

# High voltage safety

2019/01

# HV Connector Requirements

However, connectors (including the vehicle inlet) are allowed to be separated without the use of tools, if they meet one or more of the following requirements:

- (a) **They comply with paragraphs 5.1.1.1.1. and 5.1.1.1.2.** when separated, or
- (b) They are provided with a locking mechanism (at least two distinct actions are needed to separate the connector from its mating component). Additionally, other components, not being part of the connector, shall be removable only with the use of tools in order to be able to separate the connector, or
- (c) The voltage of the live parts becomes equal or below 60V DC or equal or below 30V AC (rms) within 1 s after the connector is separated.
  1. For high voltage live parts inside the passenger compartment or luggage compartment, the protection degree IPXXD shall be provided.
  2. For high voltage live parts in areas other than the passenger compartment or luggage compartment, the protection degree IPXXB shall be provided.

## Suggestions:

- ◆ connected: IPXXD( outside the passenger compartment and luggage compartment);  
IPXXB( inside the passenger compartment and luggage compartment);
- ◆ & separated: **IPXXB** /(b)/(c)

## Reasons:

- IPXXD/IPXXB requirement when connectors are connected is necessary protection from direct contact on live part;
- When the connectors are separated, IPXXB can protect person from unconsciously touching the live part;
- There`s no connectors could reach IPXXD when they are separated;

# HV Connector Requirements

<OICA response>

- ◆ OICA does not believe the proposed amendment is necessary and appropriate.
- ◆ OICA believes that the existing requirements properly address the safety of connectors located inside the passenger/luggage compartments.

<Explanation>

5.1.1.1. Protection against direct contact.

High voltage live parts shall comply with paragraphs 5.1.1.1.1. and 5.1.1.1.2. for protection against direct contact. Electrical protection barriers, enclosures, solid insulators and connectors shall not be opened, disassembled or removed without the use of tools.

However, connectors (including the vehicle inlet) are allowed to be separated without the use of tools, if they meet one or more of the following requirements:

- (a) They comply with paragraphs 5.1.1.1.1. and 5.1.1.1.2. when separated; or
- (b) They are provided with a locking mechanism (at least two distinct actions are needed to separate the connector from its mating component). Additionally, other components, not being part of the connector, shall be removable only with the use of tools in order to be able to separate the connector; or
- (c) The voltage of the live parts becomes equal or below 60V DC or equal or below 30V AC (rms) within 1 s after the connector is separated.

GTR No.20 requirement:

- (1) Connectors for high voltage circuit shall meet IPXXB or IPXXD requirement, when connected.
- (2) In principle, the connector shall not be separated without use of tools.
- (3) Exceptionally, a connector may be separated without use of tools, if at least one of the conditions (a) to (c) is met.

<China>

- From the response of MR Kinoshita san, he introduced a kind of connector which could meet IPXXD after separated;
- So China thinks there`s no need to modify the existing requirements of HV connector in GTR.

# Low Energy Necessity in Use

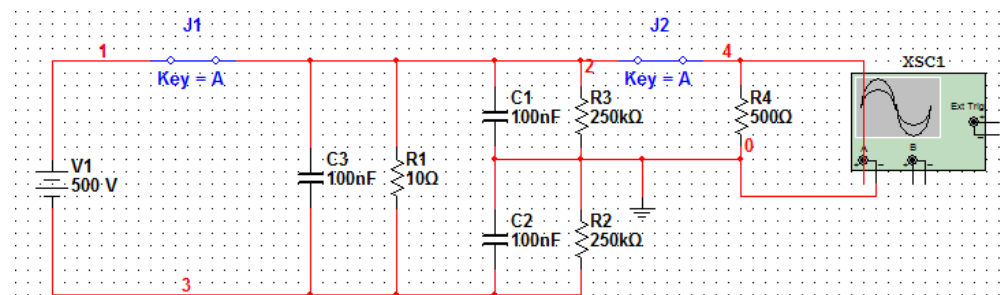
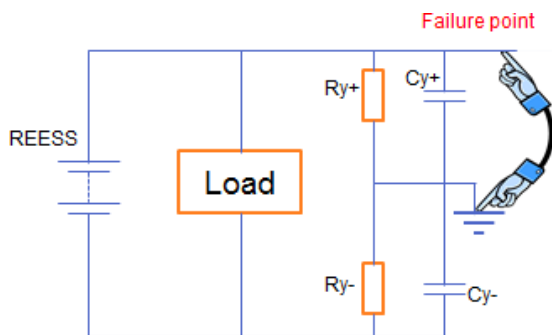
Now low energy requirement is optional choice of post crash in 5.2.2.2.

## Suggestion:

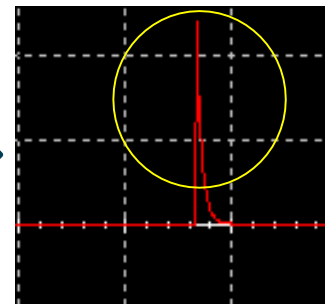
- ◆ Low energy should be necessary requirement in-use for indirect contact protection as isolation resistance requirement.

## Reasons:

- IPXXD/IPXXB requirement when connectors are connected is necessary protection from direct contact on live part;



The simulation of touching the failure point



- If the energy is higher than 0.2J above 60VDC /30VAC, it's a danger to the person when there's an one point failure.

# Low Energy Necessity in Use

<OICA response>

- ◆ OICA **understands that there is a theoretical risk of electric shock in case of single failure of electrical insulation**, e.g. damage of solid insulation of high voltage harness, the stored energy of Y-capacitor is high enough and a person touch live part and electrical chassis.
- ◆ However, OICA members **have not experienced such a problem** in the market for more than 20 years since the start of volume production of electrically propelled vehicles.
- ◆ If there are any actual cases in the field, those should be shared among the experts for overall consideration.
- ◆ Robustness of the insulation is the key element of this requirement, but it is difficult to determine the objective assessment method. Paragraph 5.1.1.2.4.2. of GTR 20 includes provisions regarding the robustness of the insulation, but no objective assessment procedure has been developed.

<China>

- On the basis of analysis in the next page, Low energy is as important as isolation resistance, so it should be considered in the GTR as isolation resistance requirement.
- Not all the safety requirements are included into the regulations only after there is an accident happened.

# Low Energy Necessity in Use

warning

Physical protection

Electric shock :  
 a) Enough current;  
    **2mA a.c. or 10mA d.c.**  
 a) Enough energy; **0.2J**

No Failure

Failure happens

Physical protection  
Strong enough

Physical protection  
Not strong enough

potential  
equalization

No potential  
equalization

Low energy and  
isolation resistance  
satisfied

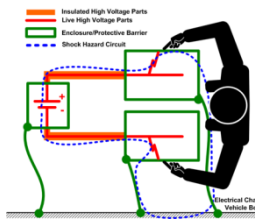
Low energy or  
isolation resistance  
not satisfied

Low energy and  
isolation resistance  
satisfied

Low energy or  
isolation resistance  
not satisfied

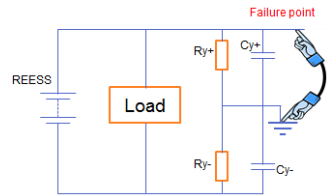


Failure Mode1



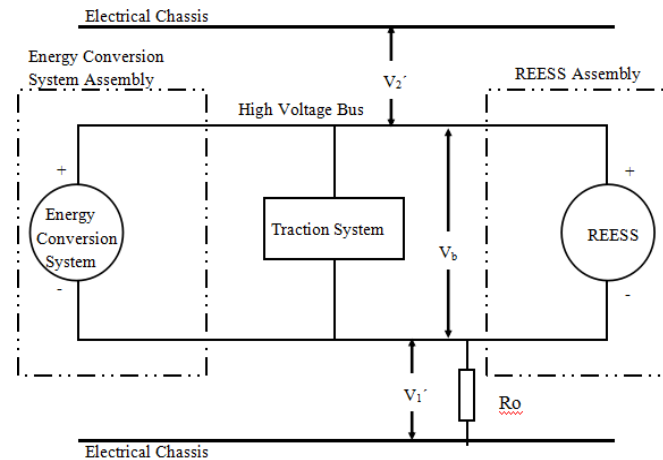
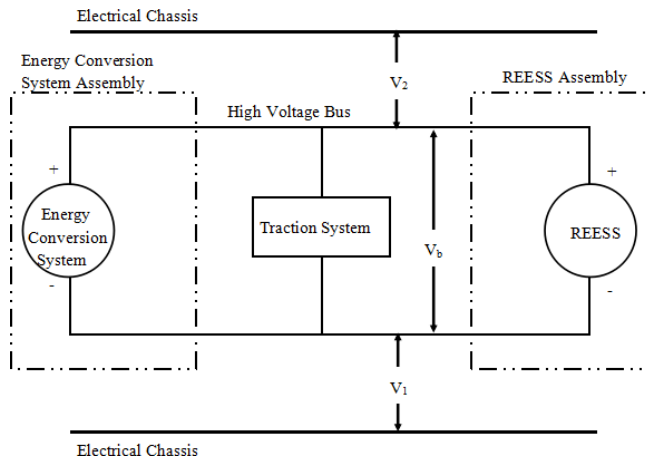
Internal short circuit in component

Failure Mode2



short circuit the exposed failure point

# Isolation resistance measurement



1st: Run the circuit ,  $V_b$  is higher than nominal voltage;

2nd: measure  $V_1$ ;

3rd: measure  $V_2$ ;

measure  $V_1$  and  $V_2$  using two same voltmeter

4th: if  $V_1$  is higher than  $V_2$ , add  $R_0$  as picture shows; (suggest  $V_0=1M\Omega$ )

5th: measure  $V_1'$

6th: measure  $V_2'$

measure  $V_1'$  and  $V_2'$  using two same voltmeter

➤ Voltage measured is more stable;

➤ This method minimized the effect of the internal resistance of the voltmeter on the result;

# Isolation resistance measurement

## <OICA response>

- ◆ What is the problem of existing procedure and why this method is needed?
- ◆ OICA believes that the proposed procedure should be treated as alternative to existing procedure.
- ◆ Technical refinements are necessary since the proposed procedure may not provide valid results in certain conditions, e.g. internal resistance of voltmeters. In addition, we should take account that the possibility of measurement errors will increase with the additional number of measurements.

## <China>

- China also agree that the existing procedure in GTR now is right.
- China also suggest the new method as an alternative method to existing procedure.



# Assessment procedure for isolation resistance monitoring system

## <OICA response>

- ◆ OICA agrees that the concept of Chinese proposal is technically correct.
- ◆ Since the proposed text is referring to the new procedure of isolation resistance measurement proposed by China which is not agreed yet, editorial improvement is necessary.
- ◆ The same issue is currently under consideration for the amendment of UN R100 and, therefore, the result can be fed back to GTR No.20.

## <China>

- China insist on the technical perspective, and welcome all the members from English-speaking nations to help for improving the edit.