FIA REGION I

ROAD PATROL TRAINING FOR EXCELLENCE 2023 Slovenia

ARC Europe

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AMZS

anwb

TOURING

CLS CLUB LOGISTICS SERVICES

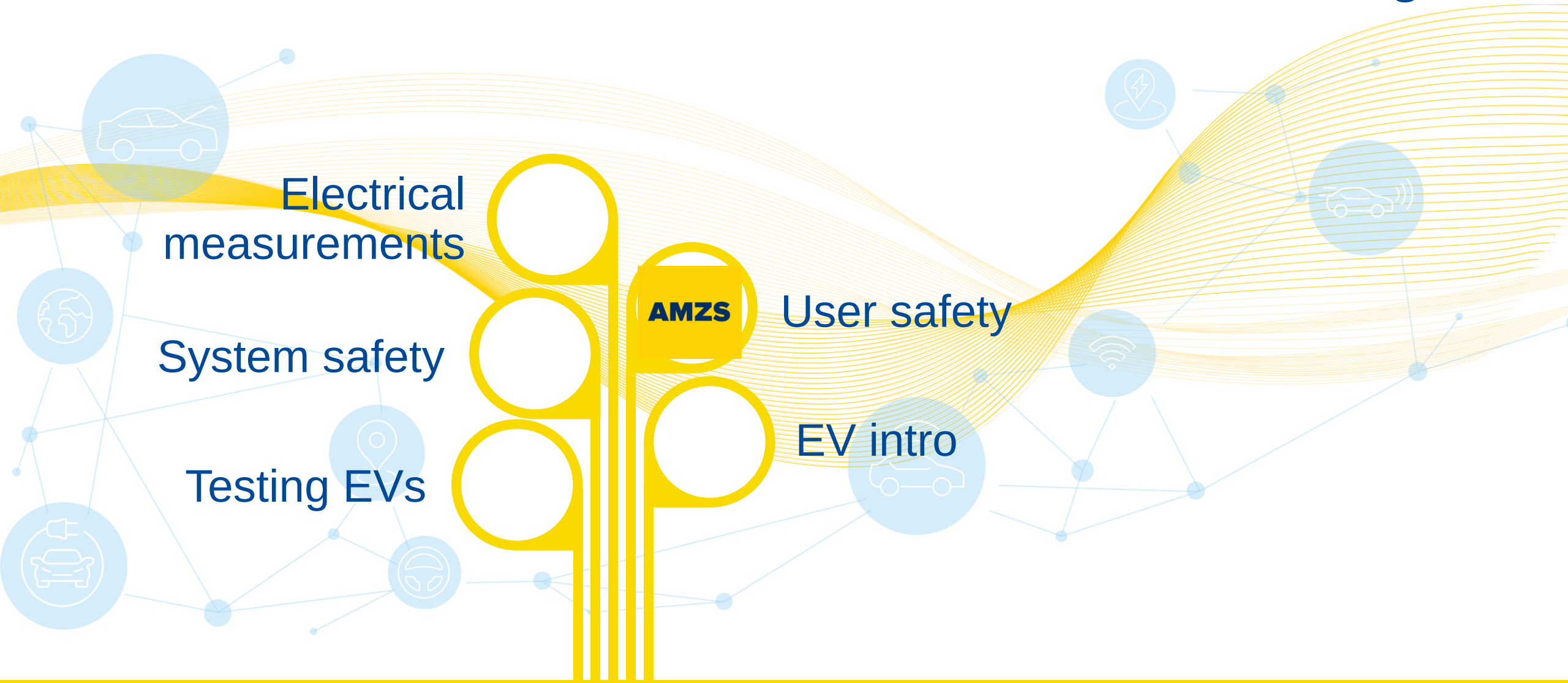
ELECTRICAL SAFETY AND ELECTRIC CARS

Metrel d.o.o.

COMPANY PROFILE

- Established in 1957
- Tradition in test and measuring equipment manufacturing
- Own R&D and manufacturing
- Programs:
  - Electrical installation safety (+EVSE)
  - High voltage Insulation / Continuity / Earth
  - Machines / Appliances / Switchgear safety
  - Power quality analysis
  - Suportive programs (Multimeters, Lab equipment,…)

Agenda


Electrical measurements
System safety
Testing EVs
AMZS
User safety
EV intro

Electrical measurements

CONCEPTS AND BASICS

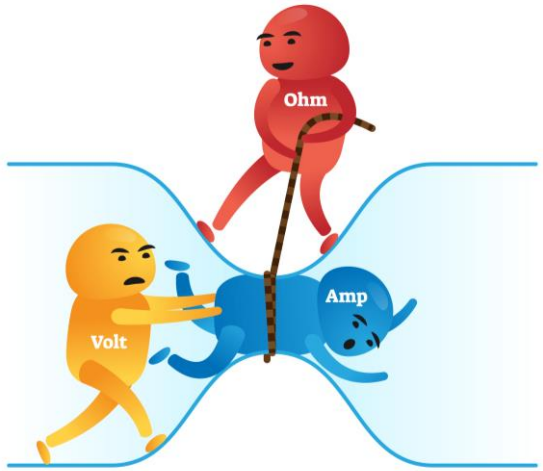
- Introduction
- Voltage and current
- Insulation
- Continuity

Introduction to Electrical Safety Measurements

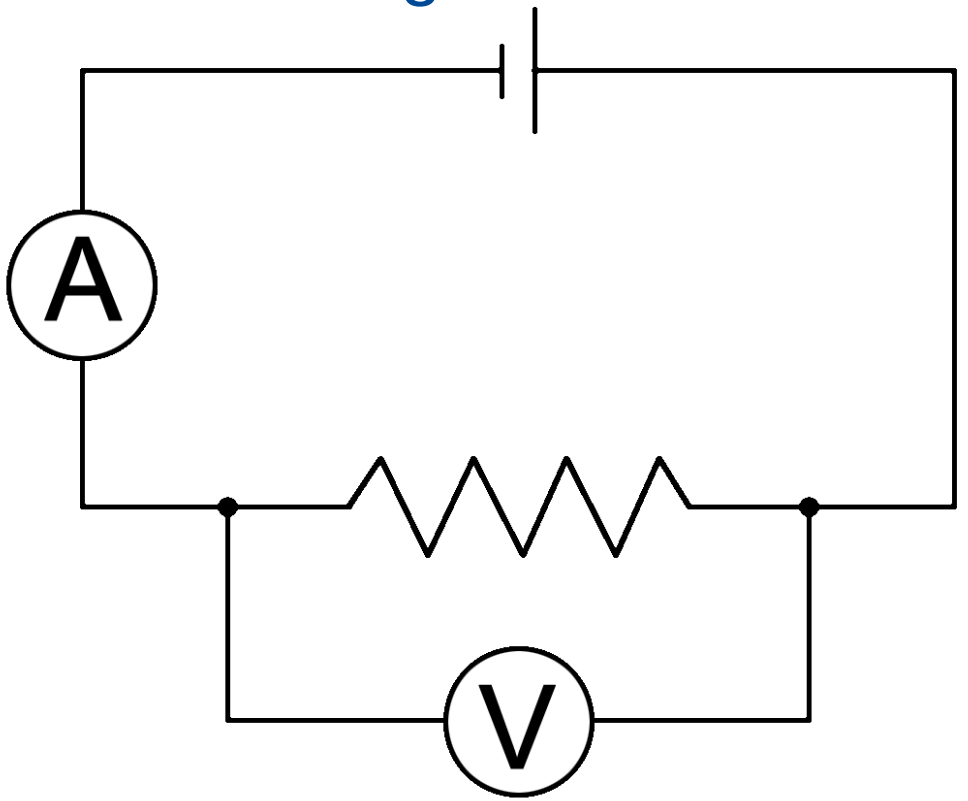
- Protection from damage from electricity:
  - Electric shock
  - Overheating and fire
  - Arc flash
- Means of protection:
  - Preventing contact
  - Preventing the presence of dangerous voltage
  - Automatic trip-out
- Electrical testing
  - Insulation
  - Equipotential bonding

Voltage and current measurements

- The Ohm‘s law



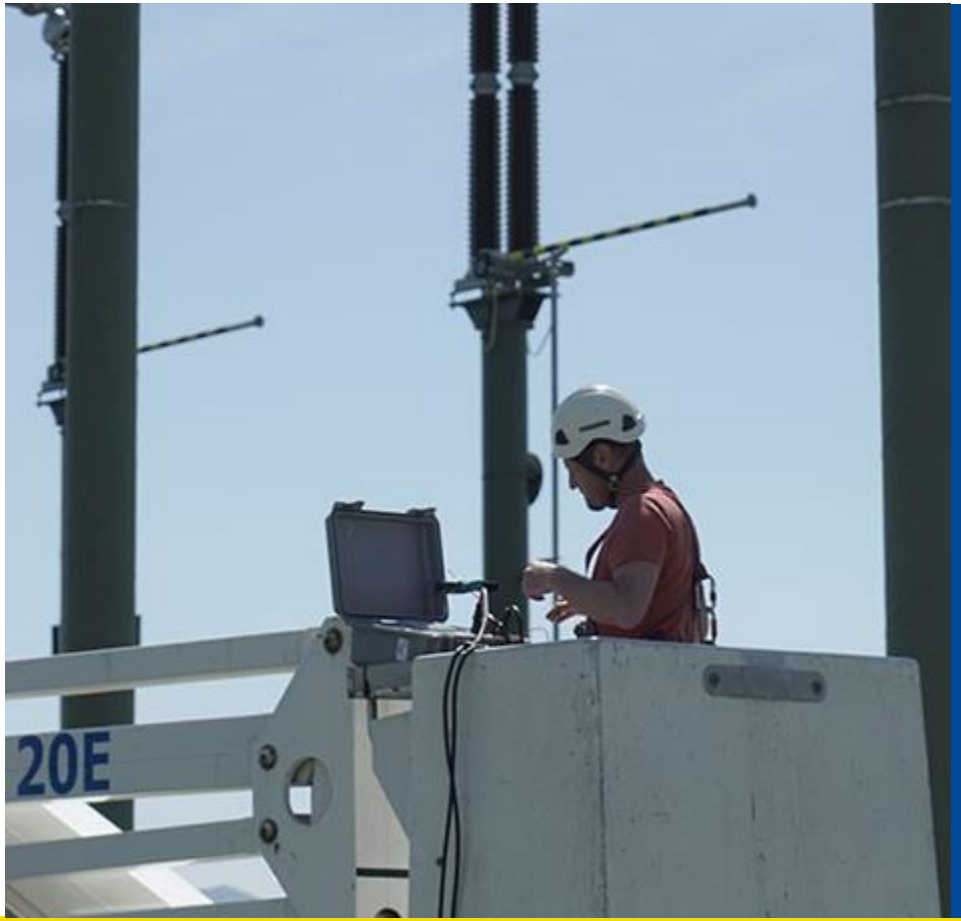
- Measuring circuit



INSULATION RESISTANCE MEASUREMENT

- ✓Measurement of high resistance.
- ✓On passive tested sample use high DC voltage.
- ✓On active tested sample use special methods.
- ✓Diagnostic factor PI, DAR and DD.

CONTINUITY MEASUREMENT

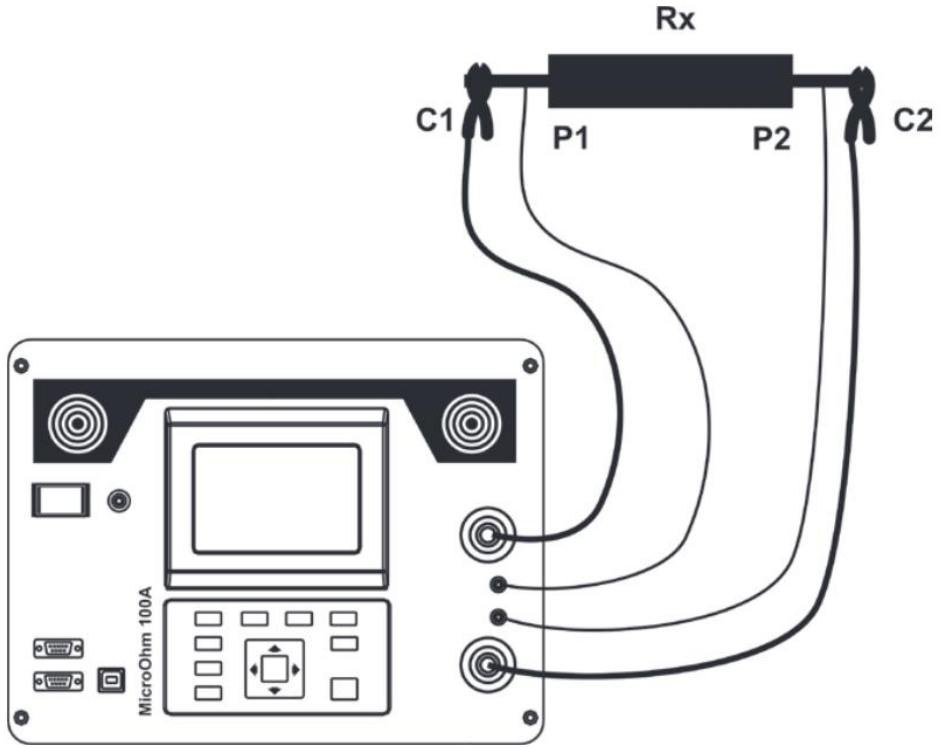


- ✓Low resistance measurement.
- ✓Use high test current to achieve high accuracy and repeatability.
- ✓Resistance of test leads must be compensated.
- ✓2-wire method vs. 4-wire method.

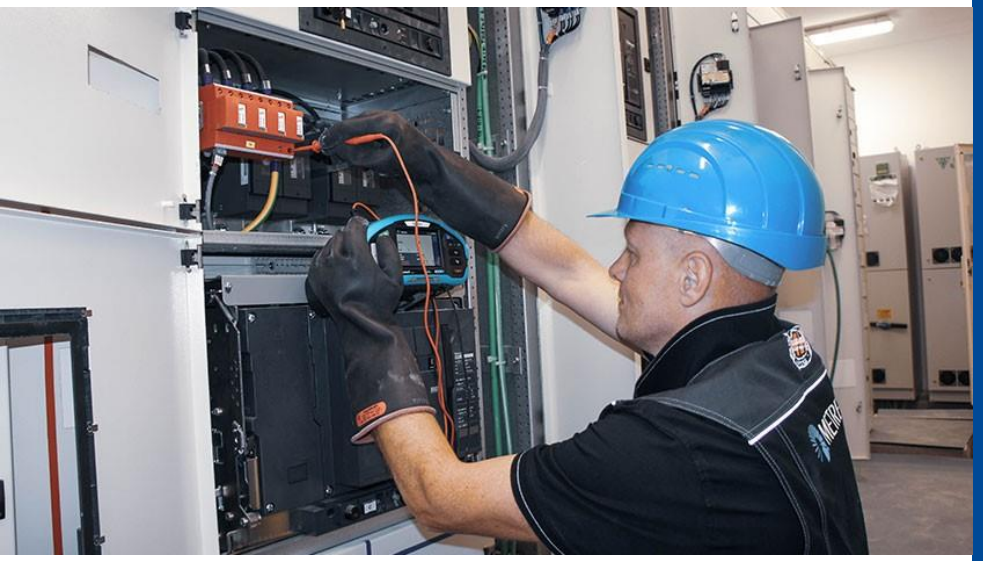
Voltage and current measurements

2-wire method

4-wire method



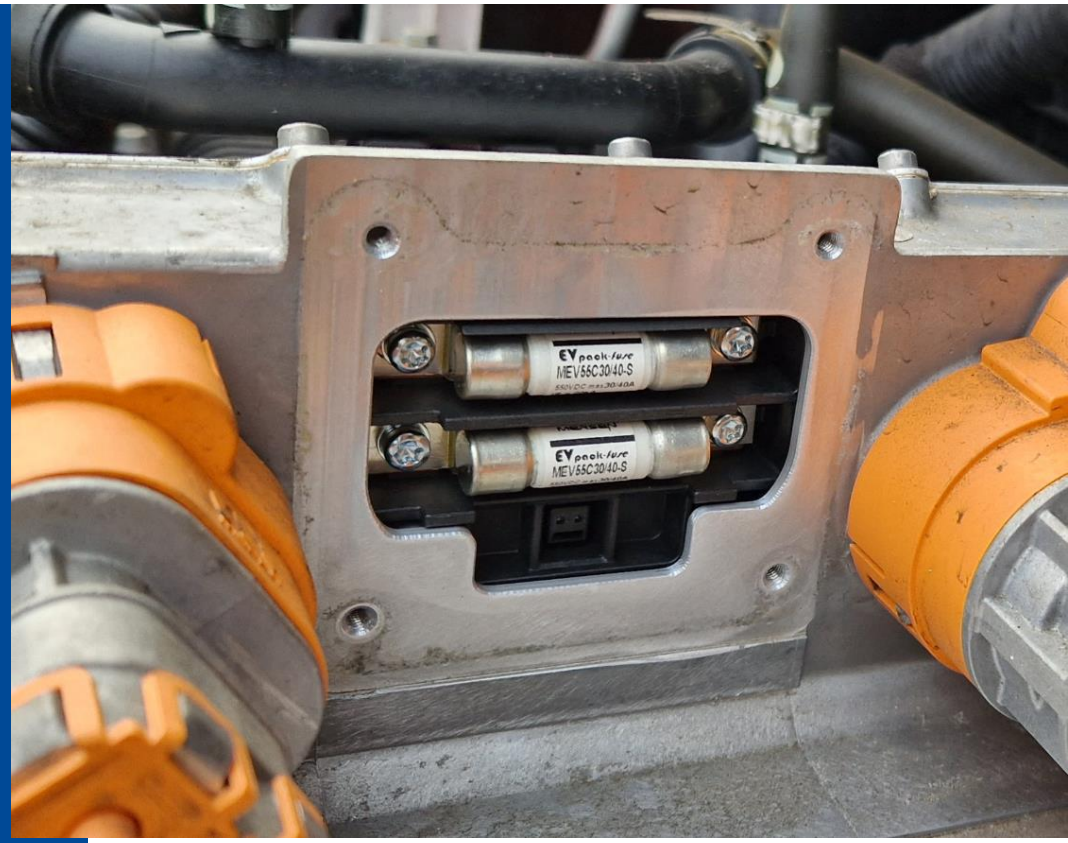
Automatic trip-out protection



- ✓Fuses
- ✓Residual current device
- ✓Surge protection devices
- ✓Coordination in the system
- ✓Selection

FUSES

- ✓Break contact by melting a thin wire in a glass housing.
- ✓Insulating material can be air, silicate or other.
- ✓Selection by break current and time delay.



User safety

During measurements

- Safe work procedures
- Safety gear
- Selecting the measuring instrument
- Measurement categories

Safety categories

- Protection against faults in the measured system.
- Levels depend on distance from the local supply and nominal voltage.
- CAT I – devices with special chargers, signal level
- CAT II – house sockets
- CAT III – installation and distribution boards
- CAT IV – directly at the local supply

Safety principles

- Work with electric supply disconnected, and prevent reconnection.
- Where this is not possible:
- Identify voltage levels, available energy, arc potential, …
- Select appropriate personal protective equipment (PPE).

Safety principles

5 golden rules for safe work on electrical installation:

- Disconnect the supply.
- Prevent supply reconnection.
- Lock-out and tag-out.
- Test no voltage state.
- Connect to ground and isolate.

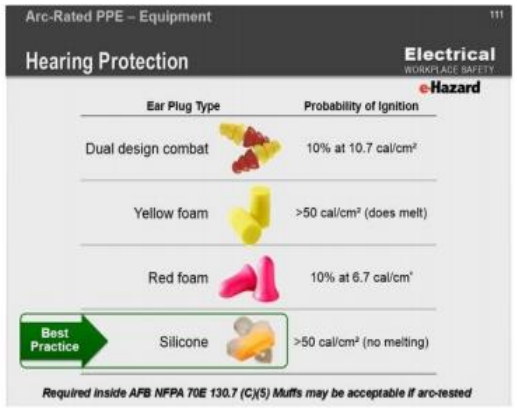
Arc Flash Features

- Arc flash is the light and heat caused by a discharge through the air.
- Dangerous for 2nd degree burns at >3 J/cm^2 or >1,2 cal/cm^2 for 1s.
- DC voltage above 400V is particularly risky.
- Select PPE by **Incident Energy** or **Boundaries calculation** method.

Arc Flash Safety Gear

Arc Rated Faceshield & Balaclava

Arc Flash Hood



PPE Category **0*or N/A** *Applies to NFPA 70E 2012 and later	Untreated natural fiber Shirt (long sleeve) Pants (long) Safety Glasses, Hearing Protection Leather & voltage-rated gloves (as needed)	
PPE Category **1** 1.2 – 4 cal/cm² Minimum	Arc-rated long sleeve shirt Arc-rated pants or coverall Arc-rated face shield with hard hat Safety glasses & hearing protection Leather & voltage-rated gloves (as needed) Leather footwear	
PPE Category **2** 4.1 – 8 cal/cm² Minimum	Arc-rated long sleeve shirt Arc-rated pants or coverall Arc-rated face shield & balaclava or arc flash suit with hard hat Safety glasses & hearing protection Leather & voltage-rated gloves (as needed) Leather footwear	
PPE Category **3** 8.1 – 25 cal/cm² Minimum	Arc-rated long sleeve shirt Arc-rated pants or coverall Arc-rated flash hood Safety glasses & hearing protection Leather & voltage-rated gloves (as needed) Leather footwear	
PPE Category **4** 25.1 – 40 cal/cm² Minimum	Arc-rated long sleeve shirt Arc-rated pants or coverall Arc-rated flash hood Safety glasses & hearing protection Leather & voltage-rated gloves (as needed) Leather footwear	

Arc Flash Personal Protection Work Procedure

- ✓One hand rule!
- ✓Stand out of the line of fire.
- ✓Turn head away.
- ✓Take a deep breath and hold it.
- ✓Do not reach across door.

EV intro

EV Types

Hybrid electric vehicle (HEV)

- Mild Hybrid

- **Full Hybrid**

- **Plug in Hybrid (PHEV)**

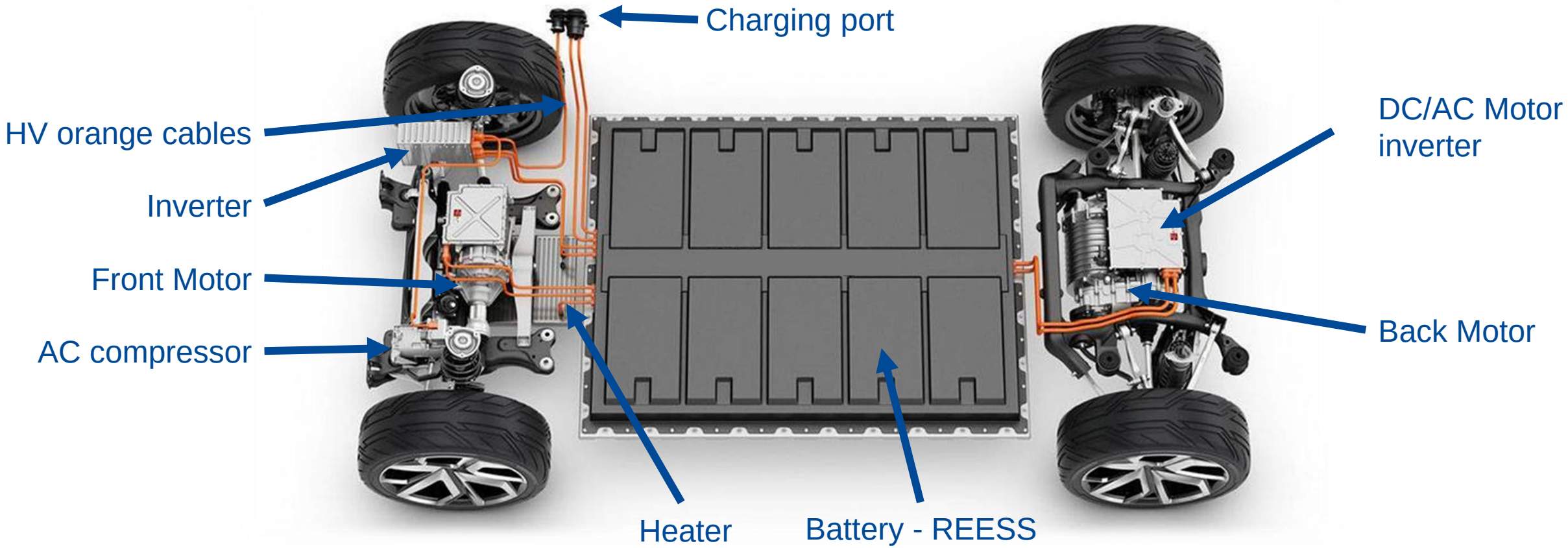
Battery electric vehicle (BEV)

Range extender (REx)

Fuel cell vehicle (FCV)

EV intro

EV HV Components

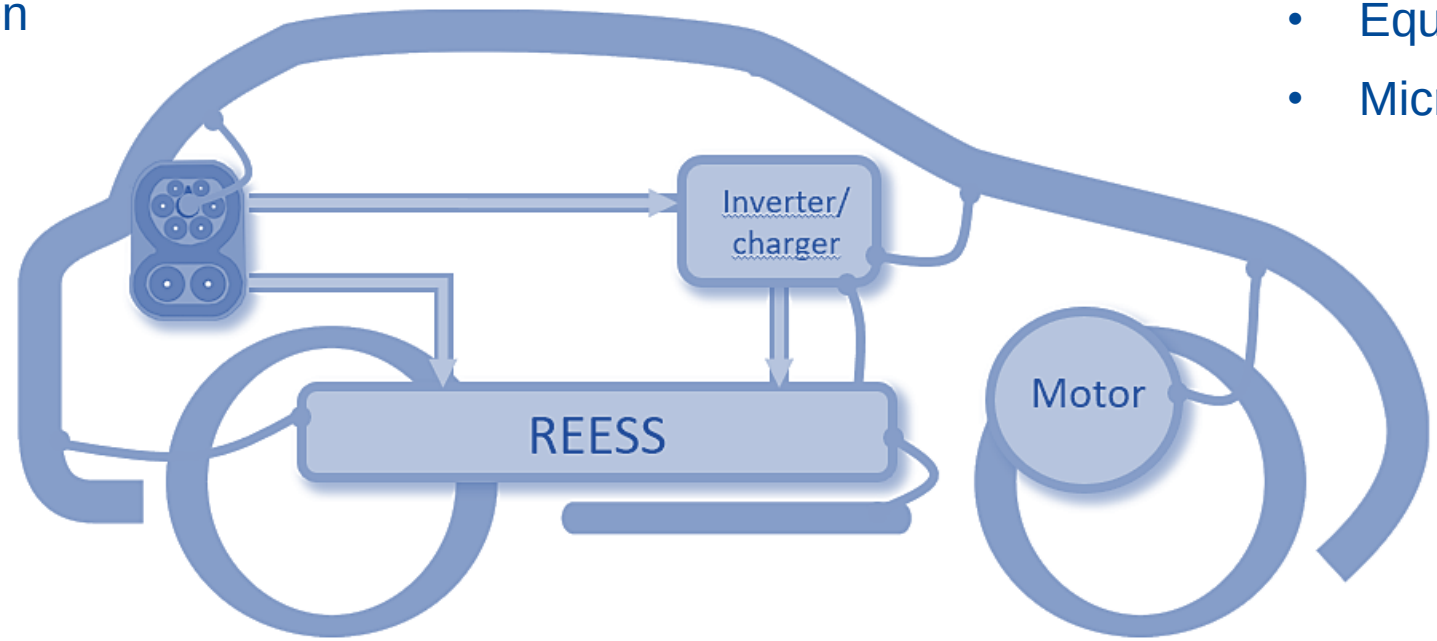


EV intro

Electrical safety of electric vehicles

Insulation

- Standard insulation
- R100 method



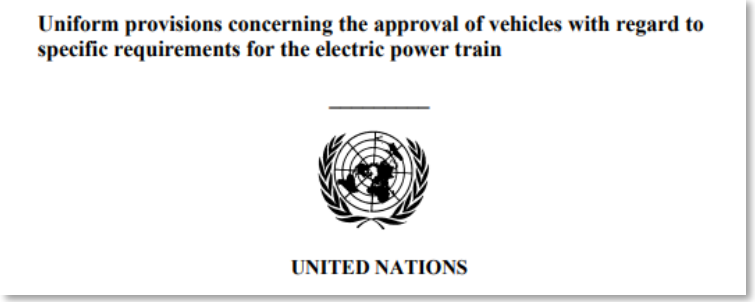
Bonding

- Equipotential bonding
- MicroOhm measurement

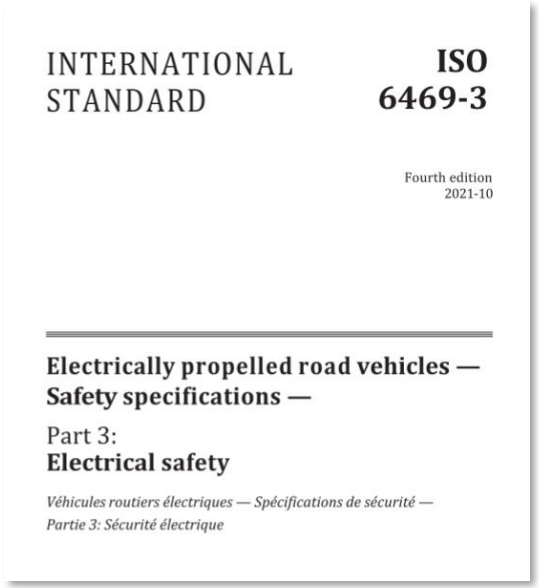
Standards for EV

Standards for EV Safety

- **UN ECE R 100** - Part II: Safety requirements with respect to the Rechargeable Electrical Energy Storage System (REESS), of road vehicles
- **ISO 6469-3:2018** - Electrically propelled road vehicles — Safety specifications — Part 3: Electrical safety
- **ISO 6469-4:2018** - Electrically propelled road vehicles — Safety specifications — Part 4: Post crash electrical safety
- **SAE J2344:2010** - Guidelines for Electric Vehicle Safety


Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train

UNITED NATIONS


INTERNATIONAL STANDARD

ISO 6469-3

Fourth edition
2021-10

Electrically propelled road vehicles — Safety specifications —

Part 3:
Electrical safety

Véhicules routiers électriques — Spécifications de sécurité — Partie 3: Sécurité électrique

Standards for EV

Standards for EV – Classes and Markings

Voltage classes	DC [V]	AC [V]
A	0 < U < 60	0 < U < 30
B	60 < U < 1500	30 < U < 1000

Marking on class B components

On protective bariers and enclosures

Figure 1 — ISO 7010-W012 - Warning; Electricity

On cables and harness - Orange colour

Standards for EV

Equipotential bonding

Resistance between two exposed conductive parts

$$R_{max} = 100\ m\Omega$$

- Test current should be at least 200 mA
- Resolution at least 0,01 Ω
- At least 5 s measurement
- Lower test time and current may be used if accuracy is sufficient

- 4-wire method for cancelling the contact resistance

Standards for EV

Insulation resistance

Methods for insulation testing:

- With internal DC source (standard Insulation)
- With vehicle DC source (R100 method)

Insulation resistance between a high voltage bus and the electical chassis should be minimum of:

100 Ω/V for DC buses

500 Ω/V for AC buses

On the charging coupler:

R_{min} = 1 MΩ

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THANK YOU