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Working Party on Passive Safety

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Item 16 of the provisional agenda
Regulation No. 100 (Battery of electric vehicles)

Draft Supplement 3 to the 01 series of amendments

Submitted by the expert from the International Organization of Motor Vehicle Manufacturers*

The text reproduced below was prepared by the expert from the International Organization of Motor Vehicle Manufacturers (OICA) proposing to remove unnecessary constraints to electric vehicle systems having a working voltage of 48 V and to adapt the safety provisions to this technology. The modifications to the text of the UN Regulation are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208, para. 106 and ECE/TRANS/2010/8, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

List of Annexes,

Annex 6, amend to read:

"Annex 6

…

Part 2: …

Part 3: Essential characteristics of road vehicles or systems with chassis connected to electrical circuits...................................."

Paragraph 2.20., amend to read:

"2.20. "*High voltage bus*" means the electrical circuit, including the coupling system for charging the REESS that operates on high voltage.

Where electrical circuits, that are galvanically connected to each other, are galvanically connected to the electrical chassis and the maximum voltage between any live part and the electrical chassis or any exposed conductive part is ≤ 30 V AC and ≤ 60 V DC, only the components or parts of the electric circuit that operate on high voltage are classified as a high voltage bus."

Insert new paragraph 2.39., to read:

"**2.39. "*Chassis connected electric circuit*" means AC and DC electric circuits galvanically connected to the electrical chassis.**"

Paragraph 5.1.3., amend to read:

"5.1.3. Isolation resistance

This paragraph shall not apply to chassis connected electrical circuits where the maximum voltage between any live part and the electrical chassis or any exposed conductive part does not exceed 30V AC (rms) or 60 V DC."

Annex 6, insert new Part 3, to read:

"Annex 6 - Part 3

Essential characteristics of road vehicles or systems with chassis connected to electrical circuits

1. General

1.1. Make (trade name of manufacturer): ....

1.2. Type: ....

1.3. Vehicle category: ....

1.4. Commercial name(s) if available: ....

1.5. Manufacturer's name and address: ....

1.6. If applicable, name and address of manufacturer's representative: ....

...

1.7. Drawing and/or photograph of the vehicle:..

1.8. Approval number of the REESS: ....

2. REESS

2.1. Trade name and mark of the REESS:..

2.2. The cell chemistry:...

2.3. Electrical specification:

2.3.1. Nominal voltage (V):..

2.3.2. Capacity (Ah):...

2.3.3. Maximum current (A): ....

2.4. Gas combination rate (in per cent):...

2.5. Description or drawing(s) or picture(s) of the installation of the RESSS in the vehicle: ....

3. Additional data

3.1. Working voltage (V) AC circuit: ....

3.2. Working voltage (V) DC circuit: ...."

II. Justification

A. Current situation.

1. Today automotive industry is making a real effort to reduce environmental impact, especially on limiting CO_2 emissions. New solutions are developped and produced to ensure reduction of emissions, and the electrification of the powertrains presents a high potential to this challenge. Electric, hybrid and fuel cell vehicles now create the possibility of having low levels of emission when using a vehicle.

2. There are nevertheless some restrictions to these technologies. They are very costly, which is a hurdle for market introduction. To ensure wide acceptance by the customers of future zero emission vehicles, mass production solutions to cut down the CO_2 emissions need to be developed.

B. Motivation and objectives for systems having a working voltage of 48 V

3. Car manufacturers are now aiming at additional solutions to reduce CO_2 emissions. The objective is to find a technology that offers a high potential to reduce the overall fleet consumption. Therefore, such technology should be compatible with every conventional vehicle model and through this, provide an opportunity for mass scale production.

4. The general idea is to replace the electric alternator of thermal vehicles with a powerful alternator/motor in conjunction with a 48 V battery. The basic functions for the CO_2 reduction are the following:

(a) energy is stored during braking instead of being dissipated

(b) energy is provided to the vehicle network (12 V system)

(c) energy is provided to support the thermal engine for vehicle traction

C. Stop and Start operation

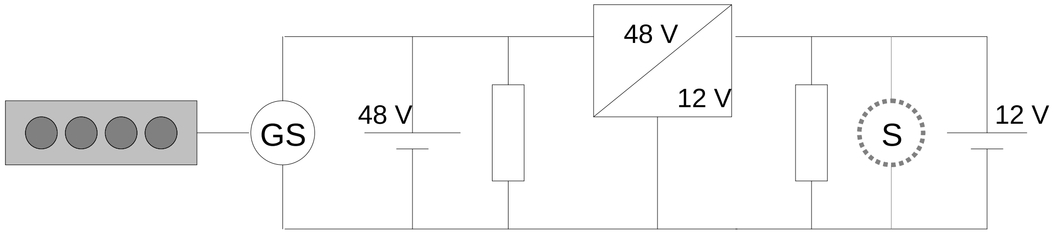
5. A system having a working voltage of 48 V allows more efficiently controlled energy flow and the potential reduction of CO_2 emissions is high. It is fully applicable to all vehicle models and hence ensures the fulfillment of the previously described objective.

6. Today, there are several major car manufacturers and automotive suppliers developing such technologies for such applications.

D. System description

7. A small 48 V battery ensures energy storage. A DC/DC converter then provides the supply of the 12 V network and the charge of the 12 V battery. The system is described in the figure below:

Figure 1



Components 48 V:	Components 12 V
Alternater/starter (GS)	starter motor (for cold cranking) – optional
Loads and auxiliaries	12 V loads and auxiliaries
48 V battery	12 V battery
DC/DC converter	

E. 48V working voltage rationale

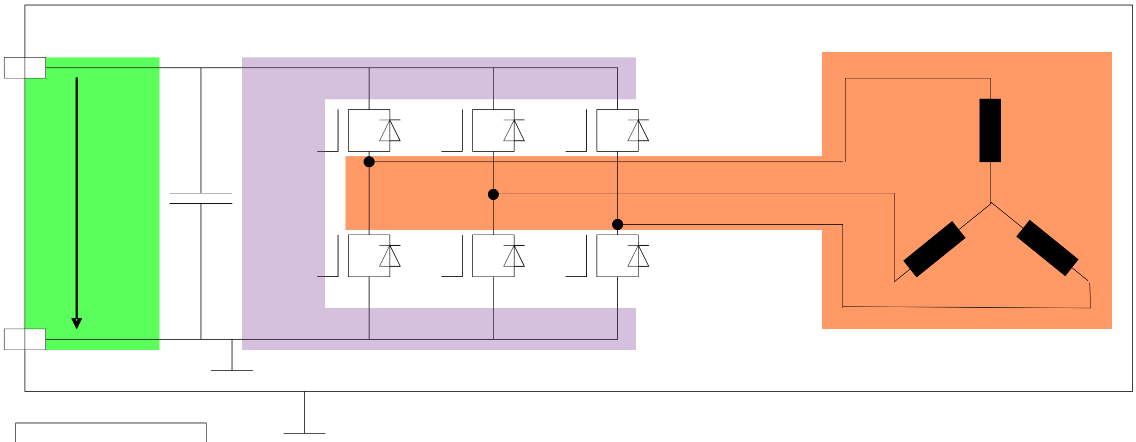
8. In order to provide the necessary power, the 48 V working voltage has been identified as the best compromise in terms of CO_2 reduction, voltage level and electric current. In fact, a lower voltage would lead to an increase of the current at the same power. This would lead to higher cross-sections of wiring and costly modifications of cells and other electronic components. On the other hand, an voltage higher than 48 V would lead to more complex systems and would be as costly as hybrids and electric vehicles (EVs and HEVs).

F. Electrical architecture and voltages

9. Two different architectures are available for such a system: one with a single housing with the motor and the inverter inside and the other one with two different housings, one for each component. In both cases, the repartition of the voltages is the same, as described in the Figures 3 below:

Figure 2

Single housing:



Housing / chassis

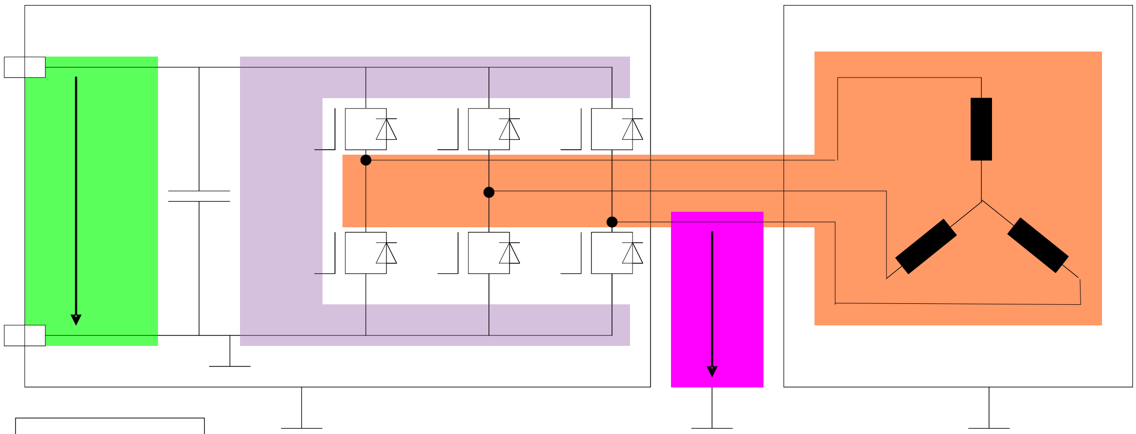
A.C.: a.c. voltages (switched / sinusoidal), a.c. current (sinusoidal)
→ in **some** operation modes U > 30 V a.c between phases,
but switched d.c. voltage U <60 V d.c between phase and chassis

D.C. voltage, switched current (ripple)

D.C.: d.c. voltage, d.c. current → U < 60 Vd.c.

Figure 3

Two housings:



Housing / chassis

A.C. a.c. voltages (switched / sinusoidal), a.c. current (sinusoidal)
→ in **some** operation modes U > 30 V a.c between phases,
but switched d.c. voltage U <60 V d.c between phase and chassis

D.C. voltage, switched current (ripple)

D.C. voltage switched

D.C. d.c. voltage, d.c. current → U < 60 V d.c

10. According to the current high voltage definition of UN Regulation No. 100, there is AC high voltage in the system but no DC high voltage. The AC high voltage is located

between the phases of the electric motor. However, the rest of the system, as well as between the phase and chassis of the electric motor is considered as DC low voltage. Today, the working voltage of the circuit is defined as the highest voltage between any two conductive parts. Accordingly, the working voltage of a 48 V system is high voltage, so the whole 48 V system would be classified as high voltage.

11. However, the system described here presents major differences with a high voltage system (as used in EVs and HEVs): to simplify the system, the battery voltage is low, as are the voltages of all other components, and there is a galvanic conection to the chassis, which means no isolation resistance.

G. Electrical safety analysis of 48V

12. In any case, electrical safety needs to be guaranteed. Electrical safety of the 48 V system would be ensured by:

(a) physical protection provided by IP degree (enclosures, barriers…)

(b) insulation of wiring

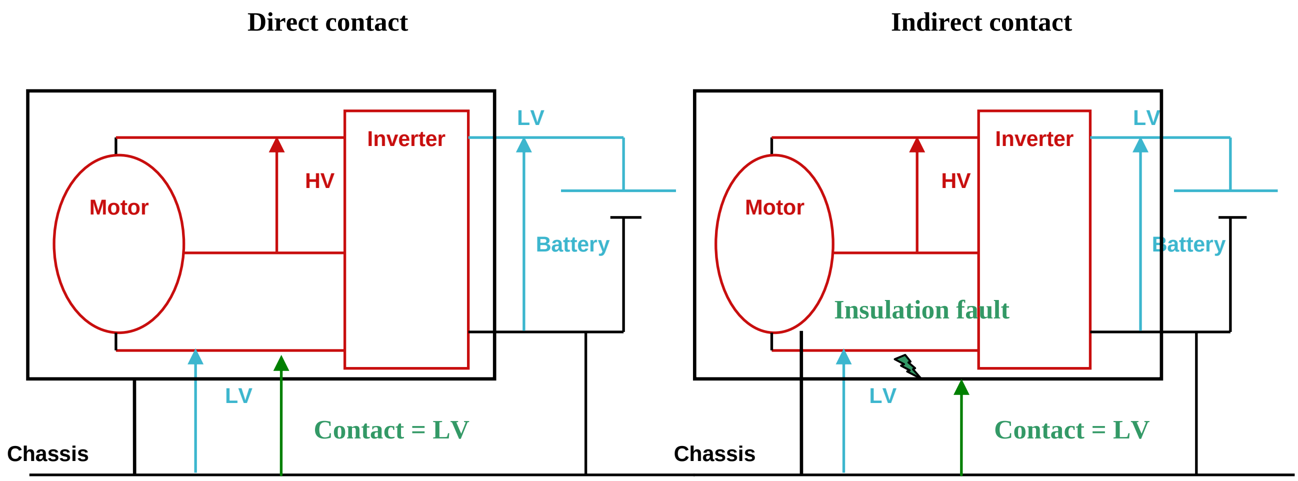
(c) equipotential bonding

13. Regarding the safety, there is no risk of being exposed to high voltage in a single failure condition, see section 5, paragraph below Figure 3 ("According to the current …2). The only way to get an electric shock is to touch two different phases of the motor with two hands, when the motor is running. Protection against direct contact is also provided by mechanically robust enclosures or insulation and two indirect contacts are avoided due to equipotential bonding. Therefore, there is no safety risk in this situation.

14. The current requirement of UN Regulation No. 100 on isolation resistance leads to an unnecessary constraint on the 48 V system.

15. In single fault conditions, there is no risk of electric shock by touching one AC phase and the chassis. Neither in direct nor indirect contact will the touch voltage be high voltage. In all cases, customers are protected, as there is only low voltage, independant of isolation resistance. Therefore, the fact that there is no isolation resistance on the system is not a safety issue for a 48 V system.

Figure 4



H. Conclusion and proposal

16. Hence, the proposal is to consider the particular circumstances of 48 V systems in UN Regulation No. 100 by ensuring the safety of the system without being forced to fullfill the insulation resistance requirement. Such a system, as described above, shall fullfill the high voltage requirements only for the part that operates on high voltage if it responds to the above specified voltage and chassis connection characteristics.

17. The proposed modification will effectively limit the voltage between the phases as well as the phases and chassis of 48 V systems. When the voltages are limited as proposed, such a design cannot be used for designing high voltage systems which are currently in the scope of UN Regulation No. 100 without protection. The proposed modification will not reduce the level of safety of high voltage EVs or HEVs because such systems will not fall under the modification, as voltage between phase and chassis would be at high voltage level. It will simply remove unnecessary constraints on 48 V systems and enable the development of this high potential technology.

18. Since the design of 48 V is less complex than high voltage hybrid- or electric vehicle systems, a new Part 3 of Annex 6 is proposed to be added to the UN Regulation to take into account the essential characteristics of the 48 V systems. For example: (i) a 48 V system cannot be equipped with a fuel cell system, (ii) for a 48 V system a 30 minutes maximum net power is not meaningful and (iii) the design of a 48 V battery is (even if it fulfils the requirements of the Part 2 of this UN Regulation) not comparable to the design of a huge and heavy pure electric vehicle battery with an electric range of 150 km or more.