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## Technical Requirements for Electrical Equipment of Machines, Machinery and Fixtures in ŠKODA AUTO a.s.

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The latest updated version of this ITS is available on the website:

For internal access (for employees) - <https://portal.skoda.vwg/skodaspace/group/specialized-information/its-interni-technicke-standardy>

For external access (for suppliers) - [https://iso.volkswagen.de/one-](https://iso.volkswagen.de/one-kbp/content/cs/kbp_private/information_1/divisions/procurement/terms_and_conditions_of_purchasing_new/koda_auto_a.s_4/koda_auto_a.s..jsp)

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The Company is not obliged to notify their business partners of any ITS updates. Therefore, we strongly recommend that everybody checks this ITS regularly. These documents enter into force on the date of their latest update. In each contract made, the applicable ITS wording shall be the one effective as at the date of issuing the purchase order concerned. Please note that in the event of any differences among the Czech, English and German language versions of this ITS, the Czech version shall prevail.

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Change number:	Date:	Note:
1.	1994-10-01	Completely revised
2.	1995-11-10	Completely revised
3.	1995-12-15	Replacing sheet 2 and 4
4.	1996-02-01	Additions to ČSN-EN standards
5.	1997-02-03	Replacing sheet 12, /art 5.4/
6.	1999-09-30	Completely revised
7.	2001-04-17	Completely revised
8.	2002-02-01	Ariel font, ŠKODA logotype
9.	2004-09-10	Completely revised
10.	2008-03-01	Completely revised
11.	2009-02-10	Partially revised
12.	2010-12-21	Completely revised
13.	2012-01-06	Completely revised
14.	2012-10-10	Update of standards, partially revised
15.	2013-11-15	Section no. 16 updated
16.	2014-10-20	Completely revised
17.	2016-11-01	Update of standards
18.	2017-08-11	Update of articles 4.9, 6.6
19.	2018-07-01	Update of articles 4.9
20.	2018-12-13	Update of articles 2.3, 4.9, 14.1, 15.7
21.	2019-12-12	Update of standards
22.	2021-10-06	Completely revised
23.	2021-11-23	Insertion of point 1.10
24.	2023-04-11	Update of articles 2.4, 3.5, 5.2, 6.9, 6.11, 7.3, 9.4, 14.1, 14.3, 14.6, 15.2, 15.3, 16.1, 16.11, 16.15, 16.43

## 1. General Requirements

- 1.1. The Contractor is responsible for the correct functionality of the machine and for compliance with all relevant EU directives, laws, government regulations, ordinances and technical standards in the country of installation, which are applicable on the equipment.
- 1.2. The Contractor must comply with the following regulations in force on the date of conclusion of the contract:
  - ITS ŠKODA AUTO a.s., <http://cts.skoda-auto.com/>  
For electrical machines and equipment in particular:
    - ITS 1.01 General technical conditions,
    - ITS 1.05 Information systems and technology,
    - ITS 1.09 Shut-offs, closing devices,
    - ITS 5.11 Electrical assembly and installation
    - ITS 5.13 Control technology.
  - Requirements and detailed specifications for the design of the equipment in the form of a technical specification issued for the relevant part of the production or project.
  - Risk assessment and risk minimisation according to ČSN EN ISO 12100 and the documents produced here are part of the scope of delivery of the machine.
  - According to ČSN EN ISO 13849-1, 2, the evaluation of the safety control of the machine must be carried out using the Sistema program. The files created must be submitted complete with the documentation for the equipment. Other evaluation methods are only permitted after agreement with the specialist department of ŠKODA AUTO a.s.
- 1.3. It is necessary to comply with the regulations, in the sense of ČSN EN 60204-1 Iss.2 and ČSN 33 2000-X-XX, applicable to electric machinery equipment, machinery and fixtures, which are not manually portable during work, powered from electrical sources with nominal voltage between wires (phases) up to 1000V~ and 1500V=
- 1.4. The Contractor has to ensure, according to ČSN EN 60204-1, ed. 2
  - Security of persons and property.
  - Trouble-free production.
  - Service life and economy during operation.
  - Ease of maintenance.
- 1.5. The Contractor, after receiving an order, prior to starting the installation on the Customer's location of installation, has to submit relevant documents, specified in the submission, or in agreed scope, such as installation plans, implementation plans, assembly plans, schedules and personnel appointment schedule. In case of changes in the electrical equipment, the modified documents have to be submitted again for written approval to the relevant department of ŠKODA AUTO a.s.
- 1.6. **The Contractor is obliged to familiarize himself on relevant standards, local decrees and customs for the particular manufacturing equipment. After expansion or modification of the current manufacturing sets the Contractor is obliged to comply with regulations relevant for the particular type of production and is responsible for the overall functionality of the machine.** The Contractor's customer service has to be available for the maintenance works during the guarantee period. The service period has to be part of the bid as a binding promise. **In case of problems with compliance with the technical submission and local customs, the Contractor is obliged to inform the expert departments of ŠKODA AUTO a.s. immediately, propose, consult and submit the solution for approval.**
- 1.7. The documents submitted by the expert departments to the Contractor may not be copied or made available to a third party or otherwise appraised without a consent of the Client. ŠKODA AUTO a.s. will obtain free-of-charge, exclusive, irrevocable, without limitation of territory and time, sublicensed user rights to the results of the work, performed by the Contractor based on this order for ŠKODA AUTO a.s.
- 1.8. All operational equipment may be operated only below limit values, specified by the manufacturer and nominal element values may not be permanently exceeded. It does not apply to limit values for voltage, current, temperature, impact protection, vibrations, oil mist, liquid fumes and other physical values.
- 1.9. No agents, harmful to the environment and health, may be used (e.g. FC-carbohydrates, asbestos etc.). No silicon and Teflon based materials may be used in the production equipment. Teflon based products may be used only with the consent of ŠKODA AUTO a.s.
- 1.10. Machinery, electrical equipment of machinery and equipment that is installed in the EPA zone (antistatic workplace) must comply with the VW 80132 standard.
- 1.11. After submission a presentation of the mechanical concept, detailed expert negotiations between the Contractor and relevant expert department have to take place. The control concept, including EMERGENCY STOP circuits, protective grills, start-up circuits and modes of operation have to be approved prior to commencement of construction by a relevant expert department. The responsibility for the complete concept, its implementation, installation and functionality is born by the Contractor according to the legislation in force.
- 1.12. In case of extension or modifications of the current equipment the Contractor is responsible for the overall functionality of the equipment, subject to extension or modification. In case of reconstruction of the current equipment/machinery all unusable components have to be removed and the documentation has to be modified accordingly. The scope of modifications of the current machinery and its character will be assessed by an expert department of ŠKODA AUTO a.s. In case the proposed modification have the character of reconstruction or a new delivery of machinery and incomplete machinery to the current machinery, the manufacturer or his authorized representative will prepare, prior to commissioning of the machinery, the EU declaration of conformity in compliance with the European Parliament and Council Directive 2006/42/ES (identical with government decree no. 176/2008 Coll.) according to the appendix II section 1 part A, and will ensure, that this declaration is attached to the machinery. The acceptance by the competent expert department is necessary.

## 2. Nominal voltages, safeguarding and protection

### 2.1. Protection against electric touch as per ČSN EN 60204 – 1 ed.3, chap. 6.

2.2. The wiring has to be protected especially against short circuit, against thermal as well as dynamic effects of short-circuit currents according to ČSN EN 60204-1 ed.3, ČSN 33 2000-5-52 ed.2, ČSN 33 2000-4-43 ed.2, ČSN 33 2000-4-41 ed.3, ČSN EN 60909-0 ed. 2 and against mutual interference (EMC). The appliances, especially electric motors, have to be protected also against overloading, the protection elements have to be installed on all phase conductors. Zero conductor protection ensured according to ČSN 33 2000-4-43 ed. 2.

2.3. Main circuit connection (connection point, voltage level) is determined by the competent expert department of the relevant ŠKODA AUTO a.s. plant. The Contractor may not rely on suppositions and assumptions regarding the network, but has to plan his equipment and implement it according to the submission of ŠKODA AUTO a.s.

The expert department has to clarify and determine the following issues, e.g.:

- line voltage,
- network type (e.g. TN-C or TN-S),
- introduction of power supply from the top or from the bottom into the distribution box,
- size of the cable eye of the connected line,
- required protection and supply line cross section.

The sequence of phases of all low-voltage equipment, including three-phase outlets, is: L1-L2-L3 (right rotating field)

Assignment of conductors in cables to potentials has to be performed as follows:

- brown (L1)
- black (L2)
- grey (L3)
- blue (N)
- green/yellow (PE)

Two weeks after contract submission the Contractor has to state for each needed line connection the expected reference (15-minute) power and connection power, in order to determine the connection points for the necessary supplies (ev. parallel supply cable) for line supply. No terminals, connectors or other connections inside the cable channels may be used.

### 2.4. Welding Network

The contractor shall clarify with the competent technical department whether there is a special welding network for resistance welding equipment (three-phase AC 3/PEN AC 400 V network as TN-C or 3/N/PE AC 690 V network as TN-S network) in addition to the general network in the plant concerned.

Welding devices are powered by AC 400V 50Hz.

- Connection lines for 400 V networks: two phase conductors and a protective conductor (PE).
- Connection lines for 690 V networks: one phase conductor, neutral conductor (N) and protective conductor (PE).

### 2.5. Reactive power compensation

In the design process, it must be determined whether the technically and economically viable solution is individual, group or central compensation. Where appropriate, mixed compensation is also necessary. Overcompensation or capacitive operating conditions of the equipment are not permitted (risk of voltage increase).

### 2.6. Inductive loads

If the reactive power of 10 kVAR is exceeded over the entire operating range for operating devices representing inductive loads (e.g. three-phase motors and coils), the minimum reactive power (for three-phase motors, reactive power at no-load) must be compensated so that a phase shift factor  $\cos \varphi$  of  $0,95 < \cos \varphi < 1$  is achieved over the entire operating range. This does not apply to automatic sprinkler extinguishers.

### 2.7. Variable speed drives

When using generators with higher harmonic frequencies, e.g. any kind of inverter, the phase shift factor  $\cos \varphi >$  within  $0,95 < \cos \varphi < 1$  and the power factor  $\lambda$  (lambda) within  $0,90 < \lambda < 1$  shall be observed, guaranteed by the Contractor and demonstrated by measurement at the request of the department for all operating modes (quadrants I to IV, metering power and partial loads).

The result is to be graphically represented and forwarded to the specialist department. The sizing calculations are to be supported by measurements after commissioning. The composition of the measurements, the operating conditions for the measurements and the results are part of the plant documentation.

### 2.8. EMC resistance

Electrical and electronic devices, safety modules, PLC control, etc. must be designed to withstand voltage changes and disturbing impulses in the ŠKODA AUTO a.s. network in accordance with the applicable standards.

General conditions: when designing the circuit, structural and technological design of the system, it is necessary to suppress the level of interfering signals directly at their source. Excessively high power, voltage and current levels of the processed signals are not allowed. Generated interfering signals must be eliminated as close as possible to the place of their origin. EMC (Electro Magnetic Compatibility) for short. It is necessary to limit the propagation of interfering signals along the line by including interference filters and surge protectors. Reduce inductive electromagnetic coupling by suitable arrangement of conductors, their shielding or twisting, spatial separation of sources and receivers of interference. Data lines must be separated from power lines by at least 25 cm; if they are separated by a metal (shielding)

partition, multiply this distance by 1.01. It is essential to observe the correct principles for the arrangement of the system earthing (low earth impedance, limitation of the formation of earth loops, separation of power supply systems, all power supply networks in TN-S system, etc.).

For EMC drives, the use of the following components must be considered for EMC compliance:

- Mains filter - prevents the network from backfeeding (harmonic frequency interference).
- Mains inductor - protects the frequency converter from surge peaks in the network.
- Output filter - harmonizes the AC output voltage of the frequency converter into a sinusoidal waveform.
- Output choke - prevents interference from the surrounding environment.
- Electrical wiring - always according to manufacturer's rules and design guidelines.
- Wiring and accessories - must be made with grounded shielding in accordance with the manufacturer's instructions. Cable routes (channels) shall be properly connected along their entire length.
- EMC module - for some manufacturers, combines mains filter and output choke in one housing.

## 2.9. Power Failure Protection

After a power interruption or failure, the equipment must be able to safely drive over the control panel and continue operation when power is restored. No loss of function or loss of data in memory is permitted, see ČSN EN 60204-1 ed.3. To ensure this condition, a spare power supply (UPS) must always be installed for PC-based systems or PC-based control systems (PC-PLC). The time to maintain the specified voltage to supply these control circuits must be determined during the design phase, each technology has different time requirements for data backup and correct shutdown. The battery charge status shall be indicated on the control panel. The specific design of the UPS must be approved by the specialist department of ŠKODA AUTO a.s.

The use of undervoltage protection for machinery must be consulted with ŠKODA AUTO a.s. In the event of a temporary loss of voltage and when the supply voltage is restored, the spontaneous start-up of motors, mechanisms or other equipment driven by e.g. pneumatics or hydraulics must be prevented. These conditions must always be indicated on the control panel.

## 2.10. Protection and Securing

Protection against electric shock must comply with ČSN EN 60204-1 ed.3 ch.6:

- from dangerous contact with live parts,
- from dangerous contact with non-live parts.

The protective circuit is made of protective conductors or conductive machine components (metal covers). All relevant metallic parts of the electrical equipment, including the machine structure, have to be conductively and visibly connected. All connection points and protective terminals have to be visibly marked in accordance with ČSN EN 60204-1 ed.3. The design and positioning of the protective conductor must comply with ČSN EN 60204-1 ed.3 Art. 8.2.

For widespread machinery, it is necessary to determine the exact position of the grounding belts in the equipment. This needs to be taken into account in the design plans and agreed with the customer in advance. When a part is removed for repair or any other reason, the protective circuit have to not be broken for the parts that remain on the machine. Metal hoses must not be used as a protective conductor but have to be connected to the protective conductor. Apparatus mounted on doors, movable covers and lids must be provided with a reliable connection to the protective circuit, except for equipment for safe voltage. If electrical equipment is mounted on the door, cover or enclosure, then the earth potential shall be connected via a wire or strap to a bonding terminal on the moving part. Doors and covers shall not be secured at their extreme position through the earth potential conductor. They will be secured e.g. by a chain, cable etc.

The clamp and grounding screw for the connection of the supply protection wire must be marked:

- by sign of protective earthing
- by letters PE and target with green/yellow colour combination

### *Protection*

Safety current circuits must no longer branch from the switched-off part of the current circuit into other, e.g. input current circuits.

### *Overcurrent protection equipment*

Where possible, circuit breakers should be used instead of fuses.

### *Values for dimensioning and setting of overcurrent protection devices*

When using several safety devices in series, selective tripping capability have to be guaranteed. For rules on motor protection and protection, see chapter 9.4

## 2.11. Surge Protectors

### *Surge protectors for switchboards*

The device must be protected by a chain of surge protectors, which have the task of gradually reducing the energy of the overvoltage to a value safe for the device. Level II to III surge protection must be used at the entrance to the control cabinet, depending on the design of the technology. The use of surge protectors must be consulted with the ŠKODA AUTO a.s. The status of the overvoltage protection needs to be signaled on the control panel. If no special control panel is installed, then on the electrical cabinet.

### *Surge protectors for control system*

For the control system, robot control, industrial PC and other electronic devices etc., a surge protection (SP) of level III or level IV (according to the calculation) is required. The surge protector must protect the power supply of the control system and its inputs or outputs wherever unwanted interference could occur (e.g. due to the length of the wiring, wiring around the source of interference, e.g. around a frequency converter or a motor controlled by a frequency converter, etc.). The installation of the PO and EMC must be approved by the specialist department of ŠKODA AUTO a.s.

### 3. Emergency Stop, Emergency Shutdown, STOP Function, Main Switch

3.1. The functional aspects of emergency stopping are given in ČSN EN ISO 13850 and ČSN EN 60204-1 ed.3. The electrical equipment of the machine must be equipped with a device capable of stopping the whole machine as quickly as possible and meeting the requirements of ČSN EN ISO 13849-1 and ČSN EN ISO 12100.

#### 3.2. Emergency stop

- In all operating modes, this function must override all other functions and actions, see ČSN EN 60204-1 ed.3.
- When a safety feature (emergency stop control, safety barrier, etc.) is activated, it must be signalled on the control panel. For larger installations where it is difficult to identify which element is activated (conveyors, welding lines, etc.), a central overview panel or beacon signals and possibly other auxiliary information equipment must be used. This must always be specified in the design brief. Emergency stop signalling is in red, safety optical barriers in yellow. Other signalling of dangerous movements (such as the uprighing of a pneumatic, hydraulic cylinder or other mechanism) shall be signalled in orange, see project specification.
- When bridging the safety protection (safety optical barrier, protective door, etc.), the automatic operation must be prevented, see ČSN EN ISO 13849-1, ČSN EN ISO 12100. The machine must be equipped with a means to select this mode with key switches, see ITS 1.09.

3.3. It is possible to restart the machine after pressing or switching the controls on the operator panel, by sounding an acoustic signal (for large and confusing devices such as lines, conveyors, etc.) and by stopping the light signal. Consult the specialist department of ŠKODA AUTO a.s.

#### 3.4. Main Switch

The main switch (see ČSN EN 60204-1 ed.3) must comply with the following requirements, among others:

- It must have an accessible handle on the outside of the cabinet. If an automatic disconnecter is used, the handles must be accessible outside the cabinet.
- The supply terminals shall bear a warning label "Caution under voltage even when the main switch is off". The supply terminals must be marked with the appropriate pictogram according to the ČSN and secured against accidental contact.

If the main switch is not also used as an emergency stop device, its handle must not be red (it must be black or grey).

The handle of the main switch shall be easily accessible and located at a height of between 0.8 m and 1.4 m above the floor or access plane (1 m preferred). The design of the main switch shall be such that it can be locked in the off position, 8 mm diameter bracket. Door locking shall not be activated when the main switch is on (it shall be possible to open the cabinet door in position 0 and I).

Circuits that are not switched off by the main switch:

- shall have a permanent warning label(s) suitably located near the main circuit breaker,
- shall have an appropriate notice in the instructions for use,
- a permanent warning label must be placed near each non-switched outlet or the non-switched circuit must be separated from other circuits,
- the conductors of the trip circuit shall be marked in orange.

#### 3.5. Connection to the source

The design of power cables must meet the requirements of ČSN EN 50565-1,2. Testing of power cables and conductors shall be carried out in accordance with ČSN EN 34 7010-82. All power conductors and cables shall be of flame spread enhanced design in accordance with ČSN EN 60332-X-X.

It is recommended that the electrical equipment be connected to a single power source. The machine connection must be made to a separate terminal block or directly to the main switch terminals. The terminals must be marked L1, L2, L3, zero potential N and protective conductor PE. The supply terminals must be protected against accidental contact with the warning sign **ATTENTION! Energized even when the main switch is switched off!** We require the possibility of connecting a measuring instrument to terminals L1, L2, L3.

#### 3.6. Operating Modes

By selecting the modes, a dangerous state must not occur, in ŠKODA AUTO a.s. mode selection is required via the EKS function or key switch and mode selection button, lockable switch, access code or key combination. The selection of the mode itself must not start the machine, for this the operator must perform a special action. When choosing a mode, it is necessary to comply with the rules in ITS 1.09 and 5.13. It is necessary to consult with the specialist department of ŠKODA AUTO a.s.

#### 3.7. Stop Function

The choice of the stopping category according to ČSN EN 60204-1 ed.3 must be determined from the risk analysis report for the supplied equipment. The stop function of the drives is superior to the corresponding start function. Switching off the actuators' stop switch interrupts the voltage to the actuators, but the control voltage is maintained. The design of the switch shall be such that it can be locked in the off position.

#### 3.8. Emergency Shutdown

Functional aspects of emergency shutdown are described in ČSN EN 60204-1 ed.3. All risks on the equipment must be taken into account in accordance with ČSN EN ISO 13849-1 and current valid legislation and evaluated in a protocol.

### 4. Control, Command and Signalling Elements

4.1. The control devices shall, where practicable, be located in dry and clean places. They shall be easily accessible for operation and maintenance personnel. Controls, except foot switches and position sensors, shall be located at a minimum height of 0,4 m above the access plane. Other locations must be consulted with the specialist department of ŠKODA AUTO a.s.

4.2. All control devices (such as limit switches, electro magnets, pressure switches, etc.) must be protected against environmental influences and mechanical damage and must be connected in a plug-in manner. All elements must be clearly, distinctly and indelibly marked on the

fixed mounting plate, on the instrument and, where applicable, on the supply cable to the instrument coil if this cannot be done in any other way.

- 4.3. In the case of control devices that are connected by socket connection, the affiliation of the pins to the socket must be unambiguously evident and the interchangeability (coding, marking) must be guaranteed.
- 4.4. Mechanically operated position sensors (limit switches) shall be so designed and located that they are not damaged when the cue is crossed. Safety functions shall be wired in accordance with ITS 5.13. The sensor bump pin shall be operated directly by a rigid mechanical bump according to ČSN EN ISO 14119.

Permanent magnet electromagnetic position sensors must not be used to sense the position of dangerous movements such as overrun protection, end positions of protective covers, position of bulky arms driven by pneumatics and hydraulics, etc.

At high switching speeds or high switching frequencies, non-contact proximity sensors must be preferred over mechanical position sensors (limit switches). These sensors shall be directly powered by the control voltage. Adapters are not permitted. Inductive sensors should not be oriented with the sensing surface horizontally upwards.

Use position sensors with IP68 connector on the device in moisture, oil, etc. In welding or electromagnetic interference areas, use only sensors that are resistant to this phenomenon.

The permissible travel speed of the position switch must not be exceeded, see catalogue values.

- 4.5. Function Control in Automatic Operation  
If the continuity or safety of operations requires a precise stop of a machine part (sliding, rotary tables, etc.), this stop must be derived from the HW actual position. It is not permissible to sense the position of the piston rod or piston using position sensors.

If a pressure switch is used in the hydraulic circuit, this switch is always subordinate to a position sensor which checks the actual position of the part to be moved and enables the following operation. The status of all sensors, limit switches and movements shall be indicated on the control panel for easy fault diagnosis.

- 4.6. Pressure and Temperature Switches  
Contact pressure switches and thermostats must have a momentary contact system and be rated at least IP54.
- 4.7. Operating Panels  
The operating panels must be arranged in such a way that the operator can see all movements generated from here. Should this not be possible, additional operator panels shall be provided. The use of portable operator panels must be discussed with the customer. The design of the panels shall comply with the General Ergonomic Conditions - ITS 1.25.  
  
Control panels must be equipped with lockable doors, resp. covers with lock E1. For multiple interlocks, only one E1 lock needs to be installed and for the remaining rotary levers.

Structure of command and announcement elements should be carried out according to ČSN EN 60 447 ed. 2. The order of the buttons is from left to right, e.g. switch-off button, switch-on button. Basic position indicator (R) on the left, operating position indicator on the right (V). If possible, incorporate the emergency stop button on the bottom left.

- 4.8. The controls for manually operated switches must be located so that they are easily accessible from the operator's position in an ergonomic position, but at least 0,7 m above the operator's access plane. Controls, switch covers and signal lights shall comply with ČSN EN 60204-1 ed.3.
- 4.9. Emergency Stop Button  
The red button colour is reserved for these functions. It must not be covered by anything and must be mushroom-shaped with a minimum diameter of 30 mm highlighted with a yellow background according to ČSN EN ISO 13850. The actuator (button) and its yellow background are required to be of a design without text or markings. Where a mark is required for clarification, a mark according to IEC 60417-5638 shall be used.

Pressing this button disconnects the control voltage and illuminates the signal beacon, either on the visualisation board or directly at the emergency stop element. Those devices that are necessary for safe stopping of the machine, e.g. optical elements (light barriers, scanners) according to ČSN EN 62061 and ČSN EN 61496-X, remain energized. Design of emergency circuits must comply with ČSN EN ISO 12100, ČSN EN ISO 13849-1, ČSN EN ISO 13857.

- 4.10. STOP Function Button  
This function is used to switch off drives and power circuits etc. The button is black in colour in the size of the actuators used, see ČSN EN 60204-1 ed.3. The red colour of the button is allowed, but it is recommended that it is not used near the unit for emergency operation.

- 4.11. START Function Button  
The white colour of the buttons must preferably be used for these functions.

- 4.12. Cycle Start Button  
For these functions, the colour is white. For button functions that must be pressed throughout the entire working operation, such as two-hand start or confirmation buttons, the colours must be black and mushroom-shaped. Two-hand switching shall comply with ČSN EN 60204-1 ed.3 and ČSN EN ISO 13851.

Wireless controls must comply with ČSN EN 60204-1 ed.3 and are subject to the approval of the relevant specialist departments of ŠKODA AUTO a.s.

## 4.13. Colour Coding of Buttons

Colour	Meaning	Interpretation	Examples of use
RED	Dangerous condition	Use in case of danger or emergency	Emergency stop  Starting emergency functions
YELLOW	Exceptional, abnormal condition		
GREEN	Safe condition	Use to prepare normal state	
BLUE	Command	Use to return to the initial state	Reset
WHITE	Starting functions	Generally for triggering functions other than emergency shutdown	START/ON
GREY	Without a certain meaning	Generally for triggering functions other than emergency shutdown	START/ON  STOP/OFF
BLACK	Switching off functions	Generally for switching off functions other than emergency shutdown	STOP/OFF



## 4.14. Colour Design of Signalling:

If a "DANGER" (see table) or malfunction occurs, the red indicator light must be on or flashing red. It must be off in the idle state. Display the operating indication (OK status) with a steady light, display the violated status as flashing as a matter of principle. To check the bulbs, the device shall be equipped with a check button that verifies the correct functioning of all light signals and indicators. The choice of variants must be consulted with the specialist department of ŠKODA AUTO a.s. Use LED indicator lights.

Colour	Meaning	Interpretation	Examples of use
RED	Dangerous condition	Dangerous conditions	Immediate action to avert a dangerous situation (e.g. by pressing the emergency stop button)
YELLOW / ORANGE	Abnormal (exceptional) condition	Abnormal (exceptional) conditions. A critical condition is imminent	Monitoring or intervention (e.g. restoring a desired function)
GREEN	Normal condition	Normal conditions	Depending on the choice
BLUE	Command	Communication of a condition requiring operator action	Commanded activity
WHITE	Neutral	It can be used whenever there is doubt about the use of red, yellow, green, blue	Monitoring and control

## 5. Auxiliary circuits

## 5.1. Using the Transformer

A decoupling element must be used to power the control circuits.

5.2. For machines, the control circuits of the individual mechanical groups must be fed from an isolating transformer, see ČSN EN 60204-1 ed.3 and ČSN EN 61558-X-X ed.X. For transformer-supplied circuits, any branch of the secondary winding which is not connected to a non-live part of the machine must be short-circuit protected.

## 5.3. Recommended Control Circuit Voltages

- DC voltage - 24V
- AC voltage (50Hz) - 230V

5.4. A ground connection or connection to an inanimate part of the machine in the event of a failure of any part of the control circuit must not cause the machine or any part of it to start unexpectedly or prevent it from stopping. One side of the control circuit must therefore be connected to the protective circuit.

Control circuits that are fed from a transformer and are not connected to a protection circuit must be provided with a device for checking the insulation condition, e.g. current protectors, which report the connection to a non-living part of the machine or cut off the power supply to the control circuits automatically.

5.5. Input and output units in electronic circuits shall, for safety reasons, be connected to the side of the control circuit not connected to the protection circuit.

5.6. If the failure of any auxiliary function (e.g. cooling, lubrication, chip removal) could result in danger to the operator, the machine or the workpiece, all drives which would cause this dangerous condition must be stopped or the required safety must be otherwise ensured. According to ČSN EN 60204-1 ed.3 and ČSN EN ISO 14118.

5.7. As a rule, transformers, rectifiers and switchgear may be loaded up to 70 % of the permissible ratings of the intended types of operation.

## 6. Installation

6.1. Where appropriate, electrical equipment shall be concentrated in one switchboard. Only devices which, because of their function, must be located at a certain place on the machine, such as pushbuttons, hand controls, limit switches, clutches, motors, etc., shall be located on the machine. For larger units where one control cabinet is reserved for the programming device and documentation, this cabinet must be located next to the control cabinet. In other connection cabinets (such as control cabinets and panels), connection connectors for the programming instrument and Ethernet communication must be located. Consult the specialist department of ŠKODA AUTO a.s. The design of switchboard bays and stand-alone switchboards must comply with ČSN EN 61439-1 ed.2.

- 6.2. Parts that generate heat must be positioned so that the heating of other components inside the enclosure does not exceed the permissible limit, see the manufacturer's catalogue value. The power and control parts must be separated at least by a partition or, for larger units, in a separate enclosure. In the case of external cooling, the air is fed into the enclosure via a filter. The power section must always be placed first from the left. **For new electrical equipment, it is necessary to use low-energy appliances as a matter of priority.**
- 6.3. Fasten switching devices, e. g. contactors, time relays, protective devices as well as series terminals, in a horizontal arrangement on the hat rail according to ČSN EN 60715.
- 6.4. All parts of the electrical equipment must be located so that they are easily accessible for replacement. They must be arranged in such a way that they can be identified without the need to remove or disconnect the line. The principles of device placement must be observed, see ČSN EN 60664-1 ed.2. Control devices are considered to be easily accessible if they can be replaced without special tools within 10 minutes.
- 6.5. Cabinets and switch cabinets, resp. install their accesses (doors) outside electrically protected fences (protective grille). Inside only with the consent of the specialist department of ŠKODA AUTO a.s.
- 6.6. Conductors exposed to damage, moving conductors or conductors in a cable chain shall be of plug-in design on both sides. Electrical components of the machine changing their location must be connected via a connector. Cables shall be highly flexible.
- 6.7. Devices that require a function check or must be replaced frequently must be accessible without having to dismantle other equipment or parts of the machine, except to open the door or remove the cover. The devices must be placed at a height of 0.4 m to 2 m above the access plane.
- 6.8. Modules and devices must not be arranged on the side walls, behind the mounting plate or frame of the switchboard.
- 6.9. Instrument connection terminals and disconnecting terminals shall be so arranged that:
  - they are positioned at least 0,3 m above the access plane so that all necessary conductors can be connected to them,
  - the opening is accessible without dismantling other parts of the machine,
  - the opening is in a vertical plane.

The design of the power cabinets shall comply, including all tests required, with ČSN EN 61439-1 ed.2. All locks, latches and keys shall comply with the ITS 1.09. The enclosure of the switchgear shall be proportionate to the effects that will be exerted on the equipment in operation, such as dust, fumes, oils, coolants, chips, possibility of mechanical damage, etc. The cooling of the switchgear shall be by forced two-zone/two-circuit circulation so that the cooling section in the switchgear is separated from the external environment.

**6.10. The ambient temperature of the enclosure must not affect the safety, durability and reliability of the components in the enclosure and the process control.**

The temperature in the switchboard must not exceed the prescribed operating values of the individual components.

In the case of temperatures above 40°C, it is necessary to install equipment for cooling the switchgear, see chapter 16. Preferably, low-energy cooling equipment (e.g. energy-saving air-conditioning units, thermoelectric cooler, etc.) must be used, but in particular make maximum use of passive cooling and correct installation of the components, using the gaps between them for proper air circulation. The use of openings for cooling air inlet and outlet is not allowed, including the use of fans with filters. Cooling will be dual zone/dual circuit so that the cooling section in the cabinet is separated from the outside environment.

Heat loss calculations must be part in the documentation.

**According to the determined total power loss, appropriate cooling measures have to be determined.**

When the door of the cabinet is opened, the cooling of the cabinet is to be interrupted by the door switch. The functions of the ventilation and air conditioning equipment are to be monitored and malfunctions or failures reported. When the warning temperature (XX °C) in the cabinet is exceeded, a message is to be displayed on the main service desk and a "stop after end of stroke" is to be initiated after 30 minutes. The message shall be confirmable.

- 6.11. All openings in enclosures, including openings in floors or foundations, shall be covered so as to maintain the coverage required for the equipment. Unused grommets shall be removed and openings plugged. Pass-throughs for multiple cables into the floor or box walls shall come with 20% reserve space, and all reserve space shall be properly sealed.
- 6.12. It is recommended that electrical equipment cabinets have doors with vertical hinges and, if possible, ejectable doors. The opening angle of the doors shall be at least 135°. The opening angle of the doors shall also be guaranteed after the installation of the cabinet switchboards. The standard door width is 0,6 m, the plinth height is 0,2 m and the cabinet height is 2 m. Cabinet switchboards to be made with closing devices in accordance with ITS 1.09. The inside of the doors shall be provided with pockets for the storage of electrical documentation. Each switchboard group or filed shall have one tilting table for programming equipment. If a design technical specification (so called Technical Assignment) is issued then the design dimensions of the switchboards apply. **Access to the control equipment must comply with the provisions of E ČSN N 60204-1 ed.3.**
- 6.13. For equipment that is manufactured to Client's requirements, at least 20% of the space in the cabinet must be left free for later modification or addition. For mass-produced machines, 10 %.

The reserve applies to the devices of the individual function groups as well as to terminal strips, wire connection channels, swing-out frames, plug-in locations in the PLC for input and output cards and program memory. In the case of fieldbus systems (e.g. Profinet module), it is necessary to maintain a minimum of 10% space in the rack for mounting modules.

- 6.14. Under no circumstances shall the following be placed in switchboard cabinets or electrical equipment rooms:
- mechanical parts and equipment that must be accessible while the machine is running,
  - moving parts, e.g. rotating shafts,
  - mechanical control devices which are not part of the electrical equipment of the machine,
  - hydraulic or pneumatic parts,
  - the exception is pneumatic logic modules - this technology is mounted in small enclosures directly to the components (valves, cylinders, etc.). Agreement with the Client is required.
- 6.15. All gaseous and liquid media required to supply the machine must be controlled. If production stoppages are expected, a pre-warning must be given to the control system before the machine reaches a standstill. If the limit values are exceeded or not reached, or if control devices are activated, the machine must be stopped immediately at the end of the stroke, if necessary.

## 7. Wires and Cables – Connections

- 7.1. **Solid core cables and conductors shall not be used in machinery installations. The provisions in ČSN EN 60204-1 ed.3 must be met.**

Conductors subject to frequent movement (operational movement) must be made with flexible cables designed for this purpose. Operational movement is defined here as a minimum of once per hour on average. For multicore cables (more than five cores), a minimum of a 10% margin must be allowed.

- 7.2. The cable insulation must be suitable for the environment and mechanical stresses. In aggressive environments where the cable comes into contact with cutting emulsions, oils, welding fluxes and other aggressive substances, PUR cable must be used (e.g. for sensors, valves, bus modules, etc.).
- 7.3. The cross-sections and types of wires shall be laid down with regard to the working environment. Generally, wires are sized under ČSN EN 60204-1 ed.3, ČSN 33 2000-5-52 ed.2, ČSN 33 2000-4-43 ed.2.
- 7.4. For installation of a machine that has the switch box and control panel outside, multi-core sheathed conductors or cables shall be used for interconnection. The wires and cables shall not have a sharp bend when installed. The minimum bending radius shall be in accordance with ČSN EN 50565-1, 2. For the use of fibre optic cable, a cable tray with a minimum bending radius shall be used. The typical bending radius is ten times the cable diameter for a single bend, and twenty times the cable diameter for a moving cable. If protective tubing is used, highly flexible, ground-resistant plastic tubing or braided flexible protective steel tubing may be used and must be secured to the structure at the end.

When using a decentralised peripheral, e.g. a bus box for sensors/controllers, the maximum length to the end device is five metres. The use of Y-distributors is only permitted for sensors or actuators with associated functions, e.g. front and rear cylinder position. The Y-distributor must not be mounted on the sensor/controller box itself, but should be routed in a five-core line to the instruments as close as possible, not more than 1 metre, and only then installed.

Devices built into doors or hinged frames shall be connected by multi-core wiring or flexible cores in a protective hose. Cable runs exceeding 2 m in height shall be secured to the cable ladder or trough at the designated locations.

The connection must be made in sufficient length and in a clear manner so that the devices can be quickly and easily replaced or tested. Only copper (Cu) is acceptable as a conductive material. The cross-sections of the copper conductors used must be in accordance with ČSN EN 60204-1 ed.3 (minimum cross-section for the internal wiring in the cabinet is 0.75 mm<sup>2</sup>, for the control wiring 0.2 mm<sup>2</sup> and for the external wiring outside the cabinet 1 mm<sup>2</sup>).

- 7.5. All connections must be in the terminals or plugged into the connector. Soldered connections are not permitted, exceptions being data and measurement lines. All wire ends in bolted connections must be provided with their own glands or cable lugs (compression connections). In the case of spring clamps, no sleeves shall be used at the end of the conductors. Two or more conductors shall not be bundled together. The use of bridges is permitted to extend the number of terminals in the terminal block. Terminals shall be numbered in accordance with the wiring plan. Only one wire may be connected to each terminal. In exceptional cases, a maximum of two conductors per output is possible.

No clamps, connectors or other connections may be used inside the cable ducts.

We assume a terminal margin of 10% for series machines and 15% for special machines.

- 7.5. The numbering of terminals should be done as ascending from left to right, or from bottom to top. The terminal numbers of one switching group in the enclosure shall be continuously from 1 upwards. Letters may only be used for mains terminals, potentials (such as j, n, m, etc.) and control terminals. Multiple terminals of the same name are not allowed, but terminals with the same potential in terminal boxes may receive the same numbers. For basic potentials such as N-light blue and PE-green-yellow, it is necessary to keep the marking also for the terminal type.

## 8. Wiring - Enclosures, Built-in Spaces and Socket Connections

- 8.1. All conductors shall run from terminal to terminal for a sufficient length. The connections must be sufficiently secured against loosening, soldered connections must not be used, and the ends of the conductors must not be mechanically stressed, which applies especially to the connection of moving parts. These must be connected with flexible conductors.

The connection lines must be of such length that the devices can be easily replaced.

For more than five-core lines, we require a minimum of 10% spare cores to be available for changes and repairs. Exceptions are main current lines and motor connections.

- 8.2. Conductors of control circuits and of the same power rating may be laid together in conduits, troughs, conduits, tubes, or may be run in multicore cable. Data, bus and meter lines shall be installed separately from power lines and adequately shielded. Conductors with different power ratings must be installed in separate bulkheads, e.g. 24Vdc control circuits separated from 400Vac power supply. Hydraulic and pneumatic lines shall not be laid together with electrical cables and lines in ducts, troughs. Exceptions are energy guide chains. For energy guide chains, use as a matter of principle dividing partitions between lines.
- 8.3. The storage material for the installation wiring shall meet the requirements of ČSN EN 50085-1 ed.2 and ČSN EN 60204-1 ed.3. The troughs, ducts and pipes for the installation of the wiring shall be located in such a way that they are not exposed to the risk of mechanical damage, they shall be sufficiently strong, in a standard design. Fixed grates or catwalks shall be installed on the floor at the location of walkways for mechanical resistance. The thickness of the closed metal trough must be at least 2,5 mm. When placed on the structure between the machine and the switchboard, the trough must be at least 2.5 m above the floor. **All troughs and ducts must be covered.** The nominal cross-section of all cable ducts or troughs may be fitted to a maximum of 80%. All unused, old installation must be removed from the troughs.
- 8.4. **In damp or wet areas, cables to electrical equipment must be fed from below.** When the cable is fed in from the side, there must be a drip arc on the cable to prevent moisture from entering the unit through the cable. It is not permissible to feed the cable from above.
- 8.5. Care shall be taken to ensure that capacitively or inductively transferred voltages between lines do not cause interference in any case. Consult the specialist department of ŠKODA AUTO a.s.
- 8.6. Metal hoses may only be used for small movements that are not frequently repeated. They must be securely connected to the protective circuit and protected against the ingress of oil, coolant or dust. It needs to be consulted it with the specialist department of ŠKODA AUTO a.s.
- 8.7. **Colour Marking of Wires**  
The colour marking of power conductors and cables must meet the requirements of ČSN EN 60445 ed.5, ČSN EN 33 0166 ed.2 and ČSN EN 60204-1 ed.3. The conductors of the non-switched circuit upstream of the main switch shall be marked in orange.
- 8.8. **Colour Coding of Individual Conductors**

• for protective conductor	- green/yellow
• for the middle conductor	- light blue
• for AC power circuits	- black
• for AC control circuits	- red
• for DC control circuits	- dark blue
• interlocking control circuits powered from external sources	- orange
• conductors of the non-switched circuit upstream of the main switch	- orange
• temporary wiring	- white
- 8.9. In decentralised electronic systems to facilitate fault finding, measuring points shall be installed at a location outside the fence. These measuring points shall be marked in accordance with the diagram with the potential symbol of the control measuring point, easily accessible, properly isolated, and sufficiently spaced to allow connection of measuring leads.
- 8.10. **Socket Connections**  
Movable and removable machine parts, see ČSN EN 60204-1 ed.3, which change their position, are connected via sockets. The supply side of the circuit must always be plugged into the socket cavity. The sockets must be secured against accidental ejection or removal. Sockets that are not currently in use must be covered with covers. If there are multiple sockets and forks on the equipment, they shall be clearly distinguished by coding. Sockets for different voltages shall be interchangeable. Grommet connections that are unused shall be covered so as not to compromise the enclosure of the switchboard.  
  
Single-phase 230V sockets must be in a version with a protective pin (not the version from the company Schuko) connected to the protective conductor. Sockets in switchboards intended for maintenance, programming devices, etc. must be connected in front of the main switch with an orange wire and marked with a safety label stating "Caution under voltage even when the main switch is off".

## 9. Drive and Control Elements

- 9.1. **General conditions**  
The standards of ČSN EN 60146-1-X must be complied with for drive and control elements. The basic requirements for drive devices are specified in EN 60204-1 ed.3. Parallel switching of contacts is not permitted to increase performance. To prevent overvoltage or overpolarisation during tripping (clutches, brakes and solenoid valves), limiting elements are used to limit the voltage to the permissible value. The limiting elements are located on the switching elements in the control cabinet or integrated in the connectors of the solenoid valves.  
  
All valve and sensor connections must be made via a connector with a signal diode. Hardware wiring in series or parallel wiring for control sensors (proximity switch, limit switch, etc.) is not permitted.  
  
The motors must be connected via a quick disconnect connector with a control contact for reporting to the control system. Higher power motors must be connected via clamps or quick couplings, see motor manufacturer, Chapter 16.
- 9.2. **Selection**  
All drive and control elements must be designed for 100% duty cycle. Motors may be designed differently for short or intermittent operation. All motors shall have the allowable power rating indicated on the type plate.

### 9.3. Assembly

All drive and control elements (motors, clutches, brakes, solenoid valves and lifting magnets) as well as the corresponding terminal blocks and plugs are installed in such a way that even in the built-in state, easy maintenance and testing is possible without the use of special tools. Access to other parts of the machine requiring maintenance must not be affected.

Functional signs (e.g. unidirectional rotation, open/closed, etc.) must be permanently positioned externally on the machine, secured against confusion and clearly visible even with the covers installed.

### 9.4. Motors

Electric motors must comply with the requirements of ČSN EN 60034-8 ed.2. Special motors may only be used when their use is unavoidable. They require written permission from ŠKODA AUTO a.s.

The nominal frequency must not be exceeded in continuous operation for three-phase motors supplied by the inverter. If a lower rated frequency is operated in continuous operation, external cooling must be sized or fitted accordingly.

It is essential to use bearings with permanent lubrication or bearings with automatic lubrication. The dimensions of the motors in terms of standardisation must comply with ČSN IEC 72-X. All conductors must be short-circuit protected. The rated fuse current or the set tripping current of the circuit breaker shall be as small as possible but appropriate to the motor inrush currents, transformer inrush currents, etc. All motors shall be overload protected. Where a circuit breaker cannot be used, a fuse may be used. The protection signal shall be reported by the control system. Protection elements shall be included in all phases. The same applies to the protection of plug-in circuits. The output of the electric motors must be adapted to the mechanical power requirement of the machine. The motors must have thermal overload protection. Only one motor can be connected to the overload protection.

The motors must be protected against speeding. If there is a risk of damage to the tool or workpiece when the drive speed is exceeded or undershot, the device must switch off the drive safely. It is recommended to use AC motors with natural or forced cooling, with a coverage of min. IP44 according to ČSN EN 60529. In some cases forced cooling is required. If the necessary data are not known, it is assumed that all asynchronous LV motors from the power of about 10kW must be started with a star / delta switch or with a soft start according to the conditions specified in ČSN 33 2190. The following circumstances must be taken into account when selecting the power size:

- network characteristics at the point of connection
- transformer power in the supply network
- the regulations of the electricity Contractor.

In the case of power motors, it is necessary to assess the power switchboard with regard to the necessity of installing power factor compensation, see standard ČSN EN 61921.

It shall be possible to easily tension or replace belts, chains and adjust couplings.

**All areas on the engine or gearbox that require regular maintenance (e.g. brushes, lubrication cartridges, connector, etc.) must be freely accessible.** The use of IE3 motors with reduced power consumption according to ČSN EN 60034-30-1 is required. Motors with efficiency class IE2 may only be used in justified cases with proof of cost-effectiveness or by stating application-relevant reasons. Their use must be consulted with and approved by the specialist department of ŠKODA AUTO a.s.

If the engine plate is not legible after installation in the compartment, a second plate must be fixed near it, clearly visible and legible. In the case of the choice of a frequency asynchronous motor, the rules laid down by the manufacturer and ČSN EN 60146-1-1 ed.2 must be observed.

Engine/motor power shall always be specified at a frequency of 50Hz in the E-Plan, including for motors/engines fed via a frequency converter.

## 10. Machine Lighting

The lighting of workplaces for finishing, repair inspections, etc. shall be governed by ITS 2.00, or the lighting concept for these workplaces shall be addressed in the technical specification.

The lighting of the machinery must correspond to the respective production operation according to ČSN EN 12464-1, see ITS 1.25, e.g. for normal production from 500 lux, workplace for fine operations 750-1000 lux. Stroboscopic effects must be avoided when using fluorescent or discharge lighting. Special emphasis should be placed on non-glare lighting. The Contractor shall provide lighting measurement reports, see ITS 2.00.

The lighting circuits for the machine must meet ČSN EN 60204-1 ed.3. The rebuildable luminaires must be suitable for workshop use with an anti-glare raster, must be 24V and must meet the protection for the given conditions. Lighting outage must not cause machine downtime. The equipment operator must be consulted for the wiring of the lighting.

Always connect the cabinet box lighting for the cabinet box via its own door positioning switch.

It is necessary to ensure glare protection, e.g. during shielding gas welding and stud welding.

## 11. Marking

11.1. The Contractor shall mark all enclosures and compartment lids covering electrical equipment with "lightning warning" according to ČSN EN 60204-1 ed.3.

11.2. The electrical equipment of the machine must be fitted with a sufficiently large label indicating where the equipment is connected.

11.3. The content of the label must meet the ČSN EN 60204-1 ed.3.

- 11.4. All replaceable components shall bear the manufacturer's marking and other information to enable their replacement in accordance with ČSN EN 81346-1, 2.
- 11.5. For machinery, all switchboards, electrical apparatus, terminals, connectors, cables and wires shall be permanently marked identical to the drawings. Each single device of the electrical equipment shall be marked next to it on the fixed plate and, if possible, on the supply conductor. For marking, use clip-on labels on the individual conductor, e.g. to the coil of the device, so that the marking is clearly visible and indelible. Marking with a sheet metal label or an engraved plastic plate ensures long-term legibility and indelibility. These labels must be permanently affixed to a fixed part of the switchboard or machine. The type and size of the font must be clearly legible. The colour of the description must not overlap with the label backing. Handwritten descriptions are not permitted.
- 11.6. Special attention must be paid to the marking of circuits that are not switched off by the main switch. Part 3.4.
- 11.7. Both ends of cables and wires shall be marked. Colour differentiation of conductors for cables to sensors may be used. Marking need not be only for wires that are connected to a connector (e.g. I/O card PLC) due to small space. Describe the wires that are connected to the rails (e.g. PE or N) with the appropriate lead numbers. Rules for marking cables and wires must be agreed with the specialist department of ŠKODA AUTO a.s.
- 11.8. Controls, such as buttons, wires, switches, etc., must be clearly and durably marked with an unencrypted function, either on the element itself or next to it. Symbols can only be used for marking in addition.
- 11.9. Label all inputs and outputs of electrical controls with addresses. Label input and output cards with absolute and symbolic addressing. The markings must be retained at the points of connection when replacing components.

## 12. Control Technology

Control technology according to ITS 5.13.

## 13. Selection of Elements

- 13.1. Only elements according to the release list, see chapter 16, are permitted. Deviations must be authorized in writing and confirmed with the ITS 1.03 form. Only identical parts of the same factory product shall be used for the same functional purposes within the same installation. This also applies to standardized parts. Exceptions may be granted and confirmed in writing only in justified cases. For larger projects a specification (narrowing) of the components used may be made by selecting from the released components of Chapter 16, ITS 1.11 (e.g. project technical specification).
- 13.2. All electrical components shall be used only in their original condition without the slightest modification. It is not permissible, for example:
- drilling holes for attachment,
  - removing any part,
  - changing the end of the shaft,
  - changes to the manufacturer's standard control hardware and software.
- 13.3. Switches must be selected so that, according to the switching frequency, the service life of mechanical and electrical parts corresponds to the service life of the machine.
- 13.4. Switching devices for electromagnetic actuators, such as clutches, brakes and solenoid valves, shall be rated for a service life of at least 10 million switching cycles.
- 13.5. The control and command elements shall reliably withstand a continuous current of 2A. The above does not apply to non-contact control and command elements.
- 13.6. The selection of electronic modules, such as power electronics, electronic control, must be authorised in writing. **It is the contractor's obligation to submit a list of the electrical components used for written approval. If a releasing list of components for an individual project has been pre-approved and issued, then no additional approval is required for these items.**

## 14. Pre-acceptance at the Contractor, Acceptance, Commissioning, Inspection of Electrical Equipment

- 14.1. General Terms and Conditions  
The process is specified in detail in ITS 1.01.

Acceptance procedure - the final acceptance (takeover) will not take place until all assembly work has been completed and the machine commissioned.

### *Electrical inspection*

The machine-relevant documentation shall include requirements for power supply (to the machinery), especially the cross-sections of the supply wires, as well as the pre-fusing type and current level. The machinery shall be connected and secured in line with all requirements laid down in the documentation.

After connecting the machinery, it is necessary to conduct an electrical inspection. The machinery connection inspection shall be carried out by an inspection engineer (certified by the Czech Technical Inspectorate) before the machine commissioning.

The contractor shall properly submit protocol 3305 on all tests performed to check the electrical safety of the machinery under ČSN EN 60204-1 ed.3, and the document shall specify the manufacturer of the machinery, name, type, serial number, year of production and other necessary information. Each machine will undergo the following checks: Article 18.1 checking that the electrical system conforms to the technical documentation; Article 18.2 checking the conditions for protection by automatic power supply disconnection; Article 18.6 functionality tests. The other tests required in Articles 18.3, 18.4, 18.5 and 18.7 are optional (mandatory test for lifting devices - 18.3 – insulation resistance according to ČSN EN 60 204-32.ed2). The Contractor shall submit an electrical safety report (Form 3305) to specify

individual circuits and measurements performed on them (tripping loop impedance, protection circuit continuity, current protector measurements, etc.). Each circuit will come with the serial number, safety device identification, safety device type, the current level and the tripping characteristics. Further, the report will list all safety devices contained in the machinery, including spare outlets in the order as fitted in the switchboard (does not apply to safe voltage SELV, PELV). If Form 3305 with a list already exists for the system, the Contractor will add all new outlets to the existing form. There shall be only one form per machine, and the form will be subsequently used for annual checks of the condition of the (electrical) machinery in use.

The form will be delivered in a signed pdf document and as an Excel spreadsheet (for further reference/checks and further extension, if any).

The form shall be provided to the Contractor by the Project Implementer.

The supplier will submit protocols on unit tests of electrical switchboards according to ČSN EN IEC 61439-1 ed3

All test reports shall be part of the documentation coming with the machinery.

#### 14.2. Commissioning

Commissioning includes, but is not limited to:

- functional tests of inputs and outputs,
- setting of motor protection devices,
- testing of all reporting devices,
- testing of all external control devices,
- functional tests and commissioning of process interlocks,
- tests of functionally authorized operation in individual types of operation,
- fault reporting simulation.

Commissioning is considered to be complete if all the prerequisites for acceptance are met. The programming and service equipment required for commissioning and programming shall be supplied by the equipment Contractor. During commissioning, the current status of the SW and HW documentation (technical documentation, program printouts and data carriers) must be permanently available at the site for the operator's (customer's) use.

The assembly supervisor responsible for commissioning will be informed of the actions taken. For the commissioning period, the Contractor must supply the corresponding replacement devices. Delivery of replacement material cannot be realized by the customer.

#### 14.3. Tests and verification of safety of electrical equipment according to ČSN EN 60204-1 ed.3 for switchboards ČSN EN IEC 61439-1 ed.3.

The measured values shall be entered in the initial inspection report or shall be annexed thereto. The Contractor shall submit reports on performed functional tests according to ČSN EN 60204-1 ed.3 especially in terms of occupational health & safety. The manufacturer is obliged to submit for inspection a risk assessment/analysis for individual workplaces according to valid legislation, including HW electrical connection, see ITS 1.01 point 3.2.

#### 14.4. Acceptance

For further provisions, see ITS 1.01.

#### 14.5. Prerequisites for Acceptance

All basic technical values contained in the contract will be observed. A report on the verification of the safety of the machinery and the electrical inspection of the supply was submitted.

See others as specified in ITS 1.01. The documentation must correspond to the actual design and must be made in the Czech language, including the translation of the text of the drawings.

The following documents are prescribed for special equipment:

- for equipment that must be tested at the customer's site, all contract test documents must be made available prior to commissioning,
- for equipment intended for use in hazardous areas, the manufacturer's attestation must be certified by a State Authorised Testing Authority,
- for electrical devices that are used as protective devices (e.g. overfill protection, leakage indication) in installations working with water hazardous substances or flammable liquids, the approval of the design department be provided by ŠKODA AUTO a.s.

**The costs of examinations and prescribed documents shall be borne by the Contractor.**

#### 14.6. Familiarisation with the Machinery

Operators and maintenance personnel must be trained to work on the machine. The duration of the training should be adapted to the requirements. The Contractor shall supply a proposal in his offer for the scope and cost of sufficient familiarization in hardware, software. Adequately prepared documentation material shall be made available to the trainees to carry out the briefing. The Contractor is obliged to prepare an outline of topics and submit an attendance list of familiar employees. The Contractor is obliged to make a demonstrable acquaintance of operation and maintenance by the operator (user) by the handover and start of operation of the machinery, see ITS 1.01 and 1.18. To make the staff familiar with the system, the Contractor shall use the latest version of Škoda Auto a.s. Form Reg. No. 1747.

Familiarisation with machinery must cover the following topics in detail:

- overall function of the machine,
- automation concept,
- hardware construction,
- installation concept,
- operating concept and reporting (e.g. operating and fault reporting),
- software structure,

- aggregate modules (aggregate module, link module),
- construction of the data link (e.g. data exchange between machine control and higher-level control),
- the possibilities of intervention in order to change parameters and texts must be explained and implemented by practical examples,
- fault finding and monitoring based on documentation, e.g. with the aid of a programming device.

## 15. Electrical Engineering Documents

### 15.1. Electric Documentation of Hardware

Documentation for new machines and equipment must be produced in the CAE-system EPLAN in version ITS 1.01. Specification of the rules for EPLAN has to meet ITS 5.13.

In addition to the data form, the documents must also be submitted in A4 paper form. The DIN drawing for the installation of the machine must contain all the information necessary to carry out the preparatory work for the installation of the machine. The documentation must contain the data for the selection of the type, characteristics and rated current of the overcurrent protective device to be installed at the beginning of the supply line and its parameters. The drawing for the installation of the machine shall include the dimensions and routes of the cable ducts, troughs and trays to be provided at the base of the machine. Further provide a location plan of the various elements distributed around the installation.

### 15.2. Software Documentation

The form of individual parts of the software documentation (e.g. PLC control, robot control) must be consulted with the ŠKODA AUTO a.s. and confirmed in writing. Specification of rules for software documentation according to ITS 1.05 and 5.13.

In addition, the following must be supplied, among other things:

- Program on a data carrier with an original description of the validity of the SW.
- A list of all SW and firmware versions under ITS 1.05 shall be delivered as part of the takeover for operation (commissioning).
- Parameters for supplied communication systems and access passwords
- The software documentation must be supplied on DIN A4 sheets. The content and form of the documentation must be agreed with the ŠKODA AUTO a.s. and confirmed in writing.

For various projects and various customers in the VW Group, certain conditions can be set for electrical connection, marking, programming, e. g. by project assignment (Lastenheft in German), such as the Group Guidelines 10-E-xxxxx, etc.

### 15.3. List of Functional Units, BOM

The list of functional units, the BOM, is an integral part of the electrical documentation and a printout in an XLS table together with a list of fast-wearing parts is supplied at the time of acceptance.

The Contractor is obliged to deliver the SAP structure in xls format, and the structure shall be compliant with the SAP PM module guideline. A template is available from the Client upon request.

The list of functional units must comply with the directive for the PM module of SAP.

It shall include all electrical devices and appliances with details required for ordering spare parts:

- functional designation in the diagram,
- description,
- main data (power, speed, voltage, current, frequency, enclosure, insulation class, etc.),
- the manufacturer's designation and the type designation of the apparatus,
- the number of identical instruments, appliances or components in the installation,
- determination of cable cross-section, design and insulation.

### 15.4. Instructions for Maintenance, Adjustment and Periodic Inspections

Instructions for maintenance, adjustment and periodic inspections must include, but are not limited to:

- preventive maintenance and periodic inspection plan,
- instructions for maintenance work, including that required for the replacement of certain components,
- adjustment instructions,
- indicate the time limits of components subject to accelerated wear,
- identify possible risks according to ČSN EN ISO 12100, and, if necessary, submit an analysis report for inspection,
- provide appropriate manuals/descriptions for each device used (e.g. drives, controllers, control units).

### 15.5. Positional Drawing or Layout Table

It must include, for machinery, information on the location of the various parts of the electrical equipment. Individual functional units, such as terminal blocks, pull-out units, sub-assemblies, modules, must be identified in the same way in all related diagrams and tables. It shall also include a diagram of the location of instruments, cabinets and terminal boxes. Further a safety concept of the layout and all elements of personal safety.

### 15.6. List of Wear Parts and Spare Parts.

This list must include a list of components that are recommended to be stored due to their faster wear and tear.

### 15.7. An annex to the electrical safety verification report of machinery is supplied with the machine as part of the ŠKODA AUTO a. s. form (No. 3305). This form must be provided to the contractor by the event organiser (e.g. the planning department of ŠKODA AUTO a. s.), this annex will be included in .xls format and on data carriers.



## 16. Releasing List of Electrical Elements

These components are generally specified and prescribed for all deliveries of machines and machinery, as well as overhauls and reconstructions. A list of released components will be sent by the PSZ unit on request.

The Contractor is obliged to use only released components for delivery to ŠKODA AUTO a. s. in accordance with ITS 1.11.

In case of necessary use of non-released components, the Contractor is obliged to send a request for an exemption from the ITS with sufficient justification for deployment at ŠKODA AUTO a.s. to the PSZ Department - Methodology and Standardisation for approval and control.

The Contractor must send the list of selected components to the user for approval.

In exceptional cases of supply of equipment intended for special applications in non-production areas such as test rooms, classrooms, laboratories, etc., provided that the equipment cannot be assembled from standardised components and operated in an efficient manner, other components may be used. The Contractor is obliged to notify any deviations when drawing up the technical specification and to have the solution approved in writing by the specialist department of ŠKODA AUTO a.s.

## 16.1. Control Buttons, Switches and Main Switches

Raster for drilling under ČSN EN 60947-5-1 ed.3

Schneider Electric	EATON-MOELLER
Siemens	ABB

## 16.2. Control Panels and Touch Screen Technology Computers

Emerson	Siemens
Phoenix Contact	

## 16.3. Large Information Boards, Command Annunciators and Information Systems

Siebert	Siemens
Wibond	

## 16.4. Warning Systems - Signal Lights, Beacons and Horns

Siemens	Turck
Balluff	Murrelektronik

## 16.5. Mechanical Limit Switches

Preferably according to ČSN EN 50041.

Balluff	Siemens
Euchner	Schneider Electric

## 16.6. Inductive and Capacitive Sensors, Groove sensors, Accessories

All sensors must be in a shock, liquid and temperature resistant housing (e.g. metal or special plastic housing) with connector and LED signalling. Sensors with a cubic shape shall have an M12 connector or, for safety components, an EMC-certified connector. All must have a minimum protection rating of IP 67. The connector shall be provided with an indication LED for status checking. If this is not possible for technical reasons, the design must be consulted with ŠKODA AUTO a.s.

Balluff	Turck
IFM - Electronic	Pepperl+Fuchs
Sick	Di-soric
Wenglor	IPF

## 16.7. Connector Passive Combiners for Sensors, Valves, Accessories

Balluff	Turck
Pepperl+Fuchs	Weidmüller
Murrelektronik	

## 16.8. Mechanical Safety Switches for Entrance Doors and Openings

Design according to ČSN EN ISO 14119 with CE certificate.

Schneider Electric	Euchner
Sick	Schmersal
Balluff	ABB

16.9. *Safety Non-contact Sensors for Entrance Doors and Openings*  
Design according to ČSN EN ISO 14119 with CE certificate.

Pilz	Schmersal
Euchner	

16.10. *Safety Switching Modules*

Pilz	Schneider Electric
ABB	Sick
Siemens	Phoenix Contact

16.11. *Single Beam Optical Sensors*

Sick	Balluff
IFM - Electronic	di-soric
Pepperl+Fuchs	Turck
Wenglor	

16.12. *Optical Safety Curtains, Barriers and Grilles*

Sick	Leuze – Lumiflex
Fiessler	

16.13. *Safety Switching Mats with Accessories*

ASO	Contra
ABB	

16.14. *Pressure Switches*

According to ITS 1.12 alternatively according to ITS 1.13

16.15. *Pressure, Flow, Temperature Watchdogs*

Turck	IFM – Electronic
Festo	SMC
Wenglor	

16.16. *Absolute Angular Measurement, Incremental Sensors*

Balluff	Heidenhain
Sick	TR-Electronic GmbH
Pepperl+Fuchs	

16.17. *Linear Measuring Systems*

Balluff	Heidenhain Turck
Sick	Pepperl+Fuchs

16.18. *Mechanical Safety Elements*

Power protection, current relays, circuit breakers, thermal protection of motors, fuse elements and automatic devices according to ČSN EN 60715, ČSN EN 50011.

Siemens	Schneider Electric
EATON-MOELLER	Jean-Müller
OEZ	ABB

16.19. *Electronic Circuit Breakers*

Weidmueller	Phoenix Contact
Murrelektronik	Jean-Müller
E-T-A	

16.20. *Switching Technology - Contactors, Motor Starters, Main Switches, Switches*

Schneider Electric	Siemens
EATON-MOELLER	ABB

16.21. *3-Phase Motors*

SEW-Eurodrive	Bauer
Nord	Siemens

16.22. *DC, AC Servo Drives*

Use must be agreed in advance with ŠKODA AUTO a.s.

Rexroth Bosch Group	Siemens
SEW-Eurodrive	Festo

16.23. *Frequency Converters*

Use must be agreed in advance with ŠKODA AUTO a.s.

SEW-Eurodrive	Rexroth Bosch Group
Siemens	ABB
Danfoss	

16.24. *Decentral Frequency Converters and Bus Controlled Motor Switches*

The use and type of bus must be agreed in advance with ŠKODA AUTO a.s.

SEW-Eurodrive	Phoenix Contact
Siemens	Danfoss

16.25. *Automatic Systems of Single Rail Drives*

Siemens, Flender, LJU	SEW-Eurodrive
VAHLE-DETO	

16.26. *Lightweight Connectors*

Lapp Kabel	Harting
ESCHA-Turck	Siemens
Wieland	Pepperl+Fuchs
Weidmüller	Murrelektronik
Phoenix Contact	

16.27. *Heavy Connectors*

Harting	Lapp Kabel
Weidmüller	Phoenix Contact
Wieland	

16.28. *Clamps, Terminals, Accessories*

Wago	Weidmüller
Murrelektronik	Jean-Müller
Phoenix Contact	Siemens

16.29. *Cable Trays, Cable Support Systems and Their Accessories*

OBO Bettermann	Niedax
Kopos Kolín	

16.30. *Control Cabinets and Their Accessories*

Version of the Lütze system "LSC B" or "LSC C". The method of implementation must be consulted with the specialist department of ŠKODA AUTO a.s.

Rittal	ABB
Del - Žďár nad Sázavou	Häwa
TVD – Slavičín	

16.31. *Compact Cabinets and Small Cabinets*

Rittal	Sarel
Del - Žďár nad Sázavou	Hensel

16.32. *Air Conditioning Units*

Unless otherwise specified, the air conditioning unit must be on the door or on the side of the cabinet.

Rittal	Pfannenberg
Häwa	

16.33. *Programmable Control Systems*

Use must be agreed in advance with ŠKODA AUTO a.s.

Siemens	Phoenix Contact
Emerson	

16.34. *Technology Computers - without Touch Screen*

Siemens	B&R
Phoenix Contact	

16.35. *Bus Systems*

Profibus	Profinet
Interbus S	IO-link

16.36. *System Decentral Periphery I/O Modules*

The use and selected components must be approved in advance by ŠKODA AUTO a.s.

Siemens	Turck
Phoenix Contact	Murrelektronik
Emerson	Balluff

16.37. *Programmable Safety Control Technology, Bus Safety Systems*

The use and selected components must be approved in advance by ŠKODA AUTO a.s.

Pilz	Siemens
Phoenix Contact	Emerson

16.38. *Network Data Elements, Switches, Routers*

The use and selected components must be approved in advance by ŠKODA AUTO a.s.

Siemens	Phoenix Contact
Murrelektronik	Emerson
Harting	

16.39. *Identification Systems*

The use and selected components must be approved in advance by ŠKODA AUTO a.s.

Pepperl+Fuchs	Balluff
Sick	Turck
Siemens	Harting

16.40. *Backup Power Supplies*

Siemens	Phoenix Contact
APC	Eaton
Murrelektronik	

16.41. *Surge protectors*

Phoenix Contact	ABB
Hakel	Dehn + Söhne
Saltek	

16.42. *Power Supplies*

Phoenix Contact	Siemens
Weidmüller	Murrelektronik

16.43. *Optical Sensing Systems*

Sick	Keyence
IFM	Turck
Cognex	Siemens
Wenglor	

16.44. *Measuring Energy Consumption*

Phoenix Contact	Siemens
Turck	Festo
IFM	Weidmueller