 Linking in the case of dangerous situations

A link between various "EMERGENCY STOP" areas is required if a danger exists for persons and/or machines/machine systems at the transfer points of linked machines/machine systems.

9.4 Safe mode

After a disruption, the machine/machine system must shut down in a defined condition (if at all possible from a technical-safety perspective).

10 Operator Interface and Control Equipment Mounted on the Machine

10.1 Status and error displays

Signal lights must display the operating status in plain view for machines/machine systems, machining cells, linked systems and assembly units:

- Red (flashing light): Disruption display (e. g. machine off due to electrical or mechanical disruption, "EMERGENCY STOP" activation)
- Yellow (steady light): Machine off due to unfulfilled start conditions (e. g. setup mode, maintenance, missing workpieces, tool exchange)
- Yellow (flashing light): Warning, machine shut-down impending due to e. g. missing workpieces in the feed, minimum stock reached
- Green (steady light): Machine running in automatic mode, normal operation
- Green (flashing light): Machine/machine system is in automatic mode and the start condition is satisfied.

The Contractor shall consult the Customer about the installation of the signal lights. The sequence of colors from top to bottom is red – yellow – green.

10.2 Distinction

A clear distinction must be possible between error messages and operating messages.

10.3 Reporting switching states

The switching states of the safety switching devices used ("EMERGENCY STOP", guard doors, two-hand start, ...) shall be reported separately to the PLC via its signaling contact. If multiple commands are to be assigned to a safety switching device, they are to be sent back individually to the PLC in addition via auxiliary contacts and displayed in the operator panel.

10.4 Light test

A light test button for each operating panel is required for more than 5 indicator lights and/or illuminated pushbuttons.

10.5 Control elements

The number of control elements (buttons for manual functions) must be small, but familiar high-use control elements must be designed as hardware buttons.

11 Electronic Equipment/Control Interfaces

11.1 Control design

11.1.1 Solutions for Powertrain – List of components

The control concept "[Solutions for Powertrain](#)" (Siemens) shall be used throughout.

The Customer must agree to and approve any deviations from this control concept.

More information (Internet access) can be found on the SIEMENS Extranet. Access is granted by SIEMENS.

11.1.2 Software

The Contractor must coordinate the software structure (PLC, NC, robot programs, etc.) with the Customer.

11.1.3 Visualization

Visual display is provided on every control unit. This shall be coordinated with the Customer.

11.1.4 Implementation of functions

Functions that are not always executed manually must be implemented within the visual display.

Functions that are always executed manually shall be implemented using separate pushbuttons.

11.1.5 Selection of operating system

When selecting the operating systems, the [approved list is](#) binding.

The operating system shall use the language of the operator.

The license number in each case shall be attached to the unit so that it is visible and cannot be lost.

11.1.6 Use of control unit

The use of a pure PC-based control unit (soft PLC, slot PLC, etc.) is not permitted.

11.2 Electronic equipment/control units

The input and output supply circuits must be divided into groups and selectively protected so that a short circuit will not lead to the CPU failing or stopping.

Inputs: 24V DC max. 2A

Outputs: 24V DC max. 8A (with 2A output cards)

AC 230 V assemblies and relay cards are not permitted.

Only one consumer may be assigned to each output and only one actuator to each input.

With decentralized peripheral construction of the I/O levels, the addressing shall be provided in associated blocks with suitable reserve areas (min. 10%) (e. g. E 0.0-0.7, further with E1.0-1-7).

When the control unit is "Off," the CPU's power supply must remain.

11.3 Software

The software and software versions for all programmable systems must be coordinated with the Customer and subsequently delivered. The release and current version must be indicated in the circuit diagram (cover sheet). [The applicable versions must be added in the case of modifications.](#)

Any necessary licenses [and documentation that is required for licensing](#) must be included.

Locking the PLC modules using know-how protection is not permitted.

The software to modify, expand, reload and archive the programmable system or systems is part of the machine/machine system's scope of delivery.

For CNC machines, the project configuration software (only Step 7 and/or S7-Graph) shall be installed on the control unit and the license included.

11.4 Control stations/Control panels

11.4.1 Program/Programming

The program of a control panel (e. g. Simatic OPs) must be available in the source code.

Standard program modules (from Siemens as a rule) must be used for programming.

11.4.2 Range pointers for the OP interface parameterization

Range pointers are preferably stored as data modules.

11.4.3 Superuser

A "superuser" shall retain the manufacturer's standard password or standard default setting.

11.4.4 Help texts

If additional information is needed to operate the machine, then the pertinent help files must be configured.

11.4.5 Setup data

Setup data/workpiece-specific data for the machine/machine system (e. g. axis data, quantity, etc.) shall be managed in the PLC for security reasons in order to secure the current data. Recipes (i. e. personnel-related programming) are not permitted.

11.4.6 Pictograms

With the use of icons, the Siemens standard must always be used. When icons are used, they shall be additionally executed in text form, e. g. using the Info button.

11.5 Programming devices

Additional programming devices, connecting assemblies, manual programming modules, as well as interface cables that are needed for the operation and maintenance of the machine/machine system must be included in the scope of delivery. Otherwise, these are to be offered separately.

It must be possible to connect a programming device at any time without disconnecting the power lines to the PLC and control panel. This must not impact the function of the control unit.

11.6 Interfaces

The interfaces and interface signals for integrated and peripheral equipment (e. g. industrial robots, conveyor systems, screwdriver control units, cooling lubricant systems, chip removal, etc.) shall be coordinated among the individual subcontractors or device and system manufacturers respectively and automatically presented for approval to the Customer. Interface signals must be implemented in 24 V DC and potential free. [The interface signals must be visualized including their status. The signal designations must be consistent.](#)

11.7 Data transmission / Service interface

The interfaces must be designed to be on the outside of the control panel or operating location and have an attached cover.

A connection for the programming device shall be provided in the switch cabinet. In the case of spatially expanded machines/machine systems, multiple connecting points must be provided. Interface connections on the CPU are to be designed with double contacts (MPI and Profibus).

11.8 Coupling several control units and systems

Bus systems shall be taken from the [approved list](#).

Coupling several control units needs to be agreed in advance with the Customer and approved in writing.

11.9 Profibus

11.9.1 Bus topology

The circuit diagram shall contain the bus topology with the following information in a clear format:

- slave address
- wire lengths running between the individual bus participants
- clear wire designations
- installation location of the bus participants in the system (block diagram)
- the bus segment must be recognizable.

11.9.2 Inspection documents

The inspection documents for the following parameters must be issued:

- The real wire lengths (min. 1 m, max. 100 m) and the impedance values of a Profibus segment.
- The transmitting level of all bus participants as a bar chart (minimum 2.5 V and no signal distortions).
- The bus cycle time (average, max/min) and the number of error messages per hour (< 30).

11.10 ProfiNet

[The design shall be coordinated with the Customer and documented.](#)

[The Profinet must be decoupled from the plant network. This is done using appropriate firewalls.](#)

11.11 Network connections for superordinate computer systems

The Contractor must coordinate the operating systems and connections to superordinate/host computer systems with the Customer.

IP is the only allowable network protocol.

Routing takes place exclusively via the Customer's own network components. Access via modem, ISDN, GSM, UMTS and DSL is not permitted. The same applies to wireless LANs that have not been approved by the Customer's IT departments. Only network access authorized by the Customer is permitted. Remote-access can only be implemented via the ZF network.

All external interfaces (serial, parallel, USB, floppy-disk drive, CD-ROM, or the like) must be deactivated through BIOS provided that they are not absolutely necessary for operation. BIOS is protected by the Customer with a password.

It must be ensured that all PC-based equipment that is connected to the data network can be operated with the virus protection (currently Symantec, version must be adjusted) stipulated by the Customer.

Windows operating systems are to be considered virus-prone in principle. It must therefore be ensured that the antivirus software made available by the Customer is up to date and that "online protection" is activated.

The Customer will provide the necessary client or server licenses and will provide support for updating antivirus software.

It must be possible to update the operating systems and applications at regular intervals according to the latest security requirements.

The security patch released either by the control unit manufacturer or Microsoft may not have any impact on the software written by the manufacturer for the entire life of the control unit.

Disconnecting the PC from the server should not affect the live system (emergency operation!); data produced during the server failure shall be buffered and reconciled when the server comes back online. Emergency operation during server failure shall be guaranteed.

The Contractor must design the machine/machine systems so that over an agreed time period, the Customer's production capacity is not limited when the IT infrastructure is down.

Should the network connection be interrupted (the network lines are disconnected), the control unit's program must still continue to run.

The machine/machine system must pass the security check (security scanner) while operating. If an Ethernet network has more than 3 connections, the machine/machine system is to be documented using a network documentation tool (e. g. Microsoft Visio). For this purpose, at least one network plan and one communication plan shall be created. A template may be provided.

The Customer will provide [an Ethernet connection](#). [The connection type and network topology in the production network shall be coordinated with the technical departments](#).

11.12 Data connection to superordinate computer systems

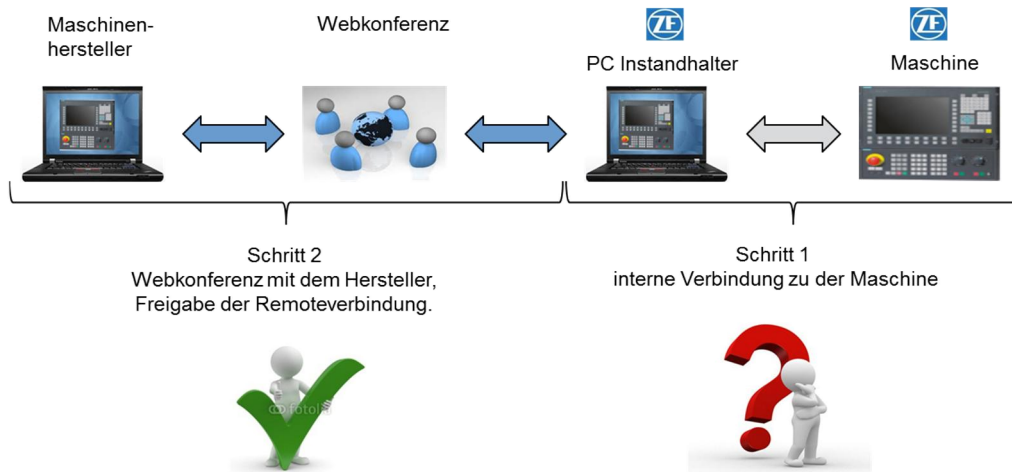
[This matter must be coordinated with the Customer's IT departments and the technical department before the system is planned and designed.](#)

[The data connection of the PLC S7 model ranges is implemented using the ZF standard connector. The Customer's IT department makes the ZF standard connector available as library.](#)

[The Sinumerik PLC components, too, can be connected with the ZF standard connector. The data connection for other manufacturers must be coordinated individually.](#)

11.13 Remote diagnosis

As a general rule, the connection is established by an employee of the Customer who connects to the machine first and then sets up a web conference with the technician at the manufacturer's site and grants remote access.



Manufacturer-specific remote maintenance solutions (VPN or wireless connections) are not permitted.

12 Switching Devices: Layout, Setup and Housing

12.1 General requirements

12.1.1 Space for buttons and sensors

Space for at least 2 pushbuttons or indicator lights shall be provided. The holes required for this must be prepared and covered.

12.1.2 Component protection

All machine/machine system electrical components shall be assembled and protected such that they cannot be damaged or triggered in the event that they are stepped on.

12.1.3 Standard locking

The standard locking method is a two-way key bit.

12.1.4 Installation space

The installation space for electrical components (terminal boxes, consoles, etc.) generally requires IP 54 type protection, a hinge and a two-way key bit standard locking system. A viewing window shall be provided for I/O assemblies.

12.2 Design and layout

12.2.1 Multilayer installation

Devices and panels may not be multi-layered in the switch cabinet.

12.2.2 Swing frame

Swing frames are only permitted if the opening angle is greater than 110° and if it is ensured that the unanchored switch cabinet does not tip over when the frame swings out.

The components behind the swing frame must be accessible.

12.2.3 Front plate

The front plate (of terminal boxes and panels) must swivel and have a catch if there are more than 6 command and message devices. The devices shall be mounted on the front panel (fastened in front with rear connection).

Devices in doors and front plates must be connected via a terminal strip.

12.2.4 Circuit diagram bag

A sufficiently dimensioned and bolted/riveted circuit diagram bag shall be provided in metal construction for storing the circuit diagram.

12.3 Switch cabinet cooling

12.3.1 Temperature

The switch cabinet temperature above control/drive components and control panels may not exceed 40°C. A constant ambient temperature in the hall of 45°C can be expected; possible temperature peaks and location-specific conditions (altitude / height, impact of the sun's radiation etc.) are to be considered.

Only cooling units with thermostats are permitted for cooling.

When the switch cabinet doors are opened, the switch cabinet cooling system must be interrupted by a door switch.

Filter fans, air-air heat exchangers and river and industrial water air heat exchangers are not permitted.

12.3.2 Prefilters

Air conditioners should be provided with prefilters.

12.3.3 Venting condensation

Condensation must be vented to the outside of the switch cabinet and removed or collected using a sufficiently sized apparatus.

12.3.4 Top-mounted cooling

[The Customer shall be consulted about the use of a top-mounted cooling unit.](#)

12.3.5 Temperature monitoring

The temperature in the switch cabinet and the control panel must be monitored and displayed as an alarm signal if the permissible temperature is exceeded (max. 40°C); but the maximum value shall never exceed 45°C.

Disruptions in cooling devices must be monitored and reported to the central control unit.

12.3.6 Heat requirement calculation

The heat requirement must be calculated to determine the required size of the cooling devices for the electrical installation space (e. g. switch cabinet, etc.) and then entered in the machine/machine system's technical documentation.

12.4 Signals ($I < 10 \text{ mA}$)

Signals with amperage smaller than 10 mA must be transmitted contactless.

13 Conductors, Cables and Wires

13.1 Color coding

Circuits that are not switched off (external voltage) by the main switch must be labeled in orange in the entire circuit (wire or flexible tubing).

Power lines and cables that are tapped before the main switch (continuous voltage) must be marked in orange in the entire route (wire or flexible tubing).

Short-circuit proof wires must be used between the main switch and the first fuse if the conductor's cross-sectional size does not match the rated amperages of the fuse.

13.2 Alignment of wiring

Data, bus and instrument lines [must be routed according to the manufacturer's installation guidelines.](#)

13.3 Multiple terminals

Sensors can be connected via initiating/sensing terminals; the use of two-level terminals and multiple terminals is not permitted. Any deviations must be submitted in writing to and discussed with the Customer.

13.4 T distributors and Y distributors

Laying multiple connections to terminals for switch cabinet assemblies or signal distributor assemblies (e. g. bus modules, passive signal distributors, fuses/relays) is not permitted. Distributing the signals with T and Y distributor plugs or similar is also not permitted due to unambiguous signal assignment.

14 Wiring Engineering

14.1 Wiring inside housings

Wires to devices on swing frames or for door assembly must have protective flexible tubing.

The switch cabinet wiring must be laid in cable ducts.

If wire-end ferrules are used, plastic protective shrouds must also be used.

14.2 Wiring outside housings

14.2.1 Cable routing

Where cable is routed, measures must be taken to ensure that no moisture or damage to the lines may occur.

Multiple M screw fittings are not permitted, cable duct systems are allowed. Ready-made lines must be replaceable without disassembling the connector.

14.2.2 Ducts

Power lines are to be laid protected in metal ducts, and covers which are more than 100 mm wide need to be designed with a hinge.

Cable ducts which can be trodden on shall be avoided as a rule and may only be used after consulting the Customer. If they are used, the cable ducts must be tread-proof.

Media-carrying lines may not be installed together with electrical lines in the cable duct.

The metal line ducts must be grounded.

14.2.3 Plug connections

Initiators and other peripheral devices shall be designed to be plug-in. The switch status must be displayed by LED. It must be easy to change the connected lines (e. g. in the cable trailing device).

The line length of sensors/actuators with fixed connection lines can exceed a maximum cable length of 1.5 m, but only in the case of easy access.

If the connection cable comes under a heavy load, then "irradiated" cables with e. g. a high temperature range must be used.

If multiple plug connections are being used next to one another, then they must be kept in order (e. g. plug coding, specified line lengths, etc.).

Up to a rated power of 36 A, all connection lines for system parts that must be disconnected for transport of the machine/machine system must have one-sided plug connections.

The setup of the sections for the cable drag chain is to be documented and the cable drag chain as an assembly must be exchangeable through unplugging within a period specified by the Customer.

Plug connections for auxiliary equipment (e. g. pumps, filters, measurement control units, etc.) must be connected behind the main switch.

15 Electric Motors and Related Equipment

15.1 Actual path measuring systems

Actual path measuring systems (e. g. glass scales) must be installed on the machine in such a way that they can be operated with minimal maintenance, i. e. are protected against dirt of any kind (e. g. using sealing air).

They must be mechanically fastened so that adjustments are not necessary when a component is replaced.

15.2 Drive elements and actuators

All drive- and control elements (actuators) must be designed for continuous duty (100%).

15.3 Electric motor design

Standard electric motors > 0.75 kW must be designed to meet energy class IE3.

15.4 Three-phase AC motors

Three-phase AC motors with a power of 7.5 kW must be preferably designed with an electronic soft start function. Up to a performance of 4 kW, the connection must be enabled by means of a plug connection. The starting conditions are to be harmonized with the respective technical department of the Customer.

15.5 Brake motors

Brake motors are only permissible with rectifiers installed on the motor.

16 Accessories and Lighting

16.1 Electrical outlet

Within the switch cabinet, there must be a Schuko electrical outlet connected before the main switch.

16.2 Lighting

The switch cabinet lighting must be wired for each switch cabinet panel via its own door contact switch [and be connected before the main switch](#).

An energy-saving machine illumination is to be installed which can be switched on/off.

16.3 Lighting and outlet circuit

Lighting and outlet circuits may not be connected on the secondary side of adapting transformers.

16.4 Workpiece and operating hour meter

The machine/machine system must include a workpiece meter which can be reset for the number of processed workpieces (total, OK / not OK parts). This is done preferably with software.

A non-resetting operating hour meter (automatic mode) or a non-resetting system workpiece meter is required, preferably using software.

If cycle-dependent maintenance intervals are necessary, then the machine/machine system must contain counting functions and a signaling system.

16.5 Measurement equipment

16.5.1 Key-operated switch

Measurement equipment must be de-selectable in automatic mode using a key-operated switch (switch settings: "with/without measurements").

16.5.2 Measurement results

Measurement results must be displayed digitally and stored until the next workpiece is processed.

16.5.3 Calipers

For every caliper, the machine/machine system's technical documentation must contain the required test protocol (DIN EN ISO 9000) with an installation assignment (e. g. caliper number). If necessary, a calibrating instrument shall also be delivered in coordination with the Customer.

17 Warning Signs and Labeling of Operating Equipment

17.1 General requirements

Identification signs must always be

- engraved, etched [or lasered](#) in aluminum [or two-layer plastic](#)
- legible
- permanently attached at a clearly visible location
- located next to components, assemblies and devices
- when the devices are concealed, located next to the installation space.

The identification signs may not be located on replaceable components, assemblies and devices.

The identification of components which carry out safety functions is to be implemented as described in TA07 Safety of Machinery, Chapter 2.1.2 Risk assessment.

17.2 Additional information

When marking components installed in the machine/machine system, the following information should be noted:

- The device names must be repeated on the associated cladding and covers.
- Arrows indicating the direction of rotation must be placed on all pumps and motors.

17.3 Inside the switch cabinet

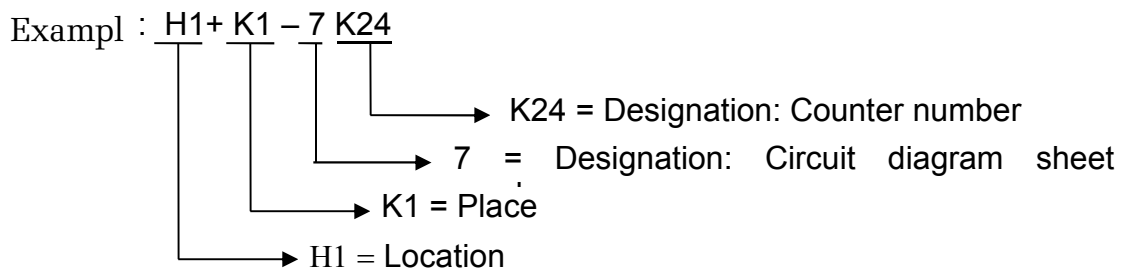
The operating equipment within the switch cabinet must be permanently labeled on the assembly plate and component.

The designations and symbols shall comply with standards.

The designation between sensor/actuator level and PLC control must be intuitively consistent/uniform.

Safety-relevant components are to be marked with +SF and yellow signs.

Component or location identification must be based on location or sheet.



17.4 Outside the switch cabinet

The operating equipment outside the switch cabinet must be completely, permanently and visibly labeled next to the component and on the cable using engraved/printed or etched signs. This also applies to any plugs, switch boxes, command boxes and operating elements.

All electrical installation space must be identified with a warning sign (lightning bolt).

17.5 Cable identification

All cables must be permanently labeled at both ends.

The target or source of the cable must be clear from the cable identification and the electrical diagram (e. g. terminal diagram).

17.6 Individual conductor identification

Devices for which multiple wires must be disconnected when replacing the device must have permanent individual conductor identification. Exceptions may be coordinated with the Customer.

18 Technical Documentation

For requirements, see Chapter II Technical Equipment Instructions, TA08 Technical Documentation.

19 Testing and Inspection

The electrical test protocol must be created according to DIN EN 60204 (BGV A3) and then included in the machine/machine system's technical documentation.

A test protocol for the insulation resistance and the equipment grounding conductor's loop resistance must be included in the machine/machine system's technical documentation.

20 Startup, Final Acceptance, Training

For startup, final acceptance and training see Document I General Information.

21 Other Applicable Documents

Standard	Designation
DIN EN 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements (Refer to Chapters 2, 6)
DIN EN ISO 9000	Quality management systems: principles and terms (ISO 9000: 2005-12-01) (Refer to Chapter 16.5.3)
VDA-LVE	Supply specifications for the electrical equipment of machines, machine systems and equipment (Refer to Chapters 2, 3)
DIN EN 61082-1	Preparation of documents used in electrical engineering
DIN EN 50178 (VDE 0160)	Electronic equipment for use in power installations

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