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The Technical Standard defines basic conditions for structure layout, equipment and design of control systems of machines and equipment. It is an extension of Technical Standard ITS 1.11 – Electrics, and it is valid in connection to this ITS exclusively.

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15.	20/09/2021	Paragraph 4 completely revised, paragraphs 5.7, 6.1.1, 7.1.6, 8.2, 10.4, 12.3.4, 12.3.5 updated, new format, standards updated

1. GENERAL DEFINITION

ITS 5.13 is based on the provisions of individual articles of ITS 1.11 Electrics.

Identification of terminals of electrical items and wires, including general rules for the written numbering system, shall comply with ČSN EN 60445 ed.5. Hardware, software and IT data networks shall comply with ITS 1.05. Documents coming with machinery and equipment shall comply with ITS 1.11. The general rules for wiring diagrams laid down in the examples below shall be adhered to, unless some other provisions have been adopted for the wiring diagrams relevant to the item concerned. Any exceptions are subject to prior agreement and exception permissions that are part of the respective articles of the business contracts or takeover protocols concerned.

1.1 Safety part of control systems

It is recommended to fit control systems with a safety part, using SAFE software. Relays and contactors shall only be used to strengthen or separate potentials. Use of relays and their mutual links to constitute the safety part of the control system is subject to approval from the ŠKODA AUTO a.s. department in charge.

To make maintenance operations simpler, we recommend using a single control system for the machinery and safety parts.

Use of two separate control systems, one for the machinery part and one for the safety part, is subject to approval from the ŠKODA AUTO a.s. department in charge.

1.1.1 Relay-based control systems

Can only be used for the simplest systems, and their use is subject to approval from the ŠKODA AUTO a.s. department in charge. Otherwise, it is not allowed to use relay contacts in designing a control system with logical functions and dependencies.

1.2 A broken wire, power outage or voltage drop must not lead to dangerous operating conditions and threats to human lives.

1.3 No machinery is allowed to restart spontaneously upon voltage restoration.

1.4 The movements and positions of individual operating units shall be checked by a terminal switch or position switch. Checking movement and position functions in terms of time is not allowed.

1.5 The emergency stop command shall take the form of de-excitation of the respective control devices. A hardware circuit or SAFE-software can be used towards this end. To activate the "STOP" command, the respective circuits can be de-excited by an electronic device.

1.6 If a button, command transmitter, contactor contact surface or relay remain activated without getting a work impulse, such situation must not lead to dangerous operating conditions.

1.7 When using safety software, the key imperative is to prevent defects during the machinery lifespan. The key properties of safety software include understandability and checkability. Project-specific rules shall be agreed with the ŠKODA AUTO a.s. department in charge.

1.8 The wiring connection examples provided herein are illustrative only. The actual design shall comply with the rules in Technical Specification.



1.9 Where safety software is used in programmable automatic safety systems, to make the programme easy-to-survey and easy-to-understand, our recommendation is to use parameterised blocks from the standard Distributed Safety Siemens Library (see Fig. 1, 2) or blocks standardised by VW and approved for the operation concerned (see Fig. 3, 4). FBs can always be called with an independent DB (see Fig. 1, 3) or multi-instance DBs (see Fig. 2, 4). The F_GlobDB.VKE1 and F_GlobDB.VKE0 addresses are acceptable only if in compliance with safety regulations and Internal Technical Standards.

Network 3 : Uvolneni ochranného prostoru 2l se zpetným kontaktem

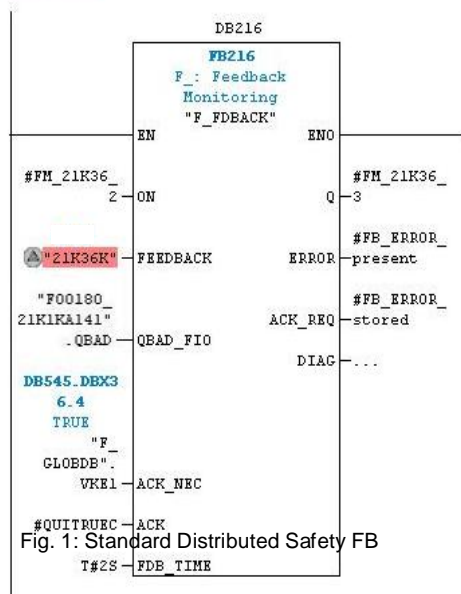


Fig. 1: Standard Distributed Safety FB

Network 3 : Uvolneni ochranného prostoru 2l se zpetným kontaktem

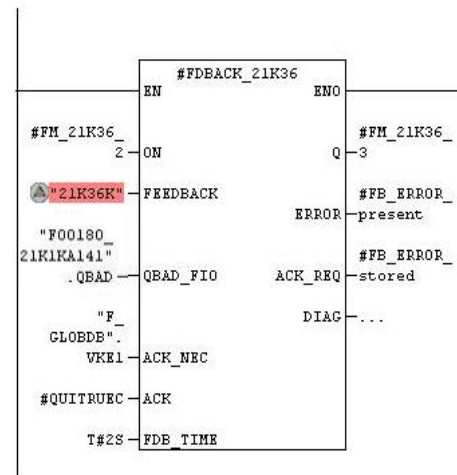


Fig. 2: Standard Distributed Safety FB with Multi-Instance

Network 3 : Uvolneni ochranného prostoru 2l se zpetným kontaktem

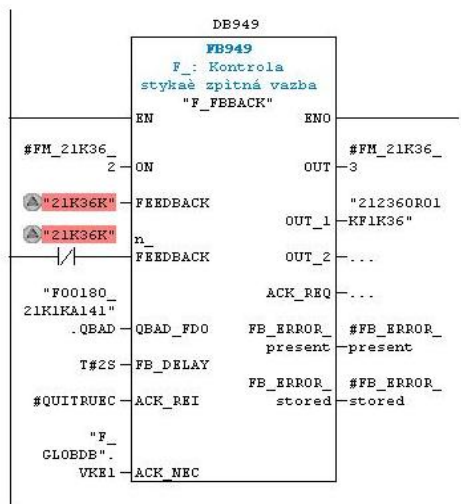
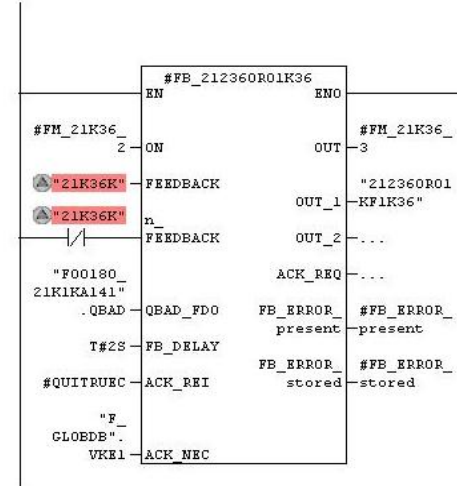


Fig. 4: Standard Project FB with Multi-Instance

Network 3 : Uvolneni ochranného prostoru 2l se zpetným kontaktem





1.10 Counting commands with a direct impact on control systems are generated to prevent false statements or incorrect counting in the event of an erroneous signal, e.g. question-based checks in conveyor systems - preparation - standardised question - confirmation. The processes of counting signal sequences and signal sequences for multiple command transmitters or command points shall be differentiated.

1.11 If the ŠKODA AUTO a.s. department in charge decides to upgrade/update some components in use, such upgrades/updates become compulsory. Data networks shall meet the requirements of the respective projects.

1.12 Abbreviations, symbols

ARG	Work group
BWS	Contactless protection systems
ESPE	Electronic protection system
PLC	Programmable automatic device, control computer
Q1	Main switch
SA1	Drive deactivator
SF_	Safety window
SG_	Safety switch
SN_	Emergency stop button
K	Relay / contactor
K0	Control voltage activation, e.g. activation of Potential "J"
K4	Emergency stop circuit
K16	Overall emergency stop
K16G	Chained emergency stop
K36	Released protective area / protective door
K40	System start
K61	Drive deactivator
K100	Releasing actuators, e.g. activating Potential "M"
K111	Confirming an emergency stop / protective circuit

2. NETWORK SUPPLY POINT AND MAIN SWITCH

2.1 Connection to the electricity network

Any connection to the electricity network shall comply with ČSN EN 60204-1 ed.3 and ITS 1.11.

Power supply connection diagram

The network connection shall comply with the equipment manufacturer requirements under ČSN EN 60204-1 ed.3. The equipment connection shall be agreed with the ŠKODA AUTO a.s. department in charge.

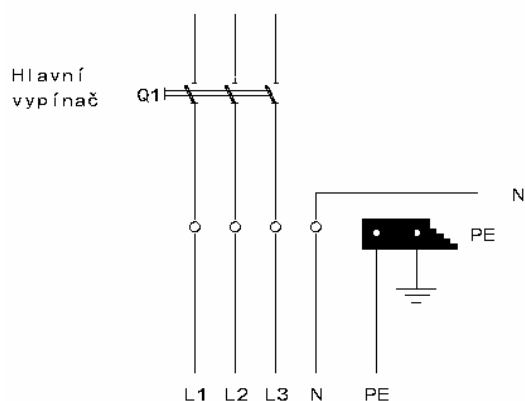


Fig. 5: Power supply for TN-S networks

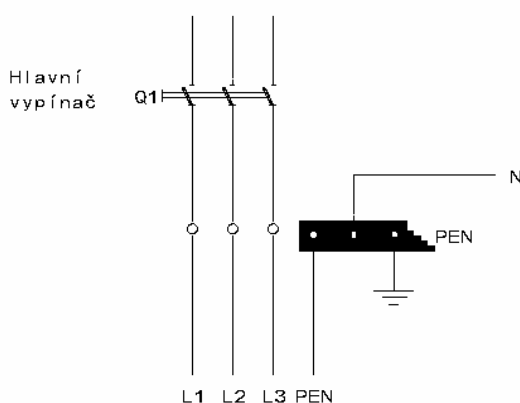


Fig. 6: Power supply for TN-C-S networks

2.1.1 It is recommended that the electrical equipment concerned be connected to a single source of electricity. If feeding the system from multiple sources by means of parallel power supply, it is essential to comply with relevant legislation and fit a power disconnector for each system.

2.1.2 Multi-point power supply connection diagram

If the connection is approved by the ŠKODA AUTO a.s. department in charge, multiple parallel power supply points shall be fitted; a load isolating switch for each power supply point shall be fitted upstream of the main switch (max. fuse 355 A).

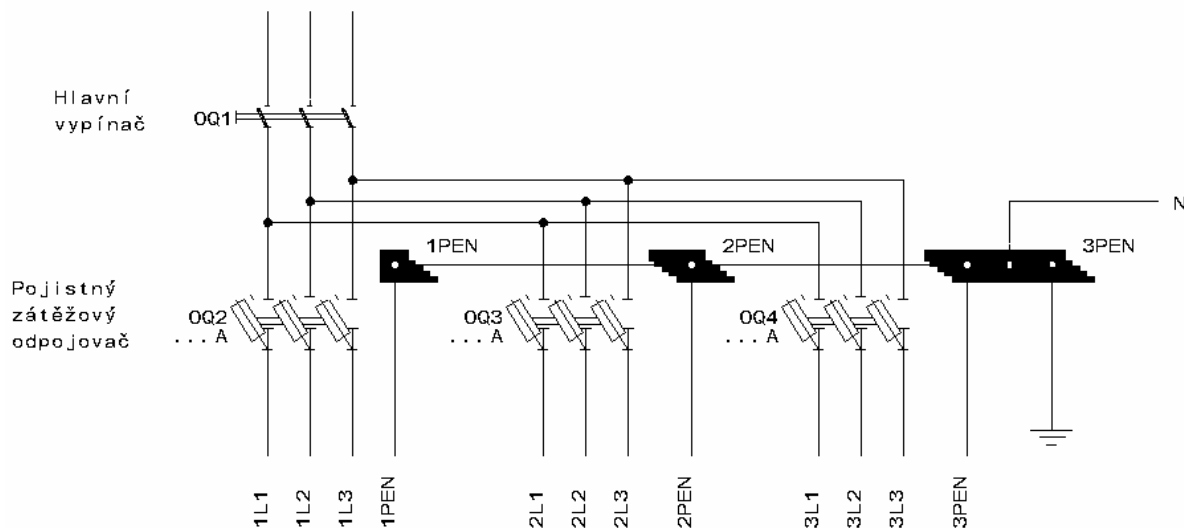


Fig. 7: Multiple parallel power supply

2.1.3 Power output measurement, power disconnecter

The electrical equipment to be supplied shall be fitted with an electricity measurement system. The measurement transformers shall feature a disassemblable core; disconnecting the primary wire is not required (different solutions are subject to approval from the ŠKODA AUTO a.s. department in charge).

Where it is possible to use controlled deactivation of the machine's powered parts (including StandBy modes, if any), the feeding of electrical circuits shall be split into two parts: power part and control part. The particular solution is subject to approval from the ŠKODA AUTO a.s. department in charge.

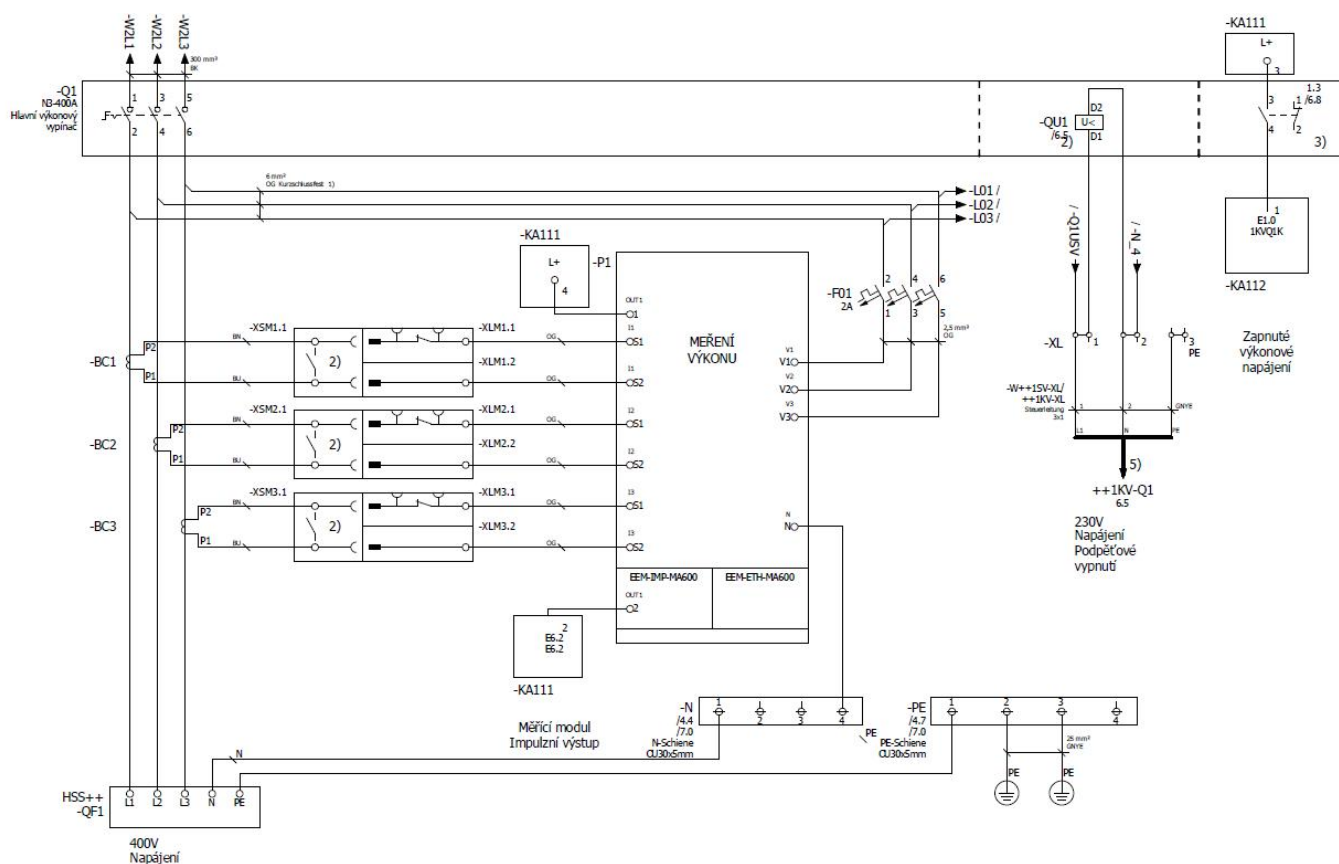


Fig. 8: Energy consumption measurement, power disconnecter

2.2 Main switch

Each machine or production equipment item shall be fitted with a mechanically controlled main switch under ČSN EN 60204-1 ed.3. The main switch shall be lockable in position "0". The control element of this switch shall be safely protected against accidental spontaneous activation (of the switch). The main switch shall comply with ITS 1.11.

Deactivation system to prevent unexpected starts.

ČSN EN 60204-1 ed.3 and ČSN EN ISO 14118 apply (Machinery Safety – Prevention of Unexpected Starts).

2.3 Drive switch

2.3.1 Drive switches are located in the distribution box door, a separate case or on the control panel. It shall be possible to secure the "off" position of the drive switch with a lock. Drives are deactivated on all poles. Power switches in drives shall comply with ITS 1.11. Switches in control system drives shall be connected to the circuit hardware or to the respective parts of the SAFE software.

2.4 Systems to disconnect electrical equipment

ČSN EN 60204-1 ed.3. applies.

2.5 The system shall be protected against unauthorised, unintentional and/or erroneous connection under ČSN EN 60204-1 ed.3..

2.6 For a drive switch implementation example see Chapter 6, Figures 36 and 40.

3.3. AUXILIARY ELECTRICAL CIRCUITS

3.1 General provisions

Control (electrical) circuits shall comply with ČSN EN 60204-1 ed.3 and ITS 1.11.

3.2 Auxiliary circuits

Circuits that are not deactivated via the main switch shall meet the requirements listed below:

- A permanent warning label shall be fitted near each non-deactivated circuit; alternatively, the non-deactivated circuit shall be separated from the other circuits.
- The wires of the non-deactivated circuit shall be marked with orange colour.

Auxiliary circuit connection example – distribution box lighting (see Fig. 9).

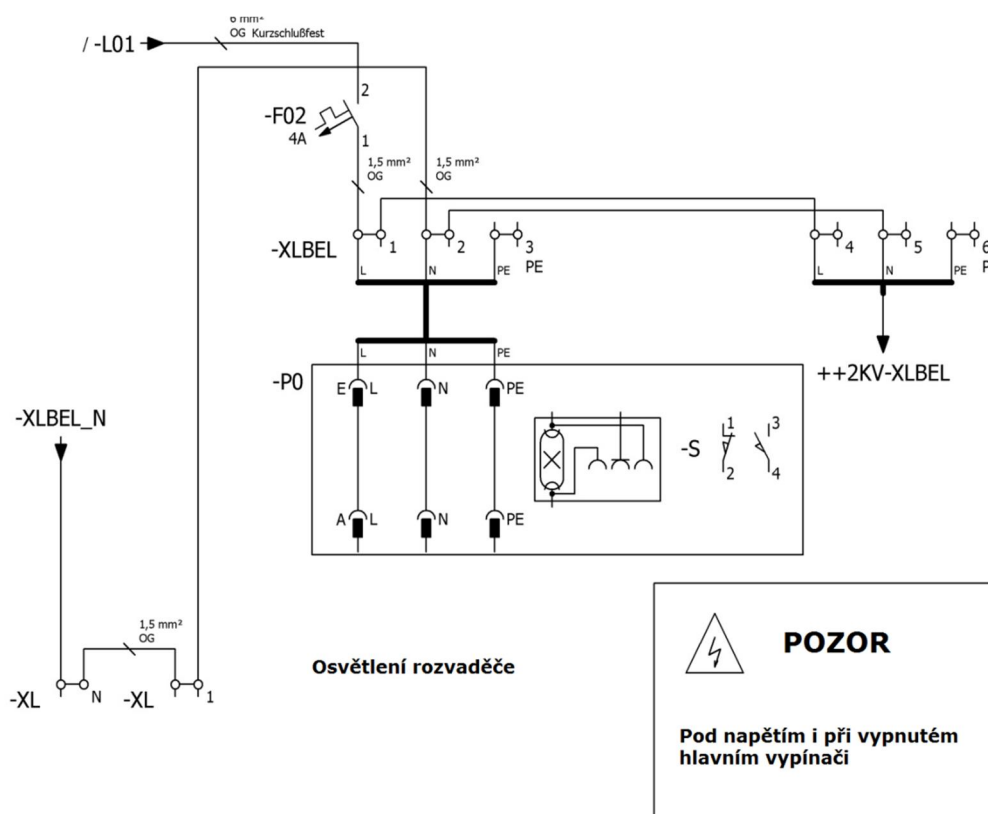


Fig. 9: Auxiliary circuit connection example



3.3 Control voltage sources

Stabilised sources are required for DC control voltage.

The earth wire in DC circuits is connected to the minus pole (-).

Fig. 10 shows the mechanism of setting up 24 Vdc control voltage.

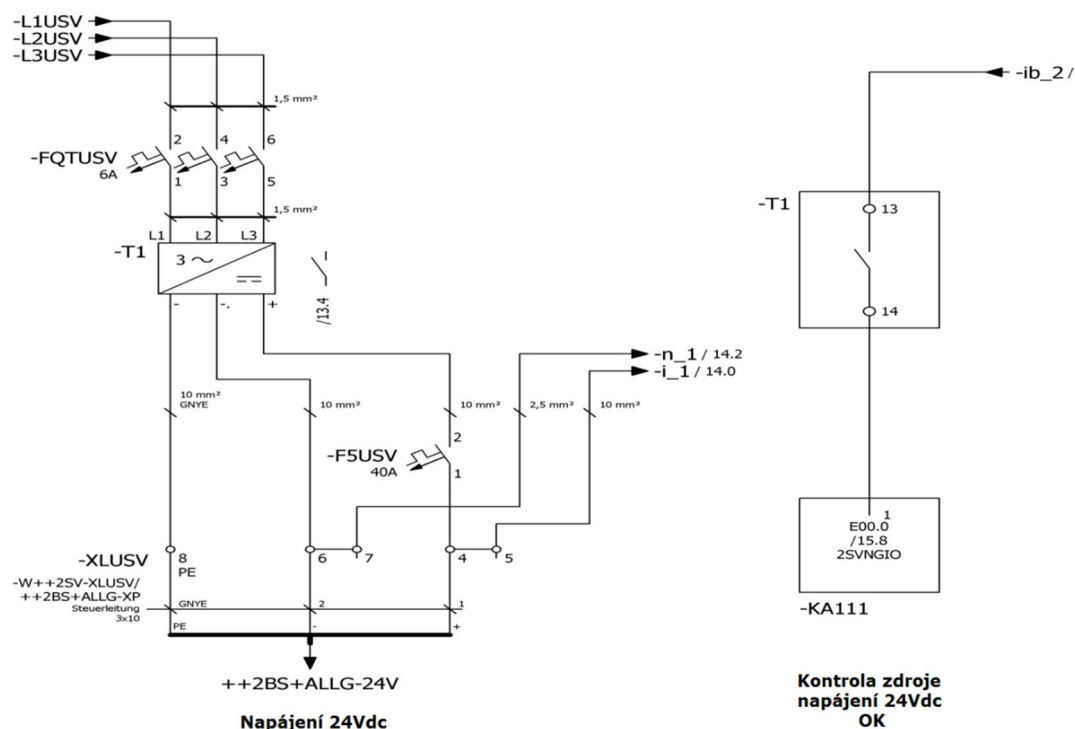


Fig. 10: Example: 24 Vdc control voltage



3.3.1 In big machines or where it is necessary to perform a particular check before starting the machine the control voltage shall be activated via an auxiliary/power contactor.

The information that **the control voltage is active**, should be indicated on the operator site.

Control voltage operation example (Figures 11 and 14).

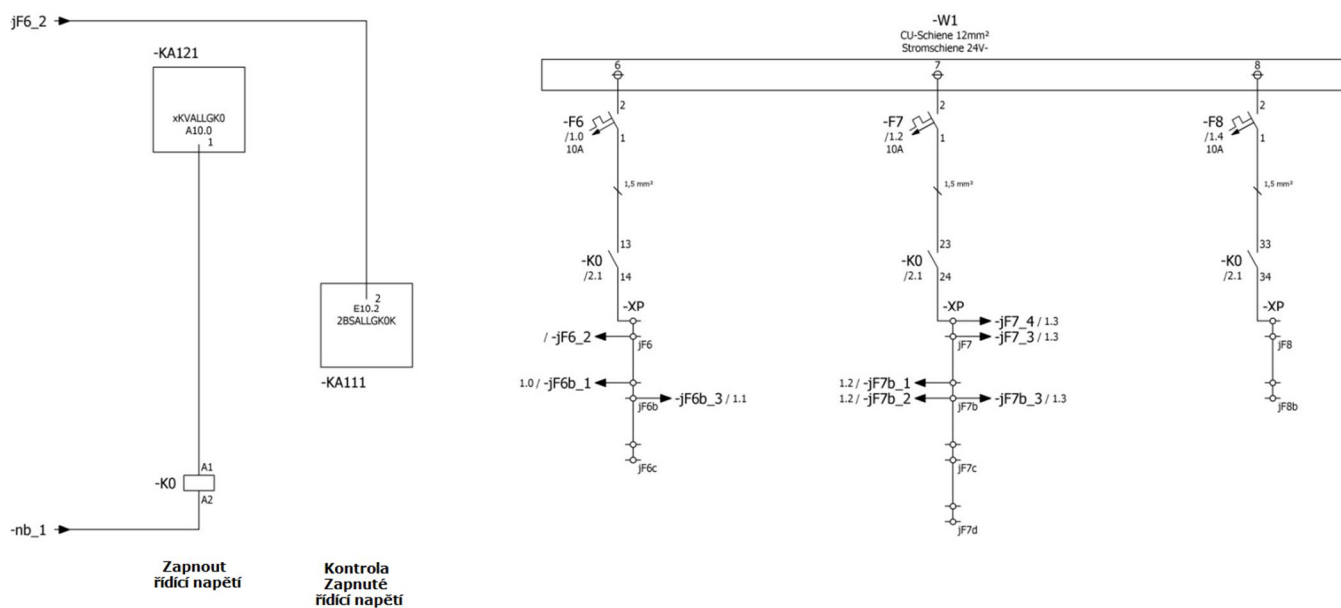


Fig. 11: Example of activating control voltage "j" via power contactor K0

3.4 Identification of test terminals

The letters listed below are used to identify individual control voltages in wiring connection diagrams:

a	Control voltage 230 VAC (right upstream of K0)
b	Control voltage 230 VAC (downstream of K0)
f	Command actuator voltage 230 VAC (downstream of K0)
g	Start actuators 230 VAC (downstream of K100)
h	Start actuators 24 VDC (from a different PLC)
i	Control voltage 24 VDC (right upstream of K0)
j	Control voltage 24 VDC (downstream of K0)
k	Flashing voltage AC 230 V
m	Start actuators 24 VDC (downstream of K100)
n	0 VDC
o	0 VDC (from a different PLC)
p	24 VDC (downstream of KCO, from a different PLC)
q	Flashing voltage 24 VDC (downstream of K0)
z	0 VAC

If, because of contact loads, parallel branches are installed, they shall be marked with the same letters and numbered in ascending order, e.g. b1, b2, b3.

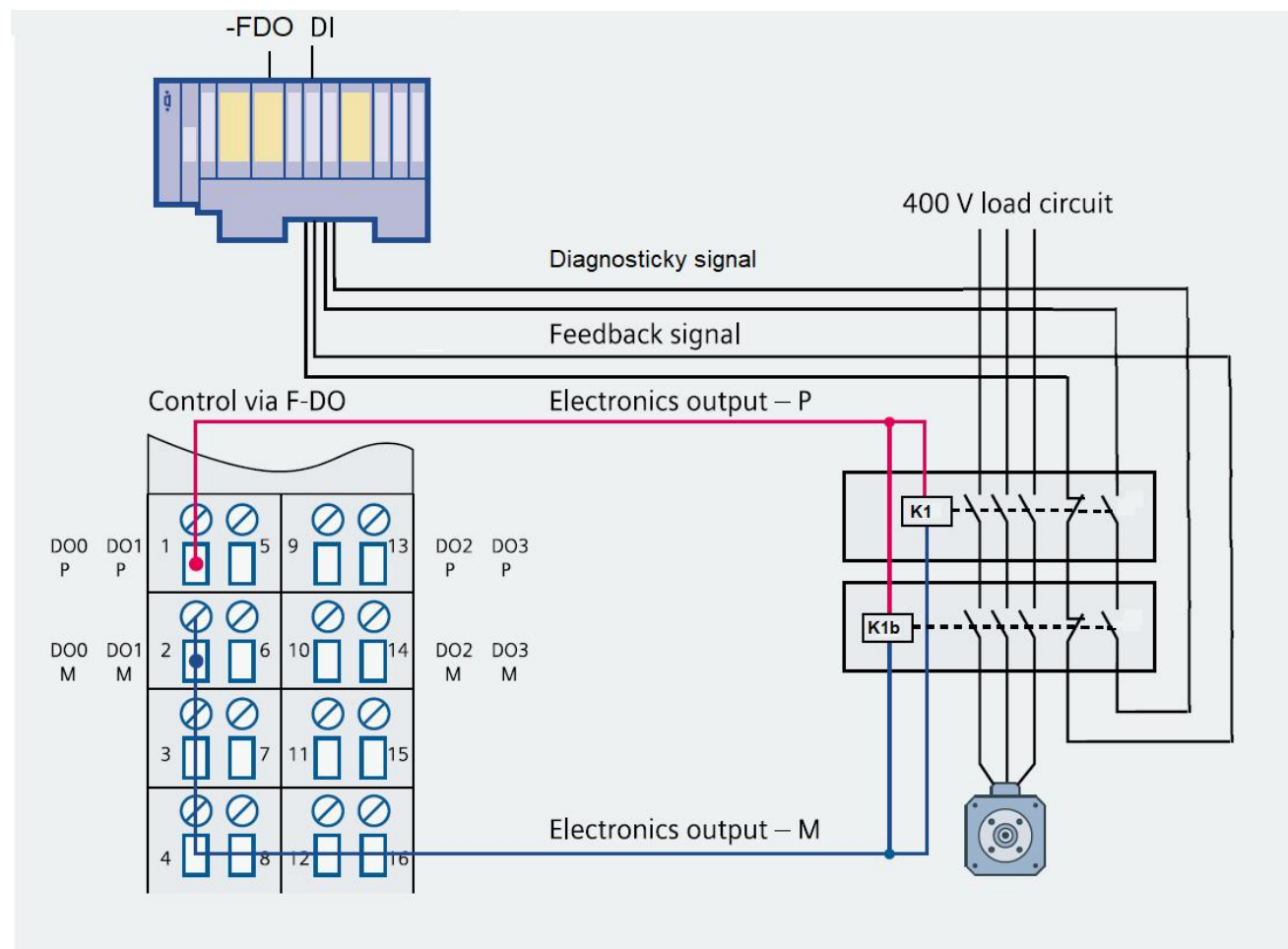


Fig. 12: Example: Start actuator activation using Siemens ET 200S cards

3.5 Electrical circuit categories

Electrical circuit installations shall be designed for simple and easy maintenance. For ease of search, auxiliary electrical circuits shall be categorised in groups, e.g.

- control
- indication
- set-up
- drive

Project-specific rules may be more detailed (e.g. maximum circuit breaker sizes) or limited (e.g. a single POWER module may feed max. 16 inputs or outputs).

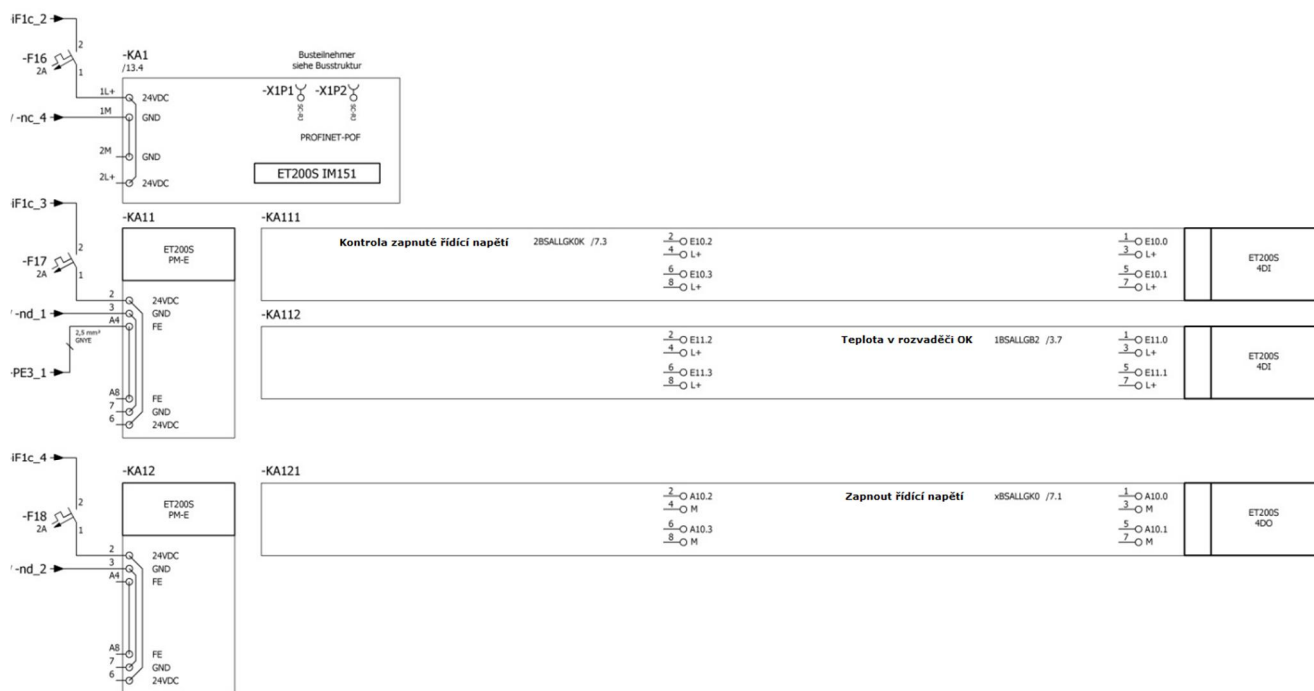


Fig. 13: Example: input and output card circuits (split)

4. SELECTION OF OPERATION

4.1 Specification of operation selection

Only one type of operation can be selected. Only control devices necessary for this type of operation are allowed to be active. Selecting automatic operation is only possible when the **start** is off. The selected modes shall be indicated individually on the operator site.

4.2. Access system

For access identification of operators, fitters and maintenance staff to the devices, EKS system (Electronic Key System) shall be used. ITS 1.09 shall be complied with.

Substitution of the EKS system using BKS key (E2, E7, E9) and passwords must be approved by the ŠKODA AUTO department in charge.

4.3. EKS (Electronic Key System).

Electronic control of access is applied especially in the following cases:

- identification, employee login and authorisation
- selection of operation type (automatic, manual operation, individual operation and others)
- selection of operation with restrictions on machine or personal safety
- selection of emergency strategy, universal use
- archiving of process parameters

4.4 General regulations for EKS

Method of installation to EKS on machinery must be approved by the electric ŠKODA AUTO department in charge.

Safety application must be also approved by the ŠKODA AUTO department of occupational safety.

Transponder / EKS key

The key itself must not indicate the employee assignment. There may only be employee code indicated. Assignment of employees is only possible by means of a database (only authorised persons of the ŠKODA AUTO operation have access to the database).

Determination of key colours and the contents of the memory space of the key must be approved by an authorised person of the ŠKODA AUTO operation.

4.5 Universal use, emergency strategies

Production equipment shall be designed for universal use. The control panels shall feature selections with/without individual operating units (e.g. with/without robot, with/without welding, with/without automatic conveyor).

While selecting a part of production technology / process, the following shall be taken into consideration:

- To release a selection, operator's login on the control panel is needed (EKS key or closing of lock E7)
- The selection itself must be displayed on the control panel and on the operator site (e.g. indicator light flashing, text message, etc.)
- The selection automatically cancels the end of sequence of the station in the automatic mode, removal of the EKS key or turning of lock E7.

The particular design of emergency strategies is subject to approval from the ŠKODA AUTO a.s. department in charge.

4.8. DKS key system

The use must be allowed by the ŠKODA AUTO a.s. department in charge.

The connection of locks (SWE) must be implemented in compliance with the documentation of the ŠKODA AUTO a.s. departments in charge.

Example of implementation, see fig. 14, 15.

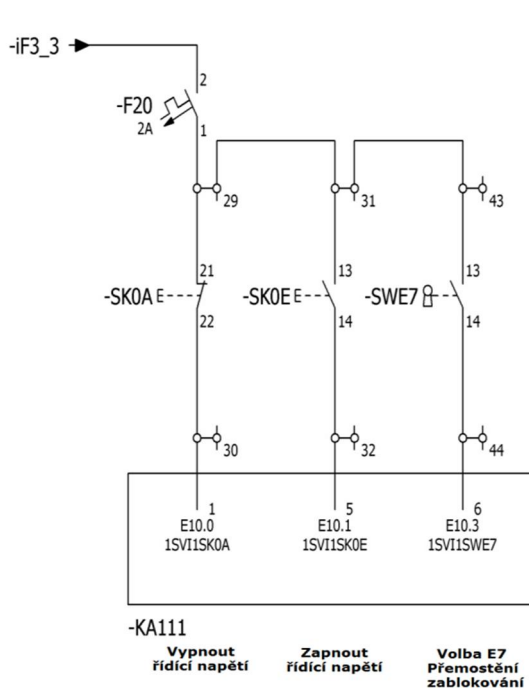


Figure 14: Switching on the control voltage

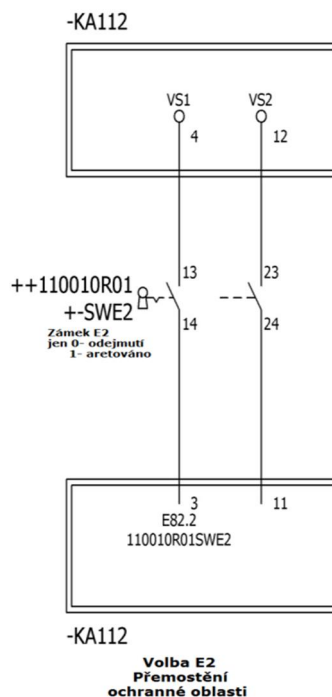


Figure 15: Selection of operation E2

5. PROTECTION SYSTEMS

5.1 General

5.1.1 Protection systems need to be selected based on proper risk assessment (ČSN EN ISO 12100) and the identified control category (ČSN EN ISO 13849-1 PL / ČSN EN 62061 SIL).

5.1.2 Measures to ensure safe operation of machinery are laid down in ITS 1.18. The following part of this document therefore only deals with impacts that protection systems may have on electrical devices.

5.1.3 When the protection system concerned is open, the control logic status must not be changed when handling the respective signalling elements/light barriers.

5.1.4 After closing the protection system and performing the respective release, the machine shall be able to restart from any logical position or make it possible to return to the basic position.

5.1.5 The protection system (including with PLCs) shall take the form of safety equipment, i.e. shall feature safety switches. The examples below are shown only with 24 VDC control voltage. With AC 230 V in place the identification needs to be adequately adapted.

5.1.6 Each entrance to the protection zone shall be fitted with a status visualisation system. On production sites the individual safety zones (e.g. protection zone K36) and the statuses of the individual safety elements (e.g. SG_ protective door) shall be indicated on a single panel. With difficult-to-survey machinery in place, the indication/visualisation of safety zones needs to be approved beforehand.

5.1.7 All confirmation buttons in protection systems shall have an indication capability (light buttons).

Signalling: Protection system closed = permanent light;
 Protection system open = flashing light.

5.1.8 Each protection system with a safety lock that makes it possible to safely enter the protection zone shall make it possible to use a personal protective lock. The use (application) of such lock shall make it impossible to close the protection system.

5.1.9 Contactless safety sensors (RFID) are required to feature a UNI CODE (responds to one particular pre-identified actuator, resistant to unauthorised handling). With SAFE software in place it is prohibited to series-connect individual safety sensors (in hardware). Each safety sensor shall be connected individually, via two channels, to PLC safety inputs. The safety function itself shall be processed in the SAFE software. Safety inputs from individual sensors will be added up in series connection and the result evaluated in a safety block.

5.2 Protection systems - direct protection

These systems are required to reliably prevent direct access to dangerous locations, in line with ČSN 33 2000-4-41 ed.3,

ČSN EN 60204-1 ed.3.

Separating protection systems

The arrangement, selection and design shall comply with the required category under ČSN EN ISO 13849-1, ČSN EN ISO 14120 and ČSN EN ISO 14119.

5.2.1 Stable protection systems

Stable protection systems opened for repairs only now and then need to be designed to be openable with just ordinary tools. Such systems therefore do not have to be monitored electrically.

5.2.2 Mobile protection systems

Mobile protection systems that have to be opened for maintenance and repairs need to be secured by means of forced contact disconnection. As the protection system is opened, the control voltage on all dangerous operations (movements) performed in the danger zone has to be disconnected. A mere closing of the protection system must not lead to a machine start. The machine has to be restarted by pressing the respective button (e.g. protection zone release or start). For a safety circuit structure see Fig. 16.

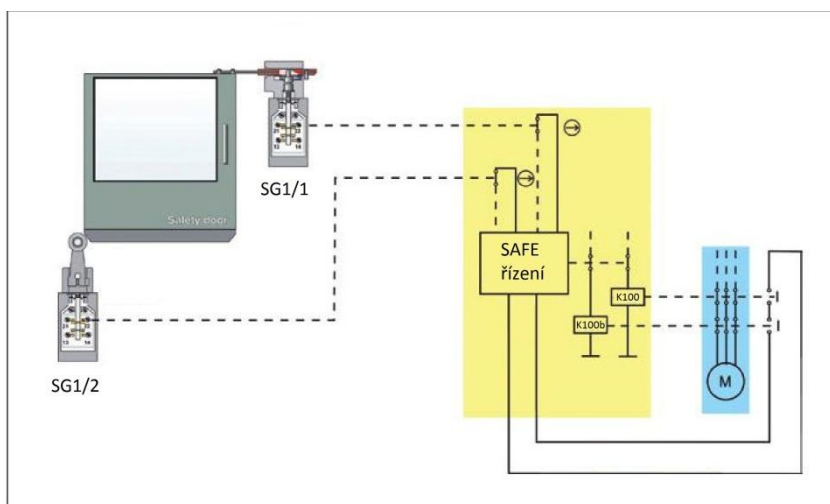


Fig. 16: Safety circuit structure

5.2.2.1 Connection diagram for a barrier with two position switches or one series-connected position switch

(2 levers).

The position switches need to be fixed to ensure that Position Switch SG1/1 is activated upon opening the protection system (deactivating the closed position) (this switch is then supposed to remain active throughout the "open" period) and that Position Switch SG1/2 is open. In the closed position SG1/2 is active and SG1/1 is open.

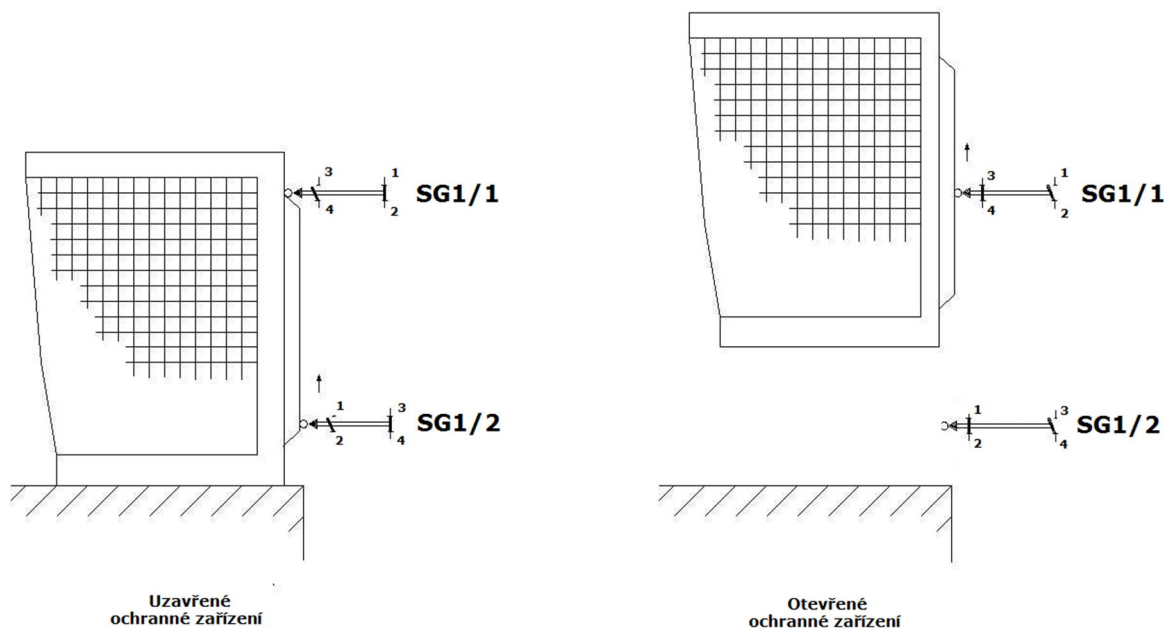


Fig. 17: Use of 2 position switches

5.2.2.3 SAFE software for protection zone functions

Individual safety sensors are connected to PLC safety inputs. Individual safety functions are designed depending on the required category (ČSN EN ISO 13849-1 PL / ČSN EN 62061 SIL) and on the detailed rules applicable in the respective projects. For an example of safety functions of a protection zone see Fig. 18.

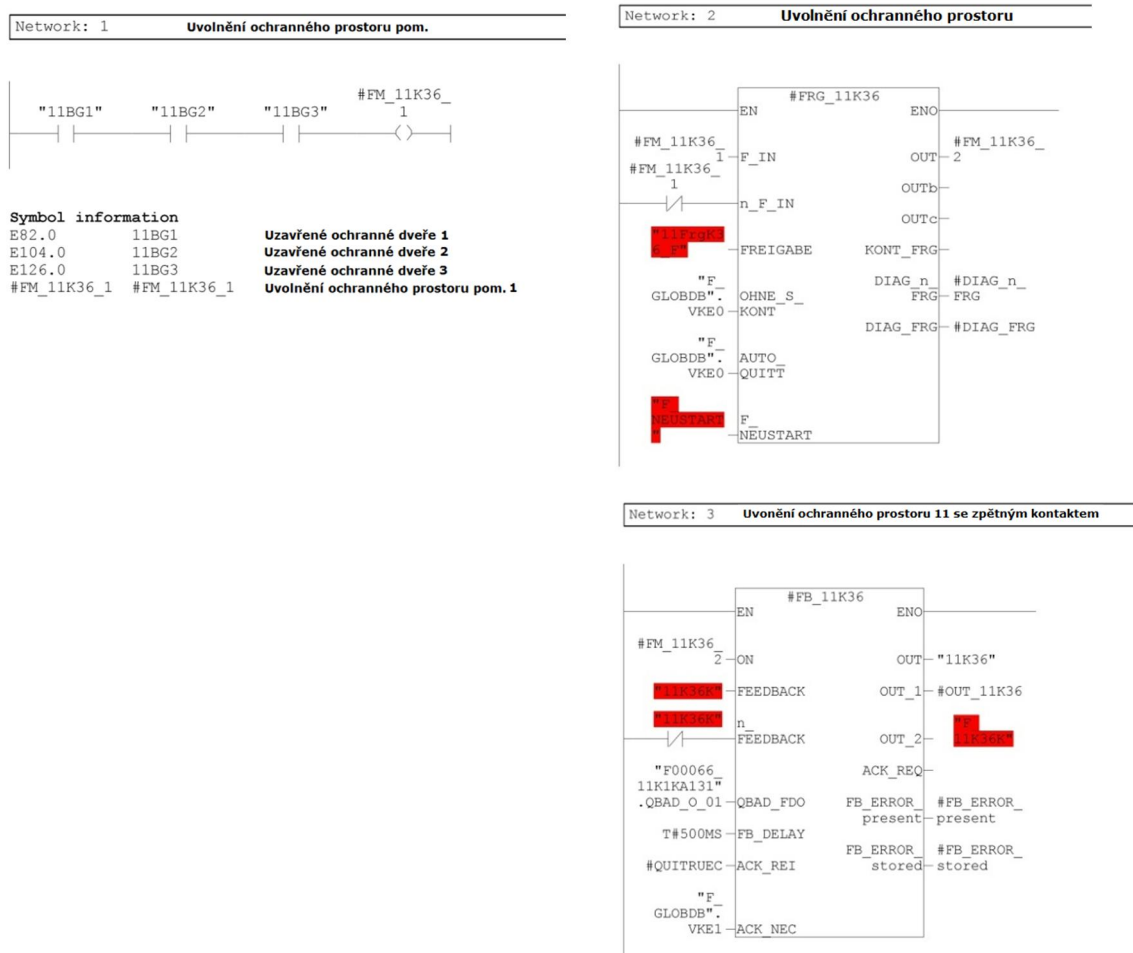


Fig. 18: Example: safety functions of a protection zone.

5.2.3 Takt/sequence-dependent mobile protection systems on operator sites

Mobile protection systems that have to open for operators according to the respective takt need to be controlled in each takt/sequence.

- The deactivation shall be controlled by means of two position switches
- When the protection system gets open, the voltage on all dangerous moves in the danger zone has to be safely deactivated.
- A regular closing of the protection system is considered to be an intentional start command.
- No additional button-activated confirmation is necessary.

If the protection system is not permanently controlled according to the respective takt/sequence, an additional, button-activated confirmation is necessary.



5.3 Protection systems - indirect protection

Non-separating protection systems.

These approach-reactive protection systems shall be designed to ensure that the staff is suitably protected, because the respective danger zone can be accessed or entered by them; see Fig. 19.

Locations for placement of protection systems shall be selected with regard to the speed of approach, under ČSN EN ISO 13855.

Whenever a danger zone is entered, the voltage on all dangerous moves has to be disconnected safely and the moves stopped timely.

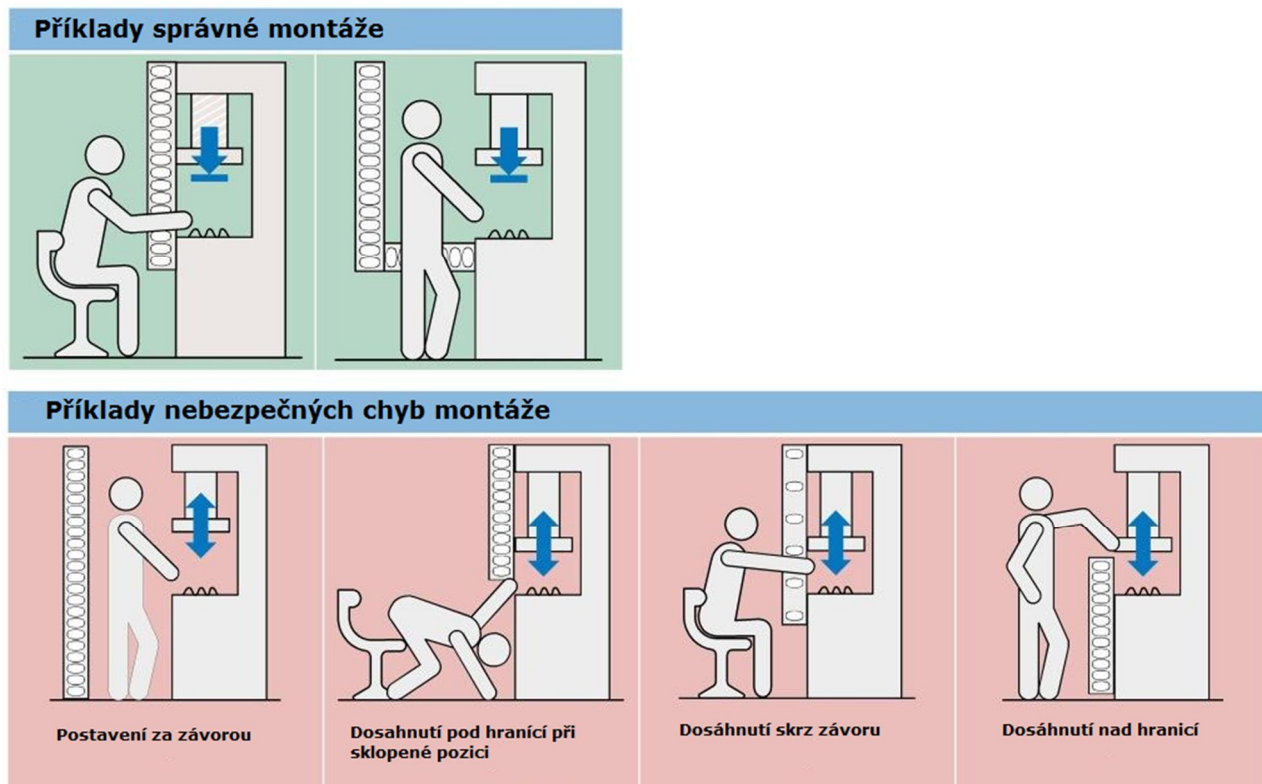


Fig. 19: Protection system examples

5.3.1 Contactless-reactive protection systems (BWS)

The arrangement, selection and design shall comply with ČSN EN 61496-1 ed. 3.

After activating the control voltage, BWS Type 2 systems need to be tested in compliance with the applicable regulations.

For BWS Type 4 systems this test does not have to be done, because after activating the control voltage the required test is done internally and the confirmation is activated only if the BWS is OK.

5.3.1.1 Injury protection systems taking the form of light barriers or light grilles to protect hands and fingers can be used in combination with protection system confirmation buttons located on the operator site (Chapter 5.3.3). Whenever a danger zone is entered or penetrated, the voltage on all dangerous moves has to be disconnected safely and the moves stopped timely. Individual safety functions for light barriers are designed depending on the required category (ČSN EN ISO 13849-1) and on the detailed rules of the respective projects. For a hardware connection example see Fig. 20; for a SAFE-software evaluation see Fig. 21.

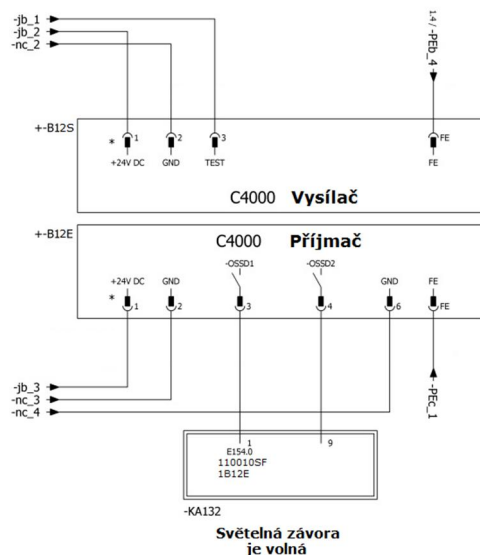


Fig. 20: Light barrier hardware connection diagram

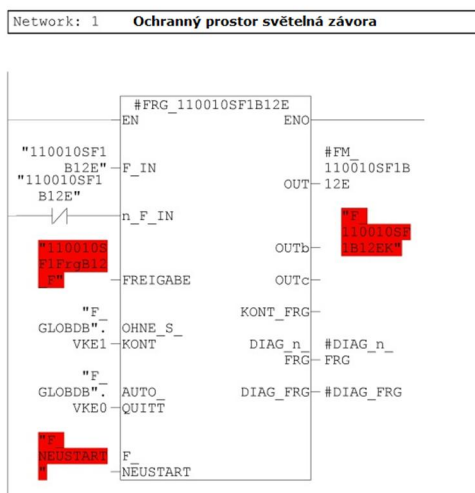


Fig. 21: Light barrier SAFE-software evaluation example



5.3.1.2 Muting principle

Muting bridges safety switches on protection systems to disable them temporarily. This way it is possible to transport material to or from a machine/system without having to interrupt the work process.

Using additional sensor signals, the muting system differentiates between humans and machines.

The recommended muting function connections are illustrated in Fig. 22 and 23.

Whenever a danger zone is entered, the voltage on all dangerous moves has to be disconnected safely and the moves stopped timely.

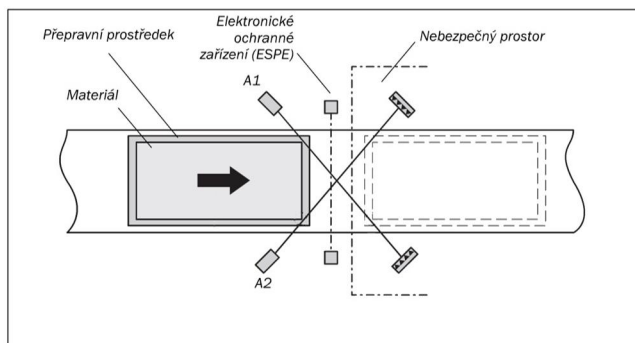


Fig. 22: Arrangement of photo cells with muting on

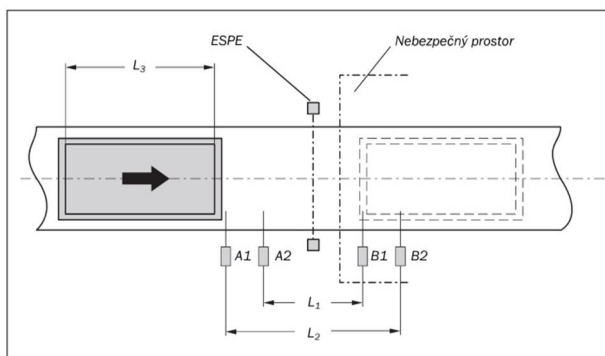


Fig. 23: Arrangement of sensors with muting on

5.3.1.3 Partial blanking of safety functions

When the muting preconditions are met, the muting system bridges the ESPE safety functions. *Partial Blanking* is a feature designed to increase safety: when the muting preconditions are met, the protective functions of the electronic protection system are cancelled only in part. One light beam (or more) remains permanently active; see Fig. 24.

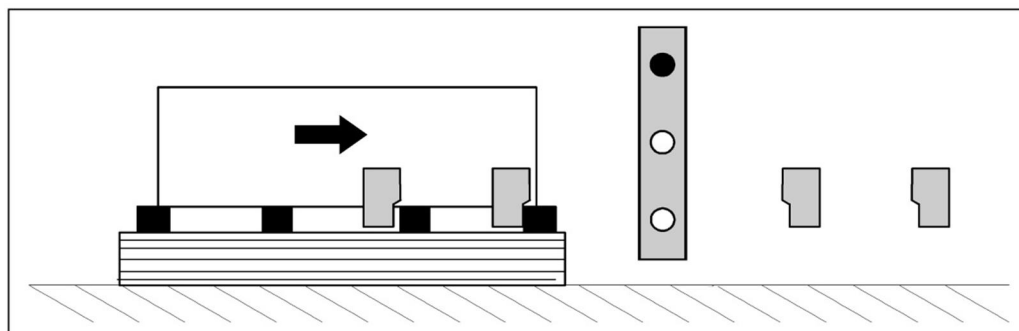


Fig. 24: Partial Blanking principle

5.3.1.4 Override

Override is a manual start of the muting feature in response to a muting preconditions error, see Fig. 25.

Please observe the following safety instructions for the Override status!

- Place the Override button to ensure that the whole danger zone is visible when this button is used.
- Override can only be activated via key switch KEW2 and only when the control system of the machine/system concerned is in manual control mode.
- The Override button (key switch) and the machine restart deactivation button must not be the same.
- The key switch (button) and its connection shall comply with ČSN EN ISO 12 100 and ČSN EN 60 204-1 ed.3.

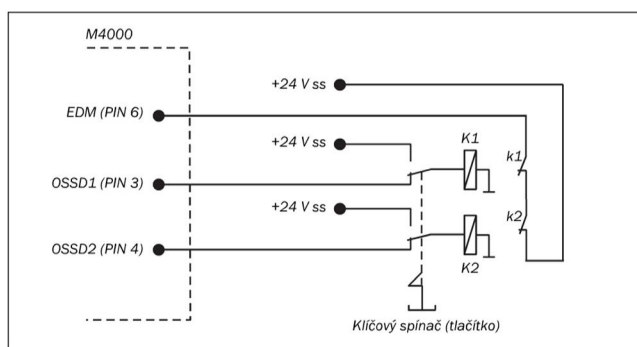


Fig. 25: Example: Override connection with muting on

5.3.1.5 Laser scanner-aided injury protection

Laser scanner-aided injury protection can be used to identify objects in the danger zone. Whenever a danger zone is entered, the voltage on all dangerous moves has to be disconnected safely and the moves stopped timely.

Individual safety functions for laser scanners are designed depending on the required category (ČSN EN ISO 13849-1) and on the detailed rules applicable in the respective projects. For a hardware connection example see Fig. 26; for a SAFE-software evaluation see Fig. 27.

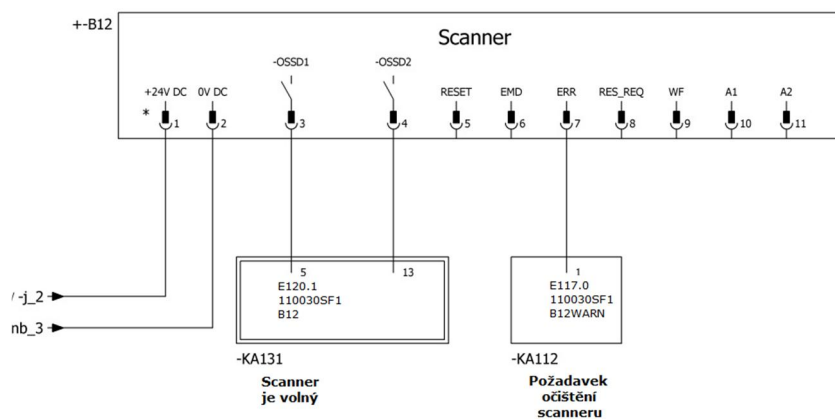


Fig. 26: Laser scanner hardware connection diagram

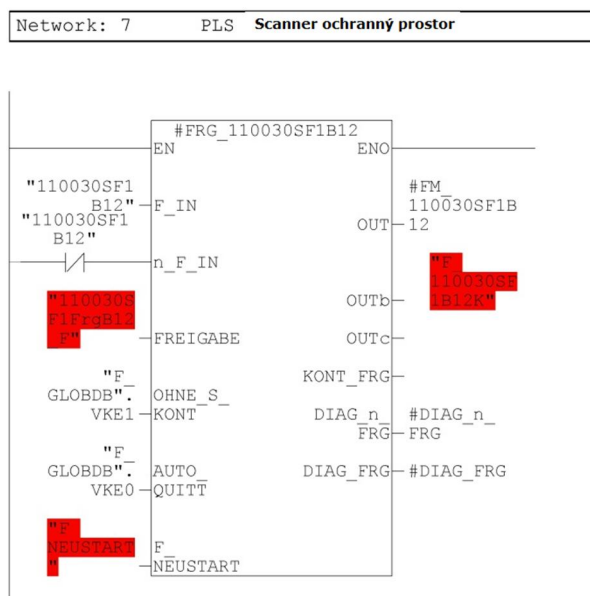


Fig. 27: Laser scanner SAFE-software evaluation example



5.4. Contact-based protection systems

Contactless safety sensors (RFID) are required to feature a UNI CODE (responds to one particular pre-identified actuator, resistant to unauthorised handling). For a safety sensor connection example see Fig.28.

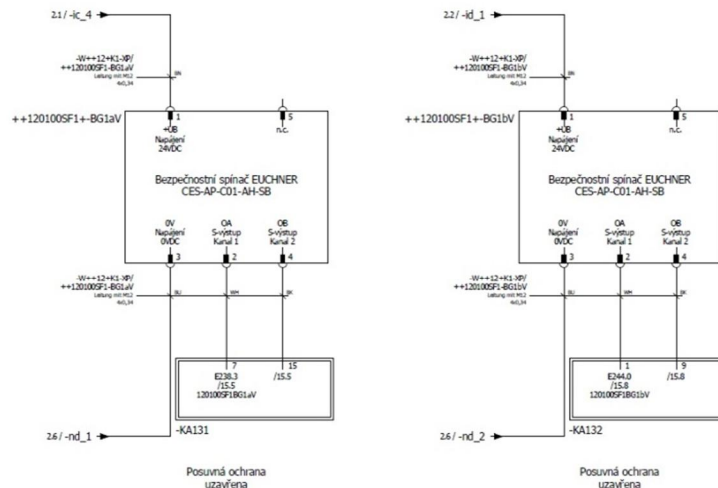


Fig. 28: Safety sensor connection example

5.4.1 Control pedal (switchboard)

The activation shall be checked by means of two position switches.

The control voltage of all dangerous moves in the danger zone shall be safely disconnected upon stepping onto the foot rest. After the danger zone is vacated, the system can only be restarted by pressing the respective button.

5.4.2 Swing flap

Swing flaps are trap prevention devices at the entry and exit points posing a danger of persons entering or being dragged into a danger zone. Swing flaps are in the category of articulated locking systems and are required to comply with ČSN EN ISO 14119. Since the absence of a swing flap is not detected, it is essential to ensure that the protective cover cannot be removed without the use of tools. When a swing flap is in use, the voltage on all dangerous moves shall be safely disconnected. After the swing flap is released, such moves can only be released by pressing the respective button (e.g. Start or a button right on the protection system).

Typical rules for installation of articulated locking systems:

- Directly mechanically operating built-in position sensor.
- Impossible to be disabled without dismounting.
- Works as an articulated bearing for the mobile part of the flap.
- The switching point has to be set with sufficient accuracy.

For a sensor application example see Fig. 29, for hardware and safe connection examples see Fig. 30.



Fig. 29: Example: safety hinge switch

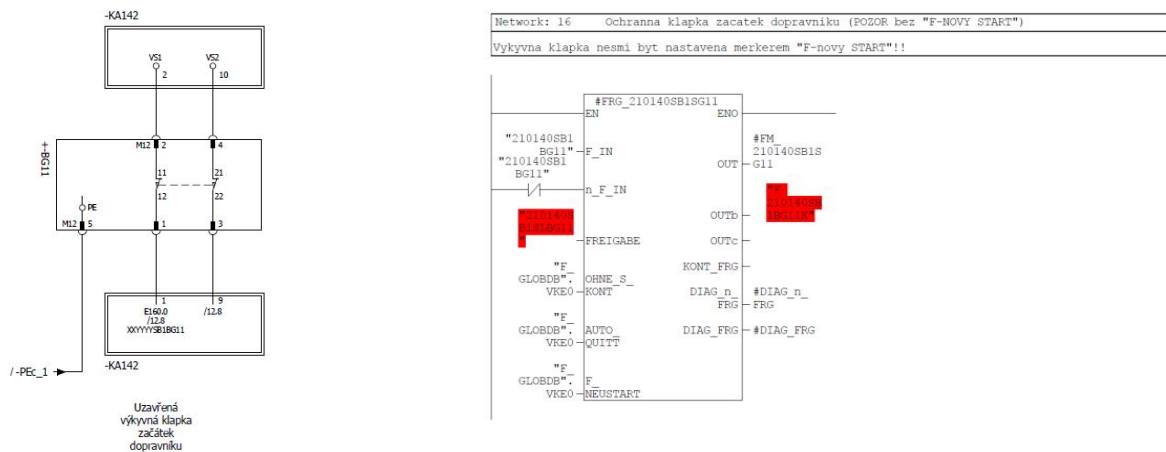


Fig. 30: Example: hardware and SAFE software connection

5.4.3 Switch mats

Switch mats shall comply with ČSN EN ISO 13856-1; can be used to safeguard dangerous locations and zones.

The control voltage of all dangerous moves in the danger zone shall be safely disconnected upon stepping onto the switch mat. After the danger zone is vacated, the system can only be restarted by pressing the respective button.

5.4.4 Switch rails

Switch rails shall comply with ČSN EN ISO 13856-2 and can be used as closing edge protection under ZH1/494.

5.5 Two-hand switches

Two-hand switches shall comply with ČSN EN 60204-1 ed.3. The types of two-hand switches in use under ČSN EN ISO 13851 shall comply with the identified control category (ČSN EN ISO 13849-1).

5.5.1 Functions - description

Control: under ČSN EN ISO 13851 "Occupational Protection". Machinery can only be started by pressing both control buttons. The buttons shall remain pressed down throughout the work cycle.

Checks: Each takt/sequence cycle shall include a test to check the control elements for possible deactivation.

Effect on machinery: If any of the control items (including both of them) of the respective two-hand control connection gets loose, the control voltage on the machine drives shall be safely disconnected.

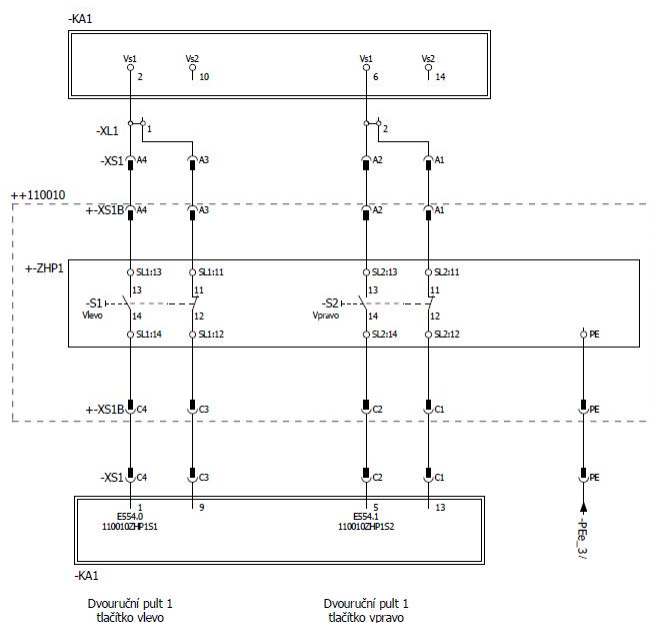


Fig. 31: Example: two-hand panel connection hardware

5.5.2 Mobile two-hand switches (two-hand panels)

Mobile two-hand switches shall be connected via a connector under ČSN EN 175301-801 ed.2. No bridging is allowed on the first two-hand panel. The bridging option shall also be available on the control panel. Solution details shall be discussed with ŠKODA AUTO a.s. departments in charge.

For an example of a two-hand panel connection with a bridging option see Fig. 32.

Connectors are allowed to be fitted exclusively with necessary contacts. Redundant cable cores shall be cut off.

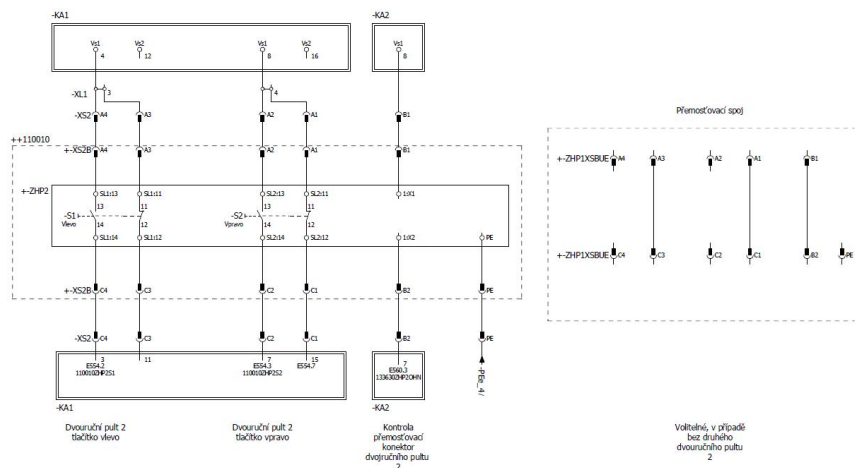


Fig. 32: Example: two-hand panel connection with a bridging option

5.6 Parallel contacts for safety switch confirmation commands

If using parallel contacts or parallel contactors for confirmation commands, the solution is required to include highly safe measures aimed at preventing the contactor(s) from getting stuck.



5.6.1 In sequence/takt-dependent protection systems the number of contacts can be increased by using an auxiliary contactor (or multiple parallel-connected auxiliary contactors), provided that the respective contactors are subject to in-takt checks.

5.6.2 If necessary, parallel contactors shall be used in takt-independent protection systems for safety switch confirmation commands. The monitoring of such auxiliary contactors (deactivation contacts) shall be done in a feedback safety circuit or the SAFE-software part.

5.8 Dead man button

When using a PLC, an inadvertent control impulse from the electronics must not lead to any dangerous move. Towards this end, a dead man button shall be used when selecting an autonomous move or adjustment on the selected bridging of the protection system (EKS or KWE2). For an example of a mobile control panel see Fig. 33.

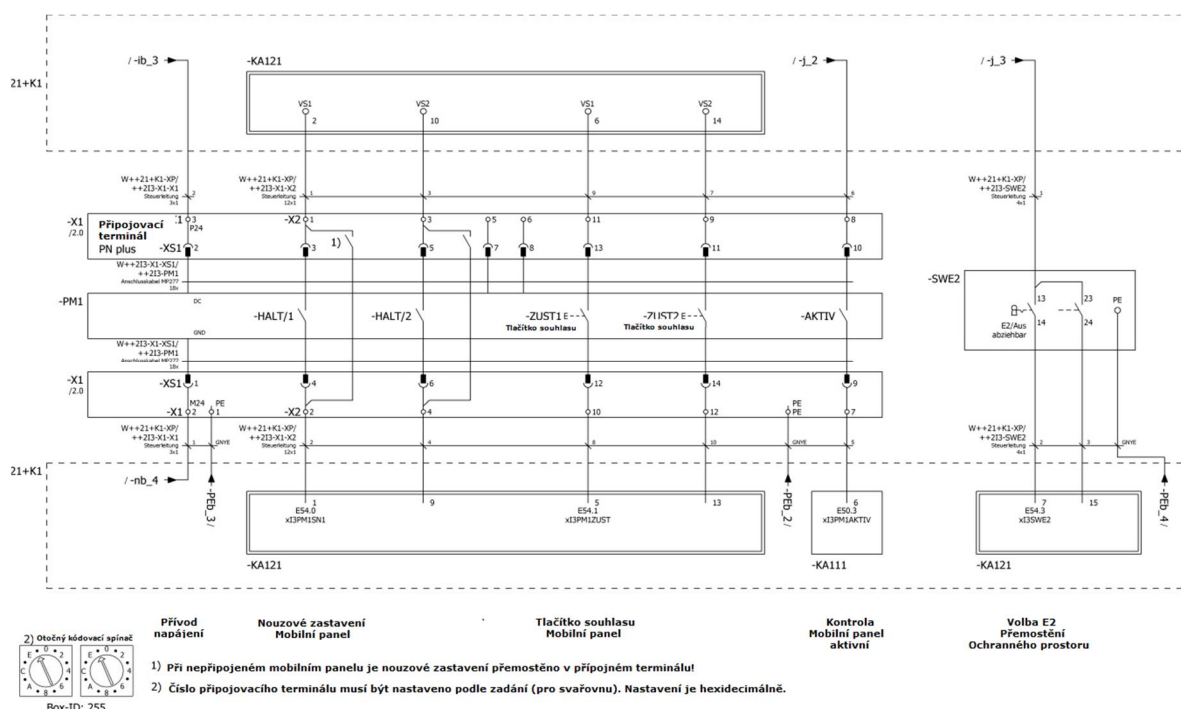


Fig. 33: Mobile panel connection diagram

6. EMERGENCY STOP (Not-Halt, E-Stop)

6.1 General

6.1.1 EMERGENCY STOP systems shall comply with ČSN EN 60204-1 ed.3 and ČSN EN ISO 13850. For the key difference between “emergency deactivation” and “emergency stop” see Fig. 34.

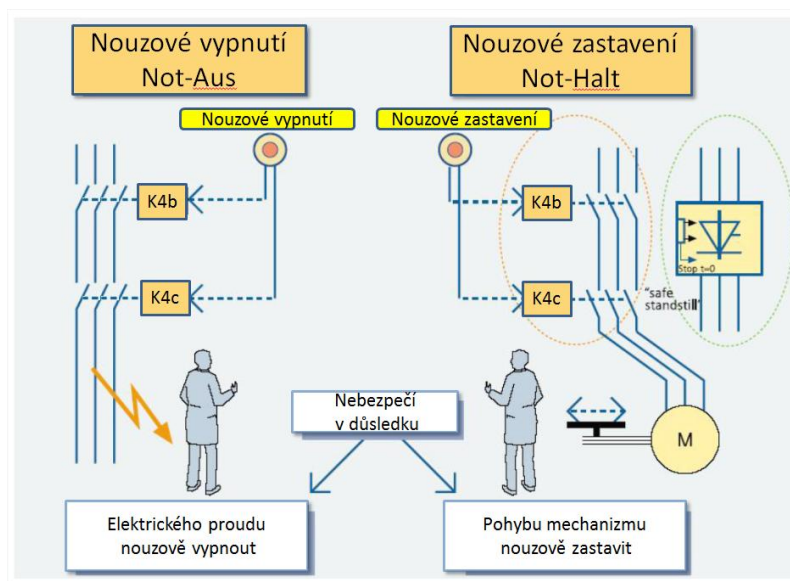


Fig. 34: Difference between “emergency deactivation” and “emergency stop”

6.1.2 Switches shall comply with Chapter 6.2 and detailed information specific to individual projects.

6.1.3 Once the emergency stop button is released, the machine must not start spontaneously. After the emergency stop has been confirmed and the "START" function released, the machine is required to start from any logical position adequate to its function(s). A key (EKS or SWE9) (ITS 1.09) shall be used to perform this confirmation in complex, difficult-to-survey conveyor systems.

6.1.4 Emergency stop circuits shall be visualised on the operator site.

As an extra item in production systems, the on-panel visualisation shall include individual emergency stop circuits (each emergency stop circuit relay K4), while also visualising the statuses of individual emergency stop buttons (SN_). In complex, difficult-to-survey conveyor systems (such as P and F conveyor systems, suspended electrical conveyors, skid conveyor systems, etc.) the emergency stop zones need to be agreed beforehand. The actual visualisation format shall be designed in line with project-specific information inputs and agreed with ŠKODA AUTO a.s. departments in charge.

6.2 Wiring connection diagram

6.2.1 Safety relay-based emergency stop circuit.

A safety relay can be used for simple machinery, subject to approval from the ŠKODA AUTO a.s. department concerned. For a connection example see Fig. 35. Emergency stop buttons are connected via two channels, with confirmation. Amplification contactors are checked by means of deactivation contacts in the feedback circuit.

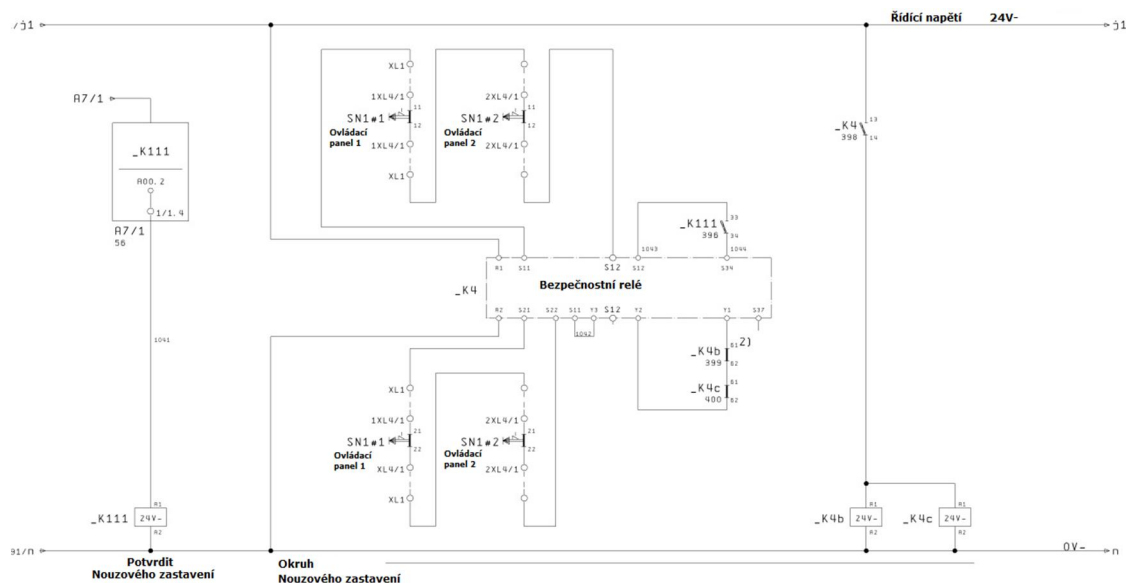


Fig. 35: Emergency stop connection example



6.2.2 Safety software-based emergency stop circuit.

It is prohibited to series-connect individual emergency stop buttons in the respective hardware. Each emergency stop button shall be connected individually, via two channels, to safety PLC inputs. The drive deactivator (SA1) is to be connected analogically.

The emergency stop function itself shall be processed in the SAFE software. Individual emergency stop buttons (safety inputs) will be added up in series connection and the result evaluated in a safety block. For an example see Fig. 36.

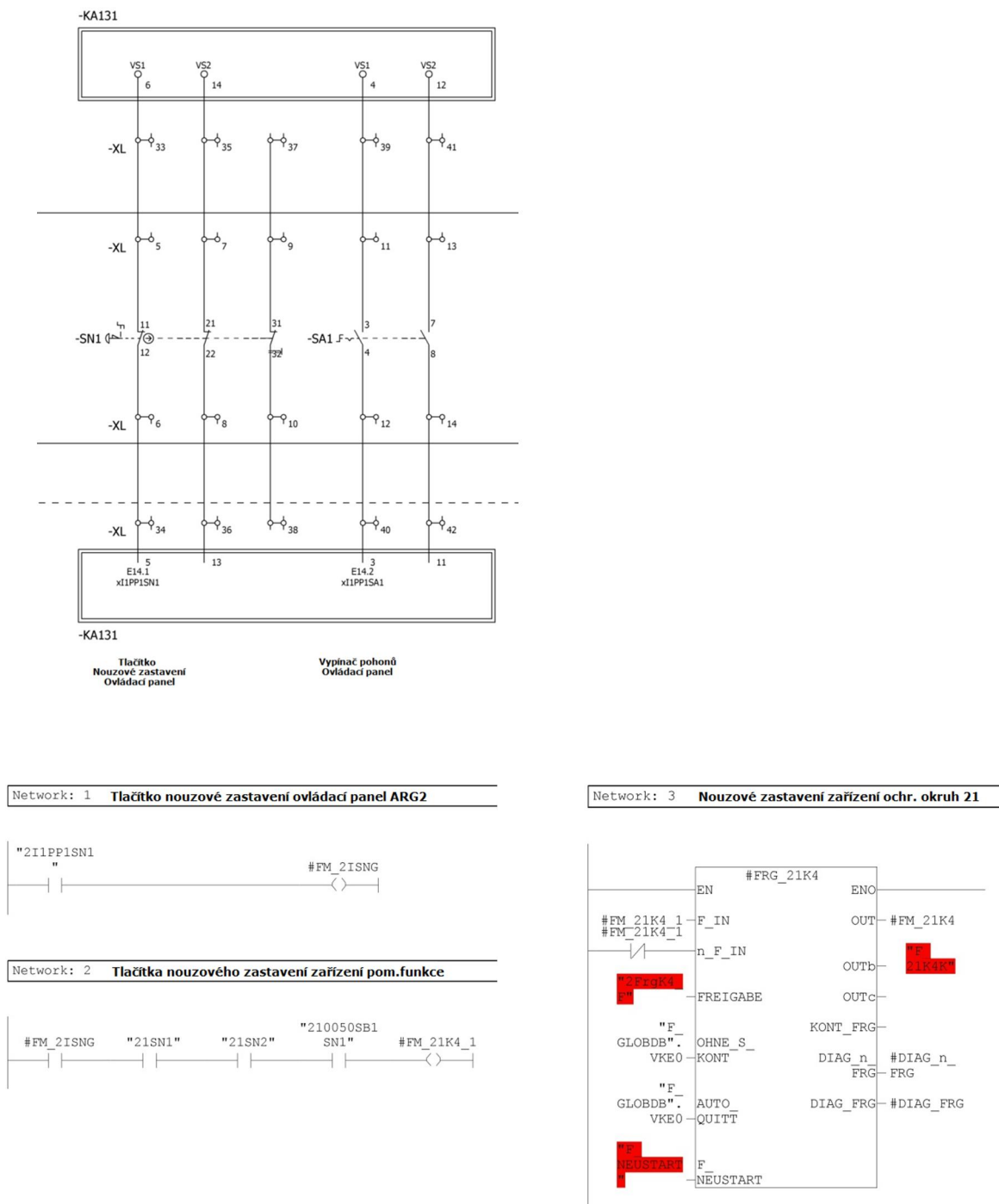


Fig. 36: Example: hardware connection and SAFE software

6.3 Safety emergency stop switches with delayed deactivation

If, after using an emergency stop button, the user needs to e.g. stop the drives in a controlled manner, it is necessary to use safety emergency stop switches with delayed deactivation. However, the voltage used for all other actuators and drive elements has to be disconnected immediately.

6.3.1 In machinery/equipment where an emergency stop may cause major losses the individual emergency stop features are subject to approval from the ŠKODA AUTO a.s. department concerned. LASER welding booths are a good example of such equipment. The roles of safety emergency stop buttons depend on the status of the respective production machinery - see Fig. 37.

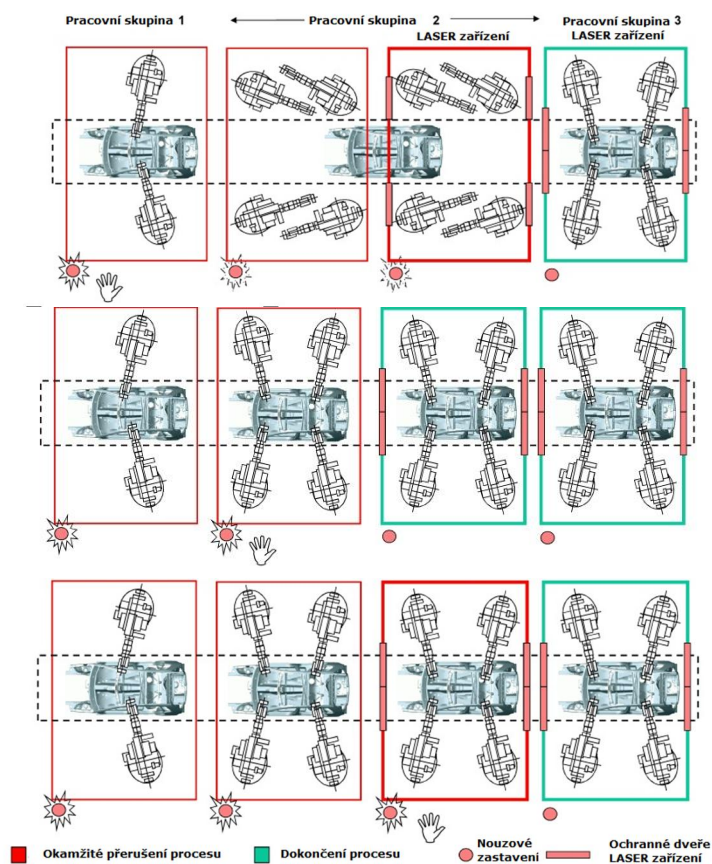


Fig. 37: Machine's response to emergency stop buttons

Chained emergency stop

Extensive machinery systems are controlled by multiple ARGs. Each ARG analyses the respective emergency stop and sends it to the master ARG. Subsequently, the chained emergency stop is sent back to the individual ARGs. The actual chained emergency stop solution shall be configured to be in line with project-specific information inputs and is subject to approval from the ŠKODA AUTO a.s. department in charge. For the chained emergency stop principle see Fig. 38.

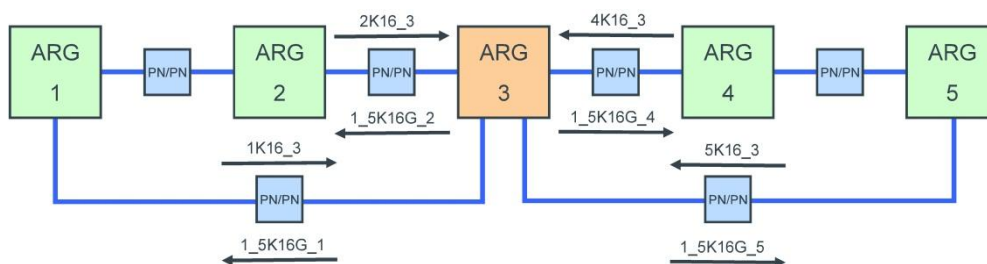


Fig. 38: Chained emergency stop principle

6.5 Drive deactivator connection diagram

Drive deactivator connected via two channels to PLC safety inputs, see Fig. 36. Drive deactivation function processed in a safety block. The example below (see Fig. 39) also includes checking the Start function for K40. To activate the drive, the Start function is required to be off.

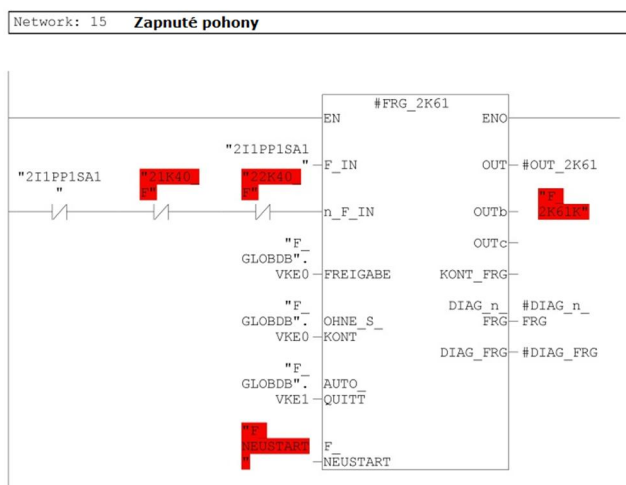


Fig. 39: Example: SAFE software for drive activation

7. DEACTIVATIONS, CHECKS AND LOGICAL LINKS

7.1.1 Sequence monitoring in automatic operation shall comply with ČSN EN 60204-1 ed.3.

7.1.2 Machines are required to stop immediately after control circuit disconnection, i.e. de-excitation of switching devices. A broken wire or short-circuiting to earth must not lead to a life-endangering condition. Restarting the machine, including after a power network outage, shall be done from a pre-define "START" status. Individual moves shall be checked depending on the position or trajectory (e.g. position switch, proximity switch). As a priority, sensors are required to check the actual movement of the terminal part. If that is not possible, the focus of such check can be on the cylinder position.

7.1.3 In DC machinery a control or regulation-circuit failure must not lead to an unacceptable condition; in particular, the following shall be observed:

If the sensing of the actual motor revs fails due to a broken wire, the revs must not change to levels over the rated speed.

If an overload leads to stopping the motor, the anchor current has to be disconnected.

The "STOP" command shall be performed in a safe manner.

If any control devices such as buttons, trajectory sensors, contactors etc. get stuck, it must not lead to a life-endangering operating condition. Their functionality needs to be checked.

7.1.4 Where multiple regulation drives are required to start synchronously, the switch box or control panel shall be fitted with a system to indicate the revs of all machines and all operating statuses. Depending on the actual mod of operation, a prior consultation may be required.

7.1.5 Protective deactivation solutions shall comply with ČSN EN 60204-1 ed.3. As a preferred solution, machinery locks shall be done in PLC.

7.1.6 Deactivation bridging

If a **machine** protection system needs to be bridged for the sake of repairs or adaptations, it can only be deactivated in exceptional cases, after a confirmation by activating the EKS key or SWE7 (ITS 1.09) to pre-select an autonomous operation or adjustment.

7.1.7 Irregularly controlled switching devices (e.g. for check-ups) shall be checked at least once upon the machine start. If such checks are done by the staff, they shall be performed by means of two mutually checked switching devices (except for power contactors).

For exceptions regarding power contactors see Chapter 11.

7.1.8 Slot checks shall take the form of one-way light barriers (without reflectors).

7.1.9 In DC motors a failure in the control chain or regulation circuit must not cause an unacceptable operating condition; in particular, the following shall be observed:

- If the actual-value reporting system fails due to a broken line, the motor revs must not change to an unacceptable value.
- If the motor stops due to an overload, the anchor circuit shall be disconnected.
- The stop command shall be performed even if the input routinely used for the required value gets impaired.

7.2 Checks of command transmitters (report checks...)

7.2.1 The terminal position of each move shall be checked by position switches or proximity switches. The switch statuses shall be indicated individually on the control panel. If a PLC is part of the system, the indication is done via such PLC.

7.2.2 Sequence/Takt-dependent switches shall check their own working and rest positions. The monitoring of their rest position should be done in a separate control branch. Command transmitter checks should also include parallel-connected switches (e.g. KE2Vb).

In the event of a failure, e.g. both terminal-position signals simultaneously, the failure is reviewed and the respective actuators are disconnected (alarm checks, pair monitoring).

To initiate individual moves, the working position of switching elements is processed in and also checked in the control system.

7.2.3 The design of pneumatic installations shall comply with ITS 1.13. A deactivation indicator is required in systems fitted with 5/2 valves for motion control and terminal position checks. This indicator shall be fitted at protective doors and on operator sites. The indicator shall be of orange colour and shall be fitted with a label in the local language ("Flashing Indicator may mean that the pneumatic cylinder got stuck."). When the cylinder gets locked, the indicator flashes, otherwise it is permanently on.

7.2.4 Where the system includes programmable PLCs, position sensors are fitted right on the inputs. The check-up logic (including delays) in the PLC takes the form of software. In standard connection formats we recommend using standard function blocks tested for functionality.

7.2.5 Machinery with motor drives required to ensure precise positions without mechanical stoppers (e.g. rotary production workbenches) shall be fitted with position switches and incremental or absolute sensors to ensure reaching the same position in each cycle.
If sensors are to be used, the required type is position/proximity (sensor). All sensors shall be checked as part of command transmitter check-ups. The hardware documentation shall include information about switching of the individual sensors - see Fig. 40.



Fig. 40: Example: sensor switching overview

7.3 Sequence/Takt checks

Functions performed gradually (after each other) shall include takt checks in cases where equivocal signals may occur in the control process, e.g. at Times 1 & 7, 2 & 6 and 3 & 5 in Fig. 38. These checks shall be remanent.

Further, sequence/takt checks are also required in cases where the control system uses short impulse signals (e.g. welding takt/sequence).

Fig. 41 illustrates the switching control process in a functional diagram. The takt/sequence check-up correctness shall be checked in each takt/sequence. Status "0" is a precondition for a working move, status "1" is a precondition for a move to the initial position. After reaching the initial position the takt/sequence check shall return to the initial status. The takt/sequence check returned to the initial status shall be the precondition for starting a new cycle.

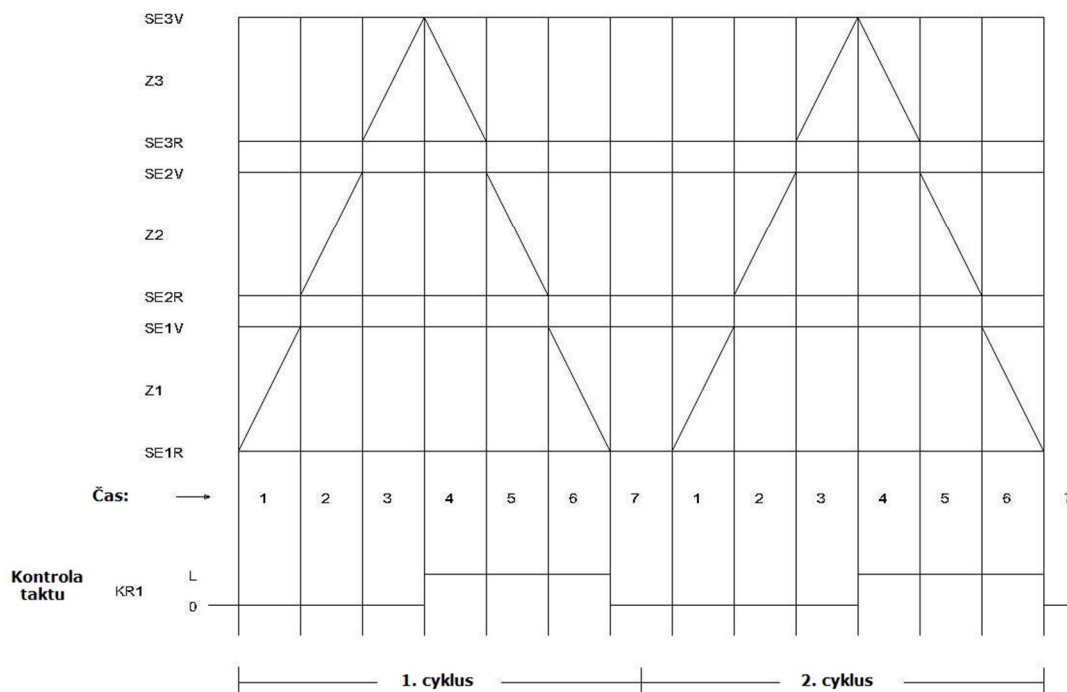


Fig. 41: Functional diagram

7.4 Part checks

To get information about the presence of workpieces for processing or relocation, parts need to be checked: all parts are subject to these checks. The part check shall be integrated into the system in a manner to ensure that it gets activated only when the part concerned has been safely fitted, and shall involve the use of two sensors. The above does not apply if the system does not enable empty takt, automatic filling or emptying. The position/proximity switch check shall be done "in-takt". Part checks shall be indicated individually on the operator site.

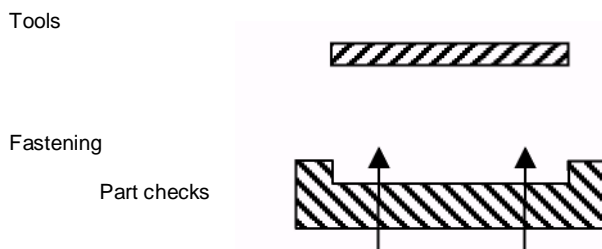


Fig. 42: Systematic arrangement

7.5 Position checks

If a particular position needs to be defined after the part concerned has been machined, an additional position check is required. This position check is required to guarantee the exact position of the part concerned. It shall be possible to set this check precisely, and the check shall indicate even the smallest of deviations. The inactive-status check shall be done "in-takt". The position check shall be indicated individually on the operator site.

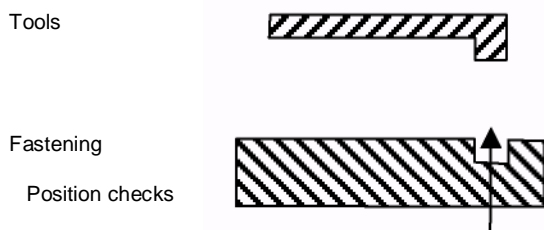


Fig. 43: Systematic arrangement

7.6 Type checks

If various machining processes are used for various parts, a part check needs to be installed. This check is required to perfectly identify differences between parts - all parts are subject to this check. Simple errors must not lead to incorrect signals. The switch check shall be done "in-takt". Resource type management shall take the form of type checks, such as position switches, travel switches or on-part information carriers. If the on-part type identification is not possible, the type identification may be done using an information carrier on the part holder, provided that such solution has been pre-approved.

Sequence management by means of type information queues is only possible in exceptional cases. If carrier or queue errors pose a risk of collision, an additional type identification shall be agreed with the client (e.g. light barriers, sensors).

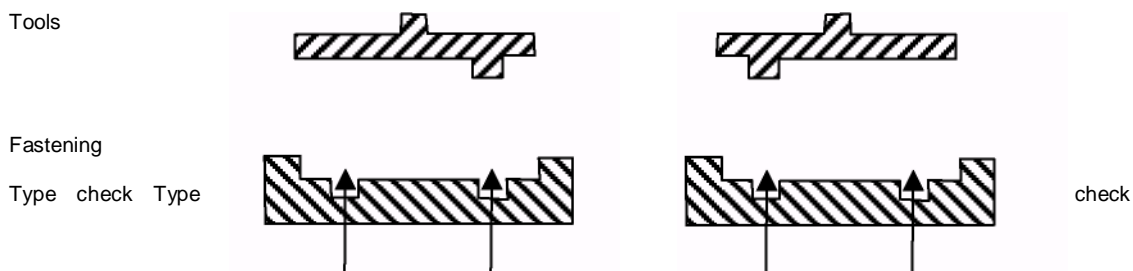


Fig. 44 Systematic arrangement

8. START A STOP

8.1 General

Start and Stop shall comply with ČSN EN 60204-1 ed.3, but the immediate shutdown shall take the form of switch de-excitation. A broken wire or short circuit must not cause any changes to endanger the machine operator(s) or the machine itself. The Restart shall be done from a pre-defined status, including after a power outage.

8.2 Start preconditions

Start preconditions such as

- Emergency stop released
- Drive deactivator active
- Operating mode selected
- Sensor pair check
- Motor protection
- Lubrication oil pressure
- Available air pressure
- Hydraulic pump on, etc.

have to be met in full. The Start can be activated only when **all** of the preconditions have been met.

If any of the preconditions fails, the Start process shall be stopped immediately.

The EKS or KWE7 mode can bridge some of the Start preconditions, e.g. air pressure.

It is recommended to visualise the Start preconditions in groups on the operator site.

Automatic production machinery shall feature a luminous visualisation system to show emergency stop and protection zone violation signals. Automatic operation can only be launched from the master control panel of the production equipment concerned. In extensive automatic system scenarios the possibility to allow the Start also from auxiliary control panels needs to be consulted with the ŠKODA AUTO a.s. departments concerned.

8.3 Difficult-to-survey production systems are expected to feature a delayed start pre-set function, with visual or acoustic warning for the operator within the delay period. The production system will start automatically after the lapse of the pre-set delay ("START of K100 actuators"). The process is illustrated in Fig. 45. The time of the required delay and the form of the warning are to be agreed with the ŠKODA AUTO a.s. departments in charge.

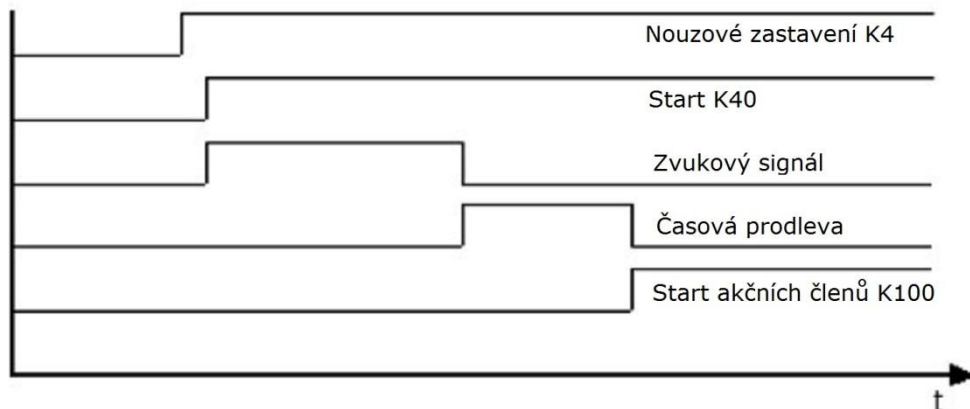


Fig. 45 Example: production system start

8.4 START of K100 actuators

A typical example of creating the safety function called START of (K100) actuators is the logical product of the following functions:

Emergency stop (K16);

Drive deactivator (K61);

Protection zone (K36);

Activated start (K40).

For a software example see Fig. 46.

Where output contactors are in use, their deactivation contacts shall be connected to the PLC input and the input checked in the SAFE software.

For a hardware contactor connection example see Chapter 3.4, Fig. 12

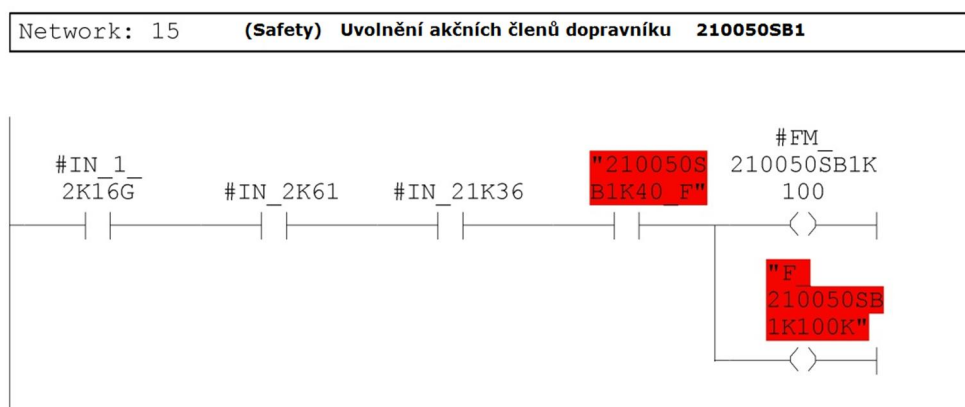


Fig. 46 Example: START of K100 actuators - SAFE software

9. 9. COMMANDS

9.1 Commands are electrical signals that leave operating units in the form of commands or are received by operating units in the form of reports. Their identification and numbering shall comply with ČSN EN 60204-1 ed.3 and ITS 1.11.

9.2 Commands that communicate across multiple operating units within an operating group can be generated by internal control voltage (within the equipment concerned).

9.3 Commands that communicate across multiple operating groups shall be based on communication gateways.

In simple operating groups such communications can be generated by potential-free contacts with 24 VDC. The objective of limiting the voltage level is to prevent a situation where unacceptably high external voltages get to the distribution box (of the operating group concerned) via command lines, despite the main switch being off.

9.4 Inbound commands need to be received before deactivations, checks and logical links to prevent bridging of safety elements and thus activation of the respective contactor in the event of a transit failure (e.g. connection to live lines). Outbound commands need to be sent only after the control software has been processed.

9.5 Commands between two operating groups shall be visualised on the operator sites of both operating groups.

9.6 Commands need to be agreed between the two operating groups. Basic safety signals shall be sent individually (emergency stop K16, activated drives K61, confirmed protection zone K36). Use the respective SAFE communication blocks for safety signals on the SAFE software level. For an example of communication (data reception and transmission) between ARG1 and ARG2 see Fig. 47.

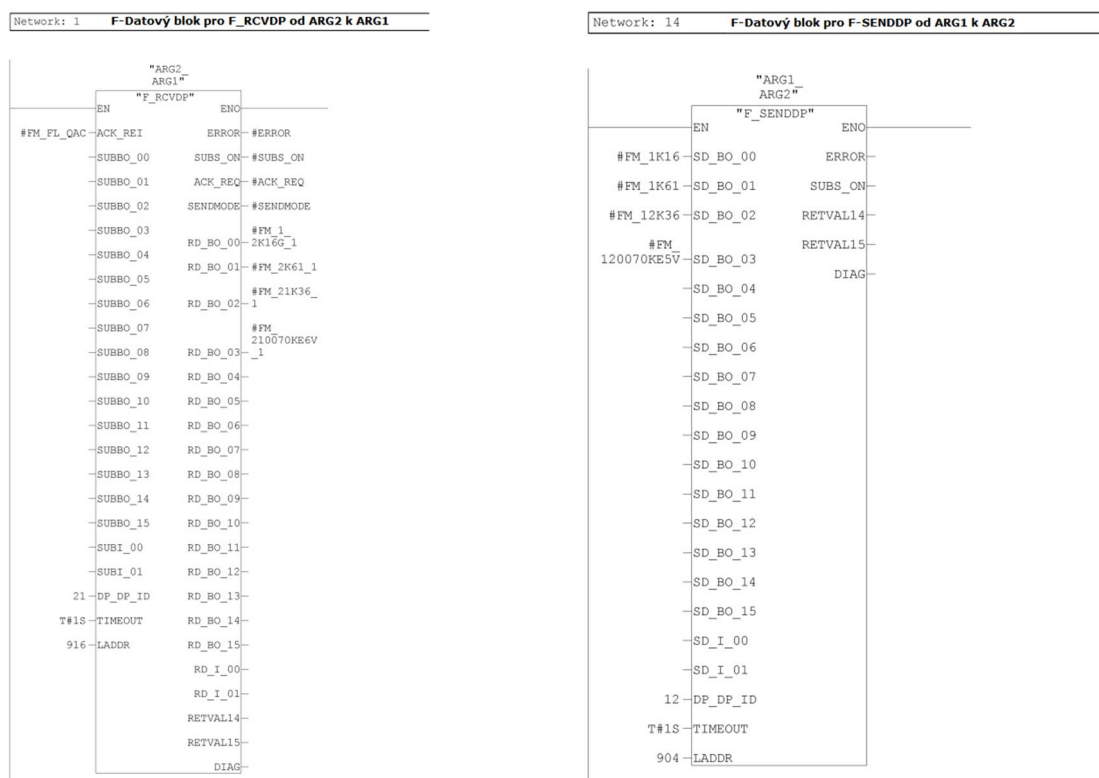


Fig. 47: SAFE software communication example

9.7 Contradictory signals such as MK10 (conveyor in the front) and MK12 (conveyor in the rear) need to be checked as part of command transmitter checks.

10. INDICATION

10.1 Single-lamp visualisation (permanent light for correct operating statuses and flashing light for failures) is preferred to the use of two different lamps.

10.2 The source to be used to select colours for command-giving and signalling devices is ITS 1.11 Chapters 4.11 and 4.12.

10.3 Where the ŠKODA AUTO a.s. department concerned specifies the required signalling format, e.g. by means of workshops, the respective rules become compulsory. For an example of detailed rules for manual station signalling see Fig. 48.

Ukazatelé pro ruční stanice Informační semafor pro pracovníky



Signalizace pro obecnou ruční stanici			
Barva:	Vypnuté světlo	Trvalé světlo	Blikání
Modrá	Čas taktu je OK	Varování konec taktu 3s před 100%	Čas taktu 100% a více
Červená	Povolení vstupu obsluhy do pracovního prostoru	Zákaz vstupu obsluhy do pracovního prostoru	Porucha
Zelená	Ochranné zařízení OK Zákaz vstupu obsluhy do pracovního prostoru	Povolení vstupu obsluhy do pracovního prostoru	Ochranné zařízení není uvolněno / potvrzeno

Fig. 48: Example: detailed rules for manual station visualisation.

10.4 The ŠKODA AUTO a.s. department in charge may set the illustration of meaning of some control elements in the form of a pictogram. For example of pictogram, see Fig. 49. Other descriptions on control panels and text reports shall be made in the user's national language. The ŠKODA AUTO a.s. department concerned may decide to have a multi-lingual version.



Fig. 49: Example of pictogram use

11. ACTUATORS

11.1 Connectors for connection of motors

For approved products and types see ITS 1.11.

11.2 To prevent overvoltage in deactivation of electromagnetic coils on couplings and valves, distributors are fitted with voltage limiters to prevent overvoltage that might damage the winding of other devices in the circuit.

11.3 ŠKODA AUTO a.s. departments concerned may prepare additional information inputs and/or workshops for individual projects in order to adopt more detailed rules for hardware and software and provide the Supplier with compulsory hardware and software models.

For an example of a hardware model for connecting the drive for a takt/sequence conveyor see Fig. 50.

For an example of a hardware model for connecting the drive for a skid roller track with a SEW changer see Fig. 51.

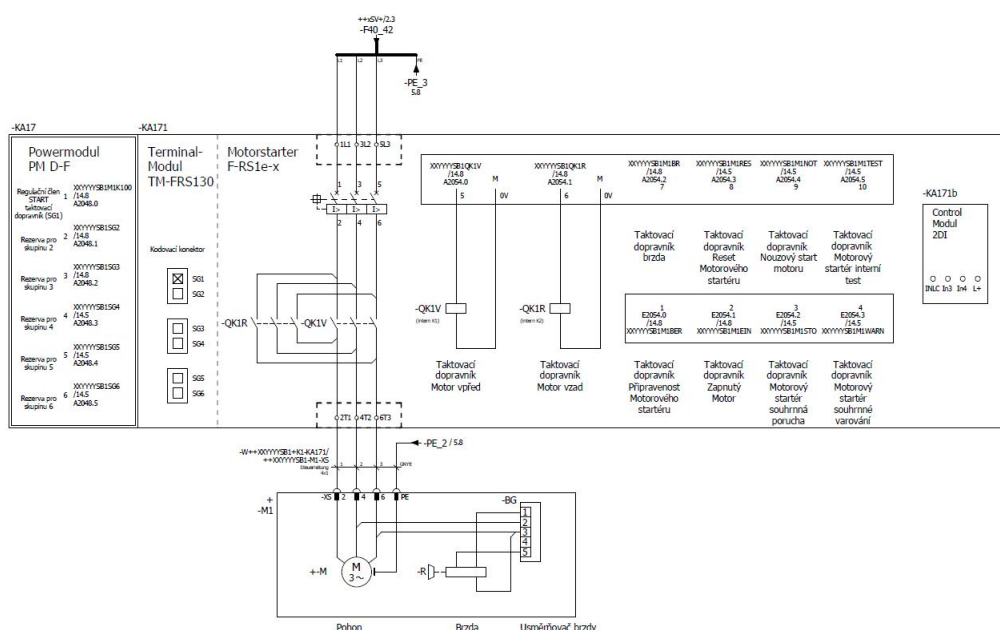


Fig. 50: Example: takt/sequence conveyor drive connection

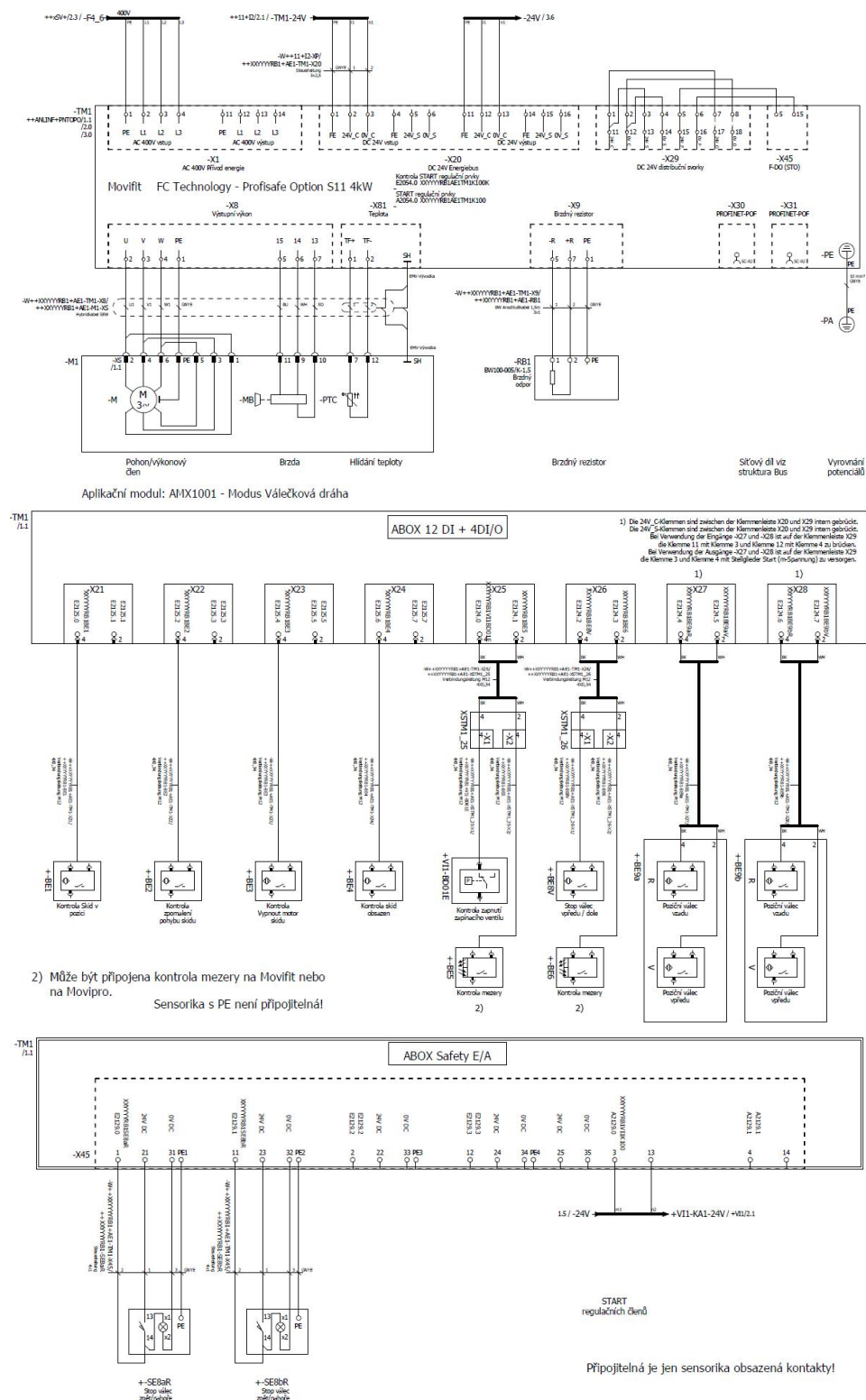


Fig. 51: Example: hardware model for connecting the drive for a skid roller track with a SEW changer

12. DOCUMENTATION

12.1 Hardware

Documentation packages coming with new machinery and equipment shall be drafted in the EPLAN CAD-system, in the version required under ITS 1.01.

Equipment modifications shall be documented in change sheets.

12.1.1 Contents

As per specimen(s) issued by the ŠKODA AUTO a.s. department(s) in charge.

12.1.2 Identification

The header shall be completed in full for each project. The identification No. and inventory No. is issued/provided by ŠKODA AUTO a.s.

12.1.3 Project structure

As per specimen(s) issued by the ŠKODA AUTO a.s. department(s) in charge.

12.1.4 Project description

12.1.4.1 The responsibility for setting the project design lies with the staff member in charge. If ŠKODA AUTO a.s. sets some basic connection format, such format becomes compulsory.

12.1.4.2 Projects shall comply with ČSN, ITS ŠKODA AUTO a.s.

12.1.4.3 The ŠKODA AUTO a.s. department in charge decides which automatic EPLAN features and functions are to be used (e.g. contact links, potential links, terminal box plans, part lists, etc.).

12.1.4.4 The ŠKODA AUTO a.s. department in charge decides which generated runs are required to be error-free.

12.1.4.5 A "Black Box" shall be used for all undefined symbols.

12.1.4.6 Documentation packages shall correspond with the actual wiring connection formats. Changes made to documents shall be put on a change sheet.

12.1.4.7 The part list (BOM) shall be complete (i.e. shall specify all equipment items, parts and components)

- Case(s) material
- Terminal box(es) material
- Terminals, cables, bridges, etc.

Items that are not part of electrical wiring connections shall be put on a special list.

12.1.4.8 Hardware documentation packages shall clearly distinguish between PLC inputs & outputs of the "standard" category and the SAFE category. A dual frame is to be used for SAFE inputs and SAFE outputs. For a frame design example see Chapter 4.1, Fig. 11.

12.2 Hardware documentation delivery

12.2.1 E-PLAN hardware documentation packages shall be delivered on DIN A4 sheets, in the user's language: two printouts and one E-PLAN copy or as agreed in writing between the parties. The ŠKODA AUTO a.s. department concerned may decide to have a multi-lingual version of the documentation package.

12.2.2 Data carriers shall be non-rewritable, such as CD, DVD, with an original description. Data on carriers shall take the form of E-PLAN P8 (.zw1) editable data and also pdf data. If ŠKODA AUTO a.s. sets some data structure for the respective data carrier, such structure becomes compulsory.

12.3 Software

12.3.1

Functional programme blocks shall come with a manual in the user's language. Software descriptions (comments) shall be in the user's language. The ŠKODA AUTO a.s. department concerned may decide to have a multi-lingual version of the comments concerned.

12.3.2

The programme shall provide comments to all signals (inputs, outputs, markers, timers, data, flags,...), macros, programme blocks and their components in use in the user's language. If ŠKODA AUTO a.s. sets some rules for symbols, such rules become compulsory.

12.3.3

The SAFE programme shall come with a completed change sheet to specify, in particular, the SAFE software author, software version, the date of the latest change and the programme checksum.

12.3.4

The functionality of all safety elements shall be checked and documented. Proper measurements will be done to check whether the minimum safety distance specified in the safety solution has been set correctly (in connection with e.g. safety barriers and scanners, step-on platforms, two-hand panels).

Primary safety elements shall include a machine stop time measurement report.

All light barriers and scanners shall come with commissioning inspection reports.

12.3.5 Functional safety

Use the EPLAN P8 hardware documentation to export all relevant safety signals in Czech. Before starting the design of software, the Contractor must create a safety table from the signals in the EXCEL format. Such table serves as an assignment for safety PLC programmers. From the safety table it must follow which safety sensors and other elements shall have effect on the respective actuators/drives. Using this spreadsheet, the Contractor checks the validity of safety functions on the machinery concerned. The Excel spreadsheet as well as the checked and signed spreadsheet become part of the documentation package. For an example of cross-reference safety table see Fig. 52. Any different method of creating a cross-reference safety function table is subject to approval from the ŠKODA AUTO a.s. department concerned.

[illegible]

Fig. 52: Example: cross-reference safety function table

12.4 Software documentation delivery

Data carriers shall be non-rewritable, such as CD-R, DVD, with an original description and the date of production. If any image HDD data are to be delivered, the ŠKODA AUTO a.s. department concerned will select the carrier format or storage location.

12.4.1

Any software deliveries shall comply with the ITS 1.05 rules.