

	TECHNICAL CONDITIONS CONSTRUCTION DESIGN, PRODUCTION AND ASSEMBLY MACHINE TOOL ELECTRICAL EQUIPMENT	OBN 067a Sheets: 9
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**THESE INSTRUCTIONS ARE BINDING FOR ALL ŠMT EMPLOYEES.  
 FAILURE TO COMPLY WITH THIS REGULATION IS CONSIDERED A BREACH OF OBLIGATIONS ARISING  
 FROM LEGISLATION RELATING TO WORK PERFORMED BY THE EMPLOYEE!**

**I. PURPOSE**

This document establishes a binding procedure for design processing and subsequent implementation of electrical equipment of individual machine groups within the framework of internal or external processing of electrical equipment in the ŠKODA MACHINE TOOL a.s. company. External processing means the purchase of machine parts and of machine function groups or the purchase of services.

**II. DEFINITIONS AND ABBREVIATIONS**

- AC** alternating current
- DC** direct current
- IEC** International Electrotechnical Commission (International Standard)
- EN** European Standard
- DIN** German Institute for Industrial Standardization (standard designation)
- IP** degree of protection
- PLC** programmable logic controller
- CAE EPLAN** electrical design software

**III. ACTIVITY DESCRIPTION**

**GENERAL PRINCIPLES**

These technical conditions apply as general principles for the construction, production and assembly of machine groups and other parts intended for assembly of machine tools in ŠMT which contain electrical equipment. For the supply of functional groups - switchgear, control panel, power supply, automatic tool change, operator cab, hydraulic power units, technological accessories, etc., these conditions are supplemented by a set of requirements for a particular machine design. Unless stated otherwise in the contract or other written documents relating to the subject of delivery, these conditions are binding for manufacturers (suppliers).

Installation of electrical equipment must be performed only by those with verifiable professional and qualification prerequisites, validated in accordance with valid regulations (in the Czech Republic, certification according to Decree No. 50/1978 Coll. on professional qualifications in electrical engineering or newer regulations)

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## 2. STANDARDS AND REGULATIONS, POWER SUPPLY

Unless specified otherwise in the contract, electrical equipment design is governed by the following regulations:

- Directive **2006/42/EC** of the European Parliament and of the Council. Particular emphasis is placed on Article 13 “Procedure for partly completed machinery” with the requirements for technical documentation as set out in Annex VII, Part B, Installation Instructions in accordance with Annex VI and the Declaration of Installation in accordance with Annex II, Part 1, Section B
- Directive 2014/35/EU of the European Parliament and of the Council
- Directive 2014/30/EU of the European Parliament and of the Council
- Act No. **22/1997 Coll.** on technical requirements for products and Act No. **90/2016 Coll.** on conformity assessment of specified products when made available on the market.
- Corresponding Government Regulation No. **176/2008 Coll.** (On Technical Requirements for Machinery), No.**118/2016 Coll.** (Conformity assessment of electrical equipment designed for use within certain voltage limits) No.**117/2016 Coll.** (Conformity assessment of products in terms of electromagnetic compatibility) and their possible amendments.
- Standards as amended:
  - ČSN EN **60 204-1** Safety of machinery – Electrical equipment of machines.
  - ČSN EN **61439-1** Low-voltage switchgear and controlgear assemblies – General provisions.
  - ČSN EN **ISO 12100** Safety of machinery – General principles for design – Risk assessment and risk reduction,
- And related documents according to Chapter IV. ANNEXES AND RELATED DOCUMENTATION AS AMENDED

The standard design is defined for power supply 3 x 400 V, 50 Hz, TN, where the intermediate wire must not be used as an operational one. Voltage and frequency tolerances according to ČSN EN 60 204-1 as last amended. The control voltage for sensors and valves is 24 V DC, the minus pole grounded only with the power supply.

Variation according to other regulations and other power supply networks is subject to special arrangement and must be specified in the contract.

The technical annex to the ŠMT contract contains a detailed technical specification of the subject of the contract, and, if needed, a wiring diagram and specification of used components. **The contract subject execution must correspond exactly to the technical specification.** In exceptional cases, a change can be made. **Any change must be preliminarily negotiated in technical terms and agreed in writing by the ŠMT electrical engineering department.**

## 3. ACCEPTANCE

Provisional acceptance is performed within the scope specified by the “Acceptance Protocol” or according to the order. The location of provisional acceptance is determined by an agreement between ŠMT and the supplier. Final, valid acceptance of equipment is performed in ŠMT after commissioning. If a particular device cannot be commissioned in ŠMT for technological reasons, then final valid acceptance of the device is dated on the day that the final machine is put into operation at the end-user’s site.

#### 4. CONDUCTORS, PROTECTIVE HOSES, CABLE DUCTS

Flexible **multi-core cables** should be used for assembly, preferably with a PUR jacket or oil- and cutting-fluids-resistant PVC with type and manufacturer designation, with cross-sectional conductors of 1.5 mm<sup>2</sup> and a maximum of 50 conductors. The minimum conductor cross section used is regulated by their load and voltage drops with respect to the total length of the cable from the security element and must not be less than 0.75 mm<sup>2</sup>. Exceptions are the cables of metering sensors and cables for devices designed for a smaller conductor cross section. There must not be any conductor with a cross section smaller than 0.14 mm<sup>2</sup> for metering and 0.2 mm<sup>2</sup> for other cables.

**Termination of the individual conductors** must be created by means of crimping, using tools specified by the manufacturer. These terminals must be insulated in the terminal boards. The use of solder joints is unacceptable.

**Cables in moving leads** must be specifically designed for this purpose by the manufacturer and stored so that mechanical damage is avoided.

Cables running on the surface of machine parts must be installed in **cable ducts, protective hoses or cable pipes**, or where there is no risk of damage. Cables must be secured to the surface with firm clamps. Using adhesive clips is unacceptable.

In the cable ducts and movable leads, the reserve space of min. 20 % must be maintained for possible additional adjustments.

The **cable jacket material** must be resistant to the effects of oils, cutting fluids and metal chips. For moving leads, the permissible bend radius must not be exceeded and the cable ends must be attached so as to avoid mechanical stress or sharp bends at the point of attachment. Where cables are located near the moving parts of the machine, a distance between the cable and this part must not be less than 25 mm.

Cables and conductors that are **energized even when the machine's main power switch is turned off** must have orange coloured signal and must have a warning label.

All **cables** must be **marked** with a sleeve at the ends where they enter the distribution box, the cabinets and devices (valve, sensor, etc.), with the identification number of the cable and the connection point corresponding to the documentation. All conductors in the terminal boards, spare ones included, must be connected to terminals and marked by the connection point. This requirement also applies to terminal boards or busbars for distribution of supply voltage.

In multi-field distribution board, the protective conductors must be additionally marked with a target label from where the conductor is connected. There must not be any free terminals or components such as diodes, resistors, etc. in the connection.

**Cable passages** through cover plates, ducts, etc., must be free of burrs and fitted with rubber or plastic edges.

The use of insulating tapes for sealing cable entries into boxes or devices is not permitted.

**For hydraulic and cooling units** (panels), the cables must be positioned so that they do not touch the oil and liquid and are protected from mechanical damage. It is recommended to weld the console to the tank cover to fix the cable tray with the height of 200 - 300 mm, a fixing foot for the 40 x 60 mm tray. The terminal board must be fixed to the body of the unit (panel) at least at three points. The cable trays must be, preferably, of a wire design and the cables must be insulated.

The body of the device (unit, panel, etc.) must have an **earthing lug** with a M8 thread in an accessible place for connection of a protective conductor labelled for earthing. A surrounding area of the thread of min. 17 mm must be plated.

## 5. TERMINAL BOARDS AND DISTRIBUTION BOXES, SWITCHGEARS

Minimum **protection degree** of the boxes, including their inputs, must be IP65 and IP54 for the switchgears.

Box material: metal, lids must be designed with unlosable screws. If the design of the boxes does not exactly match the specification in the tender documentation of the specific equipment, it must be approved in ŠMT.

The **outlets** of the boxes must be made with the appropriate bushings so that none of them are pointing upward, the preferred position is towards the ground.

**Terminations of the control conductors** from the wall of the box to the terminal board must be easily accessible. For this reason, the minimum distance between the wall and the terminal must be at least 50 mm and the conductor must not be tightened.

**Terminal board** must contain terminals designed for cross sections of the conductors used. Terminals of the same potential must be interconnected with the corresponding connection bridges, but not with the connected conductors. Terminals with different voltages must be separated by an insulating partition. Only one conductor may be connected to each terminal.

**Each conductor must be labelled** the same way as the terminal to which it is connected, spare conductors included. Spare conductors of the control and power circuits must all be marked and connected in the terminal box. For cables that are shielded (both signal and power), all unused or spare conductors must be connected to the ground.

If the device contains **terminals that are permanently energized** even when the main switch is switched off, these terminals must be placed separately from the others, fitted with a warning label and must have the degree of protection IP20 even when the terminal board cover is removed.

## 6. CONNECTORS

The **protection degree** of the connectors must be at least IP65.

The connectors must be mechanically secured against spontaneous disconnection. At least one half of the connector connection must be mechanically fixed, loosely mounted connector connection is not permissible.

The **placement** of the connectors must be chosen so as to avoid accumulation of chips and deposits of oil and coolant.

**Non-interchangeability** of connectors must be ensured by mechanical positioning, coding or labelling.

**For hydraulic and cooling units** (panels), all electromechanical elements must be equipped with a **complete device connector** designed in accordance with EN 175301-803 standard as last amended, A shape, version M with one locking screw, 2(3) poles with a protective contact, or M12 connector according to EN 60947-5-2 as last amended (5(4) poles, version for DC contactless switches, so called "coding A"). Devices equipped with the M12 connector must also be equipped with an indication of the connected voltage and the status of the built-in switch contact. Devices equipped with a different type of the device connector must be supplied with a counterpart to this connector. The solenoid connector counterparts must be equipped with an interference suppressor.

## 7. MECHANICAL AND CONTACTLESS LIMIT SWITCHES

Limit switches must only be used in sizes and shapes in accordance with EN or DIN standards. Contactless switches must be 24 V DC, connected using a connector, with a built-in status LED indication with a switching load against the minus pole (ground) of the supply voltage. The exception is safety switches, where the conductors are led directly to the safety input.

**Mechanical switches** must be operated following the manufacturer's instructions, particularly with respect to the shape and distance of the stop and with respect to switching hysteresis. Each switching unit may have only one switching or break-type contact or changeover contact. Possible override of the switch by the stop must not cause its damage.

The switches **placement** must be chosen so that they can be easily checked and replaced and at the same time must be protected against chips, oil and cutting fluids.

**Limit switches** that serve the function of a **safety element** must meet the requirements of these standards:

ČSN EN 60 204-1 ed. 2, ČSN EN ISO 12100, ČSN EN ISO 14119, ČSN EN ISO 14120 and IEC 62061 or EN ISO 13849-1 as last amended. When used in a given application, the security element must meet a level of security of at least SIL 2, or PL d.

**Linking of the limit switches** may only be performed in the nearest terminal board, not directly.

## 8. MOTORS

The **minimum degree of protection** for AC motors with axial size up to 224 is IP44. The use of DC motors is not permitted.

**Rated voltage** of unregulated AC motors is 3x400 V, 50 Hz or 3x460V, 60 Hz. Dimensions of motors for pumps, fans, etc., must correspond to an increased load for operation at 60 Hz.

**Energy efficiency class** of asynchronous motors > 0.75 kW - at least IE3, according to ČSN EN (IEC) 60034-30.

**Shape and connection dimensions** of the motors must be in accordance with IEC, or EN, standards. The exception is special motors for pumps.

Motors may only be used as supplied by the manufacturer, any additional modifications, such as drilling of holes, removal of parts, shaft end adjustment etc. are not permitted.

**The preferred motor design** is 4-pole with dimension for 100% load (S1).

For motors where the frequency control, external cooling or high starting frequency or heavy starting is used, it is necessary to use a version with built-in thermal protection of the winding.

The **placement** of the motor must be chosen with respect to accessibility for inspection, measurement and replacement. If the motor label is not easily readable, a second identical label must be placed in an accessible location (e.g. on the cover).

If only one direction of rotation is permissible, it must be permanently marked, independently of the engine in case of replacement.

## 9. ELECTROMAGNETIC COMPATIBILITY

The manufacturer must ensure electromagnetic compatibility for industrial installations in accordance with legal regulations. As a minimum measure, the following must be done:

- all devices with a 24 V DC supply voltage must be equipped with **interference suppression elements** installed in the immediate vicinity of the device. For suppression, voltage-dependent resistors - varistors, located on the contactor, relay or in the hydraulic valve connector, must be used.
- **AC motors** without frequency control must be equipped with a resistive element rated at the combined voltage of 500V AC, located in the motor terminal board or in its immediate vicinity.
- **AC motors with frequency speed control** must be provided with cable-shielded leads where the shield is grounded at both ends of the cable and at the connection points. There must be no interference suppression used for the motor, but the inverter must be equipped with an inlet suppression filter as specified by the regulator manufacturer.
- **power conductors** must be spaced apart from the signal and metering conductors, if this is not possible for design reasons, the power conductors must be located in metal-braided hoses that are grounded at their ends and at the connection points.
- special attention must be paid to conductors for **potential equalization** which must be designed in accordance with the ŠMT documentation or with the manufacturer regulations of the electronic equipment used.

## 10. LABELLING

All **mounting elements** must be labelled with metal plates with a black description in accordance with the documentation, using durable attachment. Plates must be attached to those parts of the device that do not get replaced.

**Cables** must be labelled with sleeves at both ends, with marking of the cable and the connection point (device marking) in accordance with the documentation.

**Plates and sleeves** must be placed so that they are easy to read and not covered by other devices or parts of the machine. If there are texts on the plates, they must be in the language consistent with the documentation required by the contract. The material of the plates and sleeves must be resistant to oil and cutting fluids.

If the **plate of the electric motor** is not readily readable, its duplicate must be attached in a close and easily accessible place. If the device or group of devices is covered with an opaque cover, a plate or plates indicating the devices under the cover must be placed on the cover.

**Devices that are permanently energized** even when the main power switch is turned off must be marked with a warning label.

The conductor ends for devices and terminal boards must be marked with sleeves indicating the location of the connection point. For conductors in cables with numbered cores connected to terminal boards, the number of the connection terminal on the terminal board must correspond with the cable core.

**Labelling** of devices and electrical components (terminal boards, boxes, etc.) must match the documentation. If the element or device is labelled using simplified marking of only the element,

e.g. **-X1**, then the functional (assembly) groups marking, e.g. **=Y12** or **+ U1** must be placed so that it is clearly evident where the labelled element belongs.

## 11. TESTING OF ELECTRICAL EQUIPMENT

The manufacturer is required to perform partial tests of electrical equipment within the scope of the standard or contract, especially with regard to identification of the insulation state and ohmic resistance between the body and the protective conductor. The manufacturer is required to create a protocol about these tests within the scope of the standard and deliver it together with the equipment. The protocol should contain the specific measured values of the tested electrical quantities with overall assessment, the type and the serial number of the measuring instrument used for measurement.

## 12. DOCUMENTATION

The contents and structure of the documentation must comply with the requirements of the current version of the ČSN EN 60 204-1 standard as amended, and the following requirements:

- **language version** and number of paper copies per contract
- **CD-ROM** with the documentation in PDF format
- **declaration of manufacturer** according to Act. 22/1997 Coll. and related regulations (see Chapter 2)
- in the case of devices for which the **wiring diagram is supplied by ŠMT**, the system and the labelling according to the ŠMT technical specifications must be observed, and any **deviations in connection** must be sent in the form of a written proposal to the ŠMT electrical engineering department **for assessment and, if necessary, for written approval**.
- for devices of a more complex nature, such as tool exchange systems, operator cabins, etc., the **draft of the wiring diagram** will be prepared by the supplier (unless otherwise specified), the labelling system and the connection with the machine will be agreed upon by **mutual written approval of the final version of the manufacturing documentation**.
- an integral part of the documentation for devices in which servomotors are used is the **diagram or table of kinematic relations** between the servomotors and the driven part, including metering, i.e. precise indication of transmissions in the form of fractions, velocities, sensor transmissions, etc., for the setting of the digital servomotor control.
- **circuit and hydraulic diagrams** must contain a clear description of the actuator and sensor functions, which indicate the signal value for individual operating states. Preferential is the CAE EPLAN Electric P8 v2.6 HF4 system.
- a **list of all the devices** with reference data of the device manufacturer, data about the manufacturer of the device and ordering details for direct orders from the manufacturer is included in the documentation.
- the **operating instructions** must also include functional conditions and a description or a functional diagram for the development of application PLC software.

## PERMITTED COMPONENTS OF THE ELECTRICAL EQUIPMENT

All components must be used in the original version without any additional modifications. If the manufacturer supplies accompanying documentation with the components, the application sheet, it must be included in the delivery to ŠMT.

The following table contains **permitted components for standard delivery**. The reason is to minimize the range of spare parts and to ensure service. In cases of special requirements of the end customer or upon agreement with the supplier, **a different version may be used**, which must always be **approved in writing by the ŠMT electrical engineering department**.

Material	Supplier	Note
NC technology	Siemens *)	Sinumerik 840 Dsl
Servoactuators	Siemens	motors 1FT7,1FK7, 1PH8
Standard AC motors	Siemens	1LE series
Built-in pump motors	Grundfos, Knoll	
Protective and switching devices	Siemens	Sirius series
Electronic protective elements	Siemens, Murrelektronik	
Connectors	Harting, Hypertac (formerly Interconnectron), Siemens, ITT Cannon	
Connectors on hydraulic elements	Murrelektronik, Balluff	EN 175301-803 / ISO 4400 - A shape, M12 with LED state indication, IP54 protection
Cables and threaded connections	Lapp, Igus, Helukabel, Lutze	
Protective and shielding cable hoses	Flexa KUW-EDU	or equivalent
Interference suppression elements for motors	Murrelektronik	
Security elements (locks, door switches)	Euchner, Siemens, Schmersal	
Control elements	Schlegel, Siemens, Rafi	
Boxes, terminal boards	Rittal, Schrack, IP65 and higher	Metal
Terminals	Siemens, Phoenix	
Switchboards mechanics	Rittal, Schrack	
Switchboard air conditioning	Rittal, Pfannenberg	3-Phase
24V DC power supplies	Siemens	
Transformers	Siemens, Murrelektronik, MDEXX, Michael Riedel	
Interface relay	Siemens	
Decentralised PLC peripheral	Siemens	
Cables between the decentralized peripheral and the element	Murrelektronik, Balluff	
Machine lighting	OSRAM, Howell, Lemtec, MCLED	
Cable chains	EKD, Brevetti, Igus, Kabelschlepp	

\*) alternatively Heidenhain with Siemens servoactuators or Fanuc GE with Fanuc servoactuators

**IV. ANNEXES AND RELATED DOCUMENTATION AS AMENDED**

- Decree No. **50/1978 Coll.** on professional qualifications in electrical engineering.
- Directive **2006/42/EC** of the European Parliament and of the Council, Safety of machinery
- Directive **2014/35/EU** of the European Parliament and of the Council, Electrical equipment.
- Directive **2014/30/EU** of the European Parliament and of the Council, Electromagnetic compatibility (EMC).
- Act No. **22/1997 Coll.** Product technical requirements.
- Act No. **90/2016 Coll.** on conformity assessment of specified products when made available on the market.
- Government Regulation No. **176/2008 Coll.** Technical requirements for machinery.
- Government Regulation No. **118/2016 Coll.** Conformity assessment of electrical equipment designed for use within certain voltage limits.
- Government Regulation No. **117/2016 Coll.** Conformity assessment in terms of electromagnetic compatibility
- Standard **ČSN EN 60 204-1** Safety of machinery. Electrical equipment of machinery.
- Standard **ČSN IEC/TR 61439-0** Low-voltage switchgear and controlgear assemblies – Guidance to specifying assemblies.
- Standard **ČSN EN 61439-1** Low-voltage switchgear and controlgear assemblies – General provisions.
- Standard **ČSN EN 61439-2** Low-voltage switchgear and controlgear assemblies – Power switchgear and controlgear assemblies.
- Standard **ČSN EN ISO 12100** Safety of machinery – General principles for design  
- Risk assessment and risk reduction.
- Standard **ČSN EN 16090-1** Safety of machine tools - Machining centers, Milling machines, Process machines.
- Standard **EN ISO 23125** Safety of Machine Tools – Lathes
- Standard **ČSN EN 13849-1** Safety of machinery – Safety-related parts of control systems  
- Part 1: General principles for design.
- Standard **ČSN EN 13849-2** Safety of machinery – Safety-related parts of control systems  
- Part 2: Verification.
- Standard **ČSN EN 62061** Safety of machinery - Functional safety of electrical/electronic/programmable electronic safety-related systems.
- Standard **ČSN EN ISO 14119** Safety of machinery - Interlocking devices associated with guards - Principles for design and selection.
- Standard **ČSN EN ISO 14120** Safety of machinery – Guards – General requirements for the design and construction of fixed and movable guards.
- Standard **ČSN EN ISO 60034-30** Rotating electrical machines – Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code).
- Standard **ČSN EN 175301-803** Detail Specification - Rectangular connectors - Flat contacts 0.8 mm thickness, locking screw not detachable.
- Standard **ČSN EN 60947-5-2** Low-voltage switchgear and controlgear – Control circuit devices and switching elements - Proximity switches.
- Standard **ČSN EN 55011** Industrial, scientific and medical equipment - High frequency interference characteristics - Limits and methods of measurement
- Standard **ČSN EN 61000-2-4** Electromagnetic compatibility (EMC) - Part 2-4: Environment - Compatible levels for low frequency line-borne interference in industrial plants
- Standard **ČSN EN 60228** Insulated cable cores
- Standard **ČSN EN ISO 7010** Safety colors and safety signs
- Standard **ČSN EN 61557** Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC - Equipment for testing, measuring or monitoring of protective devices
- Design directive **OBN 060** Machine safety zones.
- Design directive **OBN 062** Lock functions and their use between machine safety zones
- Design directive **OBN 026** Delivery conditions for hydraulics and pneumatics.

