



INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Název projektu: **Automatizace výrobních procesů ve strojírenství a řemeslech**

Registrační číslo: **CZ.1.07/1.1.30/01.0038**

Příjemce: **SPŠ strojnická a SOŠ profesora Švejcara Plzeň, Klatovská 109**

Tento projekt je spolufinancován Evropskou unií a státním rozpočtem České republiky

Produkt:

**Zavádění cizojazyčné terminologie do výuky odborných předmětů a do laboratorních cvičení**

**Bezpečnost práce a ochrana zdraví před úrazem elektrickým proudem**

Návod v anglickém jazyce

Číslo tématu: **5b**

Monitorovací indikátor: **06.43.10**

## INSTRUCTIONS FOR TOPIC: 5b

Created in school year: 2012/2013

Branch: 26-41-M/01 Electrical Engineering - Mechatronics

Subject: Measurement and diagnostics

Year: 2.

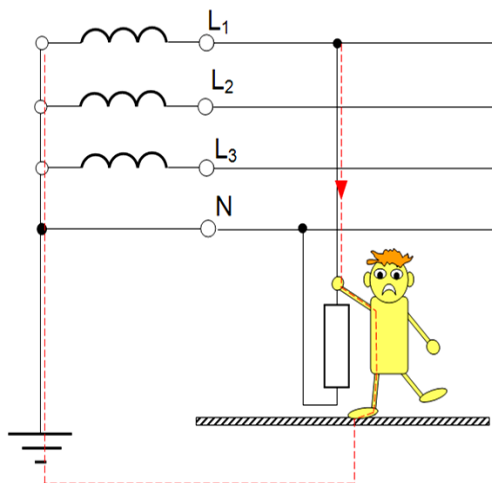
Prepared by: Ing. Milan Nechanický; translated by: Mgr. Marie Mádlová

### Health and safety at work and in the workshop

#### Contact of a person with an electrical equipment

If you touch a part of live equipment, electric current flows through the circuit: part of the impedance voltage – finger + body resistance + contact resistance foot - ground + ground - the other pole of the source.

Current size = voltage size on the part and total circuit resistance  $I=U/R$



#### Impact of el.current on human organism

When the current flows through live organism there are following phenomena:

- heat rises and may cause burns.
- current causes cell decomposition that causes e.g.blood decomposition .
- el.current causes muscle spasms
- alternating current causes heart fibrillation which leads to the cardiac arrest.

#### Impact of el.current on human organism depends on:

- current size
- current type

- current frequency
- impedance of human body
- current direction
- transit time flow
- physiological and psychological state of the organism
- size of the touch voltage

### **Current type:**

Human heart frequency is around 70 pulses per a minute. When the AC flows at frequency around 50 Hz, heart tries to adapt to this frequency i.e. around 50 pulses per a second and fibrillation and cardiac arrest appears.

Alternating current is much more dangerous for human organism than direct current.

### **Current size:**

- The bigger current size and the longer transit time of flow, the worse the impact of current on human body.
- Current value of 20mA is considered to be the limit when unpleasant feeling turns into dangerous injury or state.
- Current value of 100 mA causes death in almost all cases.

### **Current frequency:**

Dangerous frequency bands - 10 - 100Hz and 200 - 500 Hz.

### **Impedance of human body:**

- Average value is 2000  $\Omega$
- About 30 s later, the body impedance is lowered by 1/5 , so the current rises.

### **Current direction:**

Most dangerous current direction are: Head – arm, head - leg

### **Transit time of flow:**

The longer time the current flows, the more serious consequences and injuries it causes.

**Physiological and psychological state of the organism:**

Impedance of human body also depends on physiological and psychological state  
 When a person is tired, depressed, sick etc, body impedance lowers (sometimes up to the value 400 Ω).

*Note: safe current value is 10 mA of AC and 25 mA of DC*

**Size of the touch voltage :**

- Various parts of organism are different in conductivity and sensitivity to electric current. Human skin behaves as a not very perfect insulant sleeve of the body, because it is 20x less insulant than mucosa or soft inner organs.
- Voltage higher than 60V affects this skin it becomes conductive.
- That’s why limits for save and dangerous voltage are set.

**Touch voltage limits in dependence on space characteristics**

Live parts	Non live
<ul style="list-style-type: none"> <li>• By position</li> <li>• By obstacle</li> <li>• By shield (min IP2x resp. IP4x)</li> <li>• By isolation</li> <li>• By additional isolation</li> <li>• Additional protection by RCD</li> </ul>	<ul style="list-style-type: none"> <li>• By position</li> <li>• By obstacle</li> <li>• By isolation</li> <li>• By additional isolation</li> <li>• Automatic disconnection from the source</li> <li>• Doubled or strengthened isolation</li> <li>• Electrical separation from other equipment</li> </ul> <p>For supervision by qualified personnel also:</p> <ul style="list-style-type: none"> <li>• Protection by dielectric environment</li> <li>• Protection by sepatation of power supply for more than 1 equipment. Ungrounded local interconnection</li> </ul>

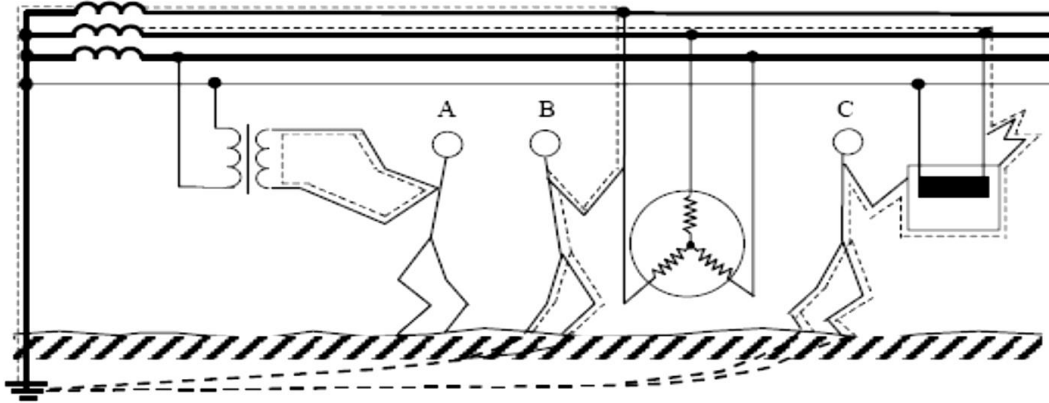
**Spaces from the view of risks of electric injuries are divided :**

- Safe spaces (dry, with nonconductive surrounding)
- Dangerous spaces (permanent or temporary risks - wet, with conductive surroundings).
- Spaces with high risk (permanent risk of electrical injuries - wet).

**Dangerous contact with electrical equipment**

1. Accidental
2. Conscious

Dangerous contact with electrical equipment:



- A) bipolar contact with live parts (direct touch)
- B) single-pole contact with live parts (direct touch)
- C) indirect contact drifting of the inanimate

### Basic rules to prevent electrical injuries

- dangerous live parts must be covered.
- accesible conductive parts must be safe in normal conditions and, also when there is one malfunction

### How to protect a person from electrical injuries

- Prevent access to live parts of equipment
- Limit the current to a safe value
- Early disconnecting from the source

### Protection class electrical equipment

**Class I:** basic insulation, protective terminal must be brought out and connected (iron, PC, motor)




**Class II:** basic and protective insulation, no other protection needed

**Class III:** charging by low safe voltage, no other protection needed

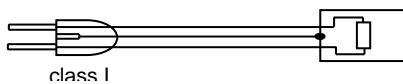
Protection by low voltage – safest.

Equipment must be supplied by small safe voltage - no dangerous current flows through the body when touching it.

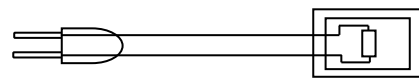
### Protection class electrical equipment:

Třída ochrany	Značka	Použití ochranných opatření
I		S ochranným vodičem (spotřebič je spojen s ochranným vodičem zařízení)
II		Ochranná izolace (spotřebič se základní a dodatečnou izolací – např. svítidla)
III		Bezpečné napětí (připojení pouze na obvody s malým napětím, např. nízkovoltové žárovky)

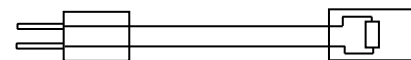
Protection class	Protection precaution
I	Protective conductor
II	Protective insulation (e.g. lights)
III	Safe voltage (e.g. light voltage bulbs)



class I



Class II (by insulation)



Class III (low safe voltage)

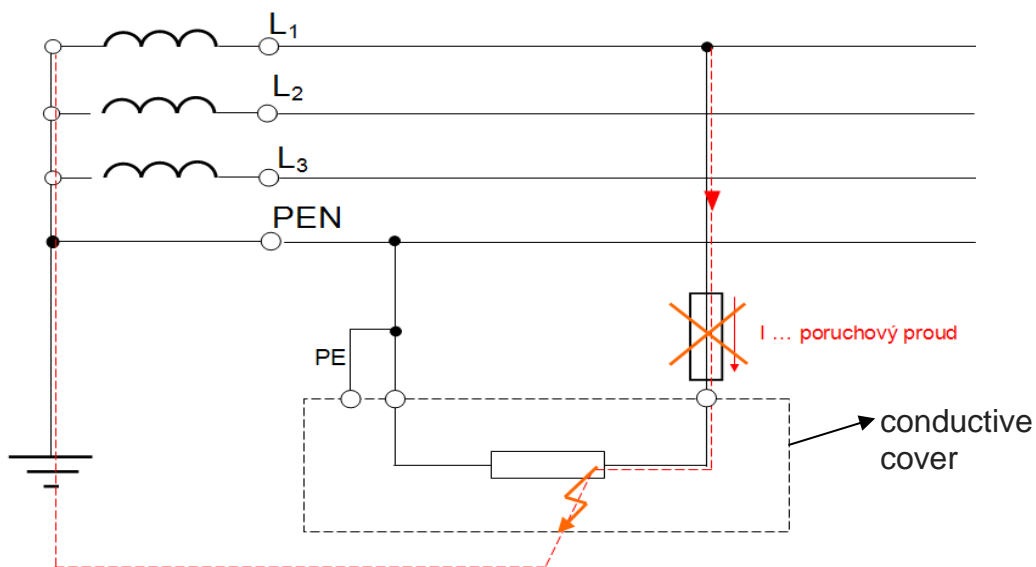
### Safe low voltage limits

Areas	Touch with parts of equipment	Maximum low voltage of live parts	
		alternating	direct
Normal and also dangerous	live	25	60
	covers isolated from live parts	50	120
Especially dangerous	live	-	-
	covers isolated from live parts	12	25

## Protection against accidental contact

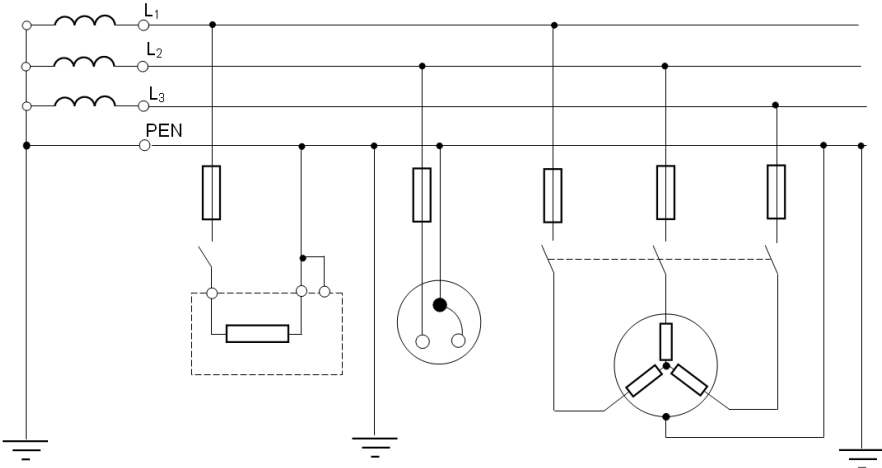
Live parts	Non live
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## Protection by disconnecting from the source

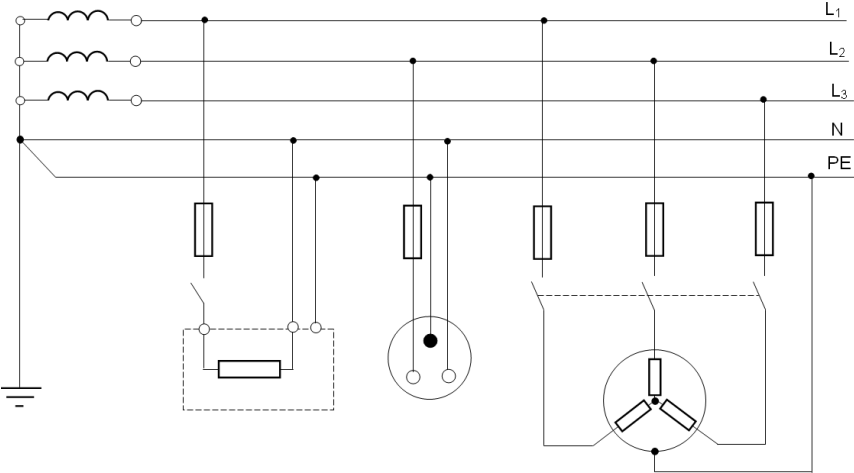


**Examples – Circuits for power net**

**Net TN-C**



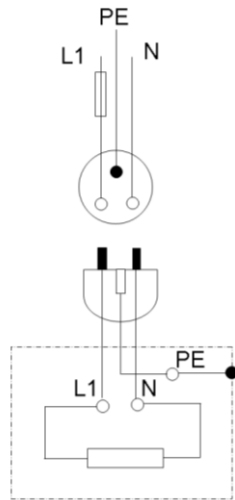
**Net TN-S**



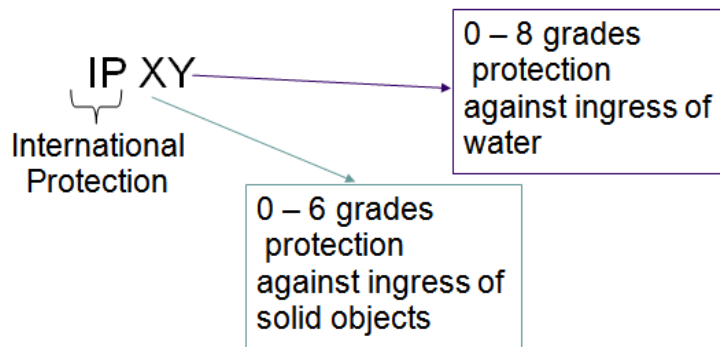
**Socket bonding:**

For the security it is necessary to keep the proper bonding of movable plug into the socket.





Electrical equipments covers:



Protection against ingress of solid objects: IP XY

<i>X - First number</i>	<i>Protection grade</i>	
	<i>Importance for protection of equipment</i>	<i>Importance for protection of humans</i>
	<i>Protection against ingress of solid objects:</i>	<i>Ochrana před dotykem s nebezpečnou částí:</i>
0	Without any protection	Without any protection
1	≥50 mm in diameter	With palm of a hand
2	≥12,5 mm in diameter	With a finger
3	≥2,5 mm in diameter	With a tool
4	≥1 mm in diameter	With a wire
5	Dust protection	With a wire
6	Complete dust protection	With a wire

Protection against ingress of water: IP XY

<i>Y</i>	<i>protection</i>	<i>description</i>
0	No protection	No specific protection
1	Protection against vertically dripping water	Vertically dripping water must be safe
2	Protection against vertically	Rain falling on the cover tilt 15° mustn't

	dripping water by the cover tilt 15°	damage the el.equipment
3	Protection against vertically dripping water by the cover tilt 60°	Rain falling on the cover tilt 60° mustn't damage the el.equipment
4	Protection against splashing water	Water splashing on the cover in various direction mustn't damage the el.equipment
5	Protection against water flow	Spraying water mustn't damage the el.equipment
6	Protection against intensive spraying water	Spraying water mustn't enter and damage the el.equipment
7	Protection against temporary immersion	When the equipment is immersed water under certain pressure mustn't enter under the cover damage it.
8	Protection against permanent immersion	Protection against permanent immersion

### **Safe operation and work with electrical equipment:**

Requirements:

- Before starting any operation- evaluation of electrical risks
- Training on security and local operational rules
- Re-testing of complicated operations
- Suitable dress and personal accessories are essential
- Only experienced and trained personal staff is allowed to operate in areas with special el.danger.

### **In laboratories and workshops:**

- It is not allowed to wear loose clothes
- It is not allowed to wear bracelets, rings, chains and other metal accessories
- Students are allowed to perform operations only with non live circuits, the connection of power supplies is done by a lecturer after the final check.
- While measuring it is allowed to touch only the isolated parts that are necessary for the manipulation
- The person who disconnects power supply in the case of accident or injury and the place must be strictly selected before. It is also necessary to check if the tools and appliances aren't damaged.

### **First aid for electrical injuries**

- Pull out the injured person of reach of el. Current. Immediately switch off or interrupt the el. circuit.
- Start to rescue by artificial respiration if the injured person does not breathe.
- If the puls is weak or non palpable , start cardiac massage.
- Call the doctor
- Report to supervisor about the accident or injury

### **Treatment of other injuries**

- Other injuries are treated only after restoring breathing and heartbeat
- Only when there is severe arterial bleeding stop it by using pressure dressing.
- In the case of open fracture take away the clothes on the bleeding site and cover with a dressing
- Put sterile drape, dressing or towel on burns of 2 and 3 degree to prevent infection during the transport of injured person. Pour cold water on the small burns.

### **How to extinguish electrical equipment**

- It is appropriate to switch the equipment off before extinguishing
- When the equipment is live use :
  - fire apparatus:
    - snow
    - powder
    - halon
- Don't extinguish fire with water or foam

**Attention: on fire of el.equipment, there might be toxic gases**

**Always immediatelly report the fire**

Zdroj:

poznámky z předmětu *Základy elektrotechniky* - 2. a 3. ročník SPŠ elektrotechnické v Českých Budějovicích

**Bezpečnost práce a ochrana zdraví před úrazem el. proudem - Health and safety at work and in the workshop - slovníček odborných termínů**

**Vocabulary**

**Slovníček**

accident , accidental	náhoda, náhodný
appliance, device	přístroj
appropriate	vhodný
average	průměr, průměrný
bleed, bleeding, blood	krvácet, krvácení, krev
bond	spojení, připojení
breath, breathing	dech, dýchat, dýchání
bulb	žárovka
cardiac arrest	zástava srdce
cause	způsobit, příčina
check	kontrolovat, kontrola
circuit	obvod
conductive, conductivity,	vodivý
insulate, insulant, insulator	izolovat, nevodivý, izolator
conscious	vědomý
consequence	následek
cover	obal
current	proud
alternating current AC	střídavý
direct current DC	stejnoseměrný
current size	velikost proudu
decomposition	rozpad
disconnection	odpojení
equipment	vybavení, zařízení
extinguish, fire extinguisher	uhasit, hasičský přístroj
first aid	první pomoc
flow	proudit, procházet
heartbeat	tlukot srdce
immerse	potopit
impact	dopad

impedance	odolnost
ingress	pronikat, /voda, plyn/
injure, injury	zranit, zranění
loose clothes	plandavé šaty
malfunction	disfunkce
measure	měřit, míra
necessary, essential	nutný, povinný
obstacle	překážka
plug	zástrčka
precaution	upozornění
pressure	tlak
remove	odstranit
requirement	požadavek
resistance	odpor
rule	pravidlo
shield	štít
socket	zásuvka
source	zdroj, připojení
state	stav
supply	napájet, zásobovat
touch	dotýkat se
treatment	péče
value	hodnota
voltage	napětí