

R100-3 ISSUE RISK FOR AC 48V MOTOR GENERATORS



Management Summary

Submitted by the expert from CLEPA the European Association of Automotive Suppliers

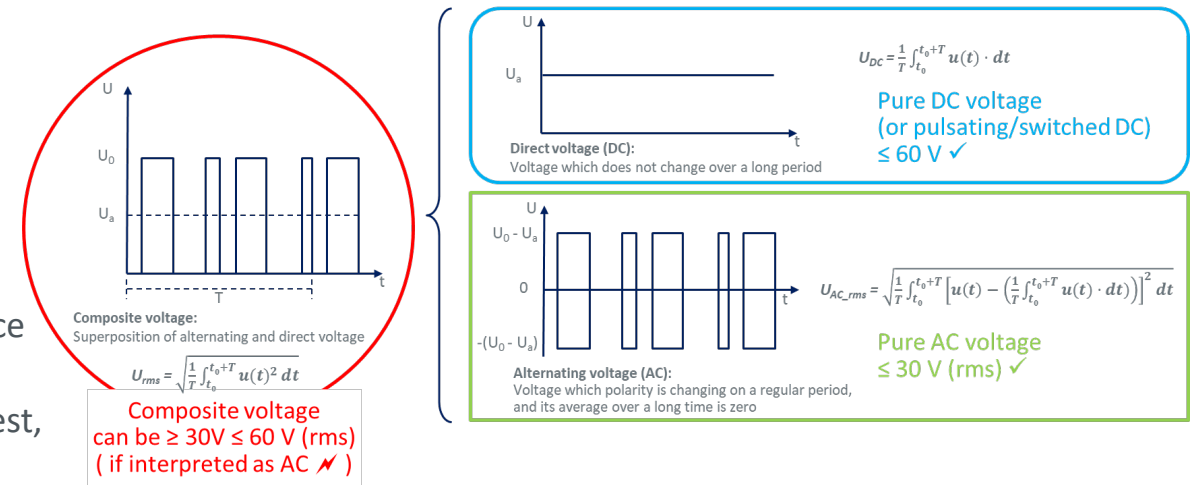
Informal document GRSP-69-03 (69th GRSP, 17-21 May 2021 agenda item 23(g))

• Topic

- The 03 series of amendments to UN Regulation no. R100 “Electric Vehicles Safety” was recently established and is applicable from 2023 for new approvals and from 2025 for all vehicles. It is mandatory for vehicle approval in the European Union.
- For 48V systems a new “specific voltage condition” is included in this amendment: In case certain voltage thresholds are exceeded an isolation resistance test (not new) after exposure to water (new) has to be passed successfully.
- Compared to the 02 series of R100 the new “specific voltage condition” is more severe “... $\leq 30 \text{ V AC (rms)}$ ~~or~~ **and** $\leq 60 \text{ V DC}$.” moreover the “water test” is newly introduced.

• Issue

- Already with R100-02 there is a risk for mis-interpreted in a way that 48V air cooled Motor Generators can't meet it. (But the isolation resistance test (w/o water) can be passed)
- The new “specific voltage condition” increases the risk of mis-interpretation. In this case the new “water isolation resistance test applies”.
- Air cooled 48V Motor Generators are expected not to pass this test, which will be mandatory in Europe



• Approach

- Amend paragraph 2.42 by additional a footnote regarding the (correct) interpretation of composite voltages: **“Note 2: For pulsating DC voltages (alternating voltages without change of polarity) the DC threshold shall be applied.”**
- Amend also GTR20 paragraph 3.42 accordingly

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Summary

References

Insert a new paragraph 2.42., to read:

"2.42. "Specific voltage condition" means the condition that the maximum voltage of a galvanically connected electrical circuit between a DC live part and any other live part (DC or AC) is ≤ 30 V AC (rms) and ≤ 60 V DC.

Note: When a DC live part of such an electrical circuit is connected to chassis and the specific voltage condition applies, the maximum voltage between any live part and the electrical chassis is ≤ 30 V AC (rms) and ≤ 60 V DC."

Insert new Paragraphs 5.1.4. to 5.1.4.4., to read:

5.1.4. Protection against water effects.

The vehicles shall maintain isolation resistance after exposure to water (e.g. washing, driving through standing water). This paragraph shall not apply to electrical circuits that are galvanically connected to each other, where the DC part of these circuits is connected to the electrical chassis and the specific voltage condition is fulfilled.

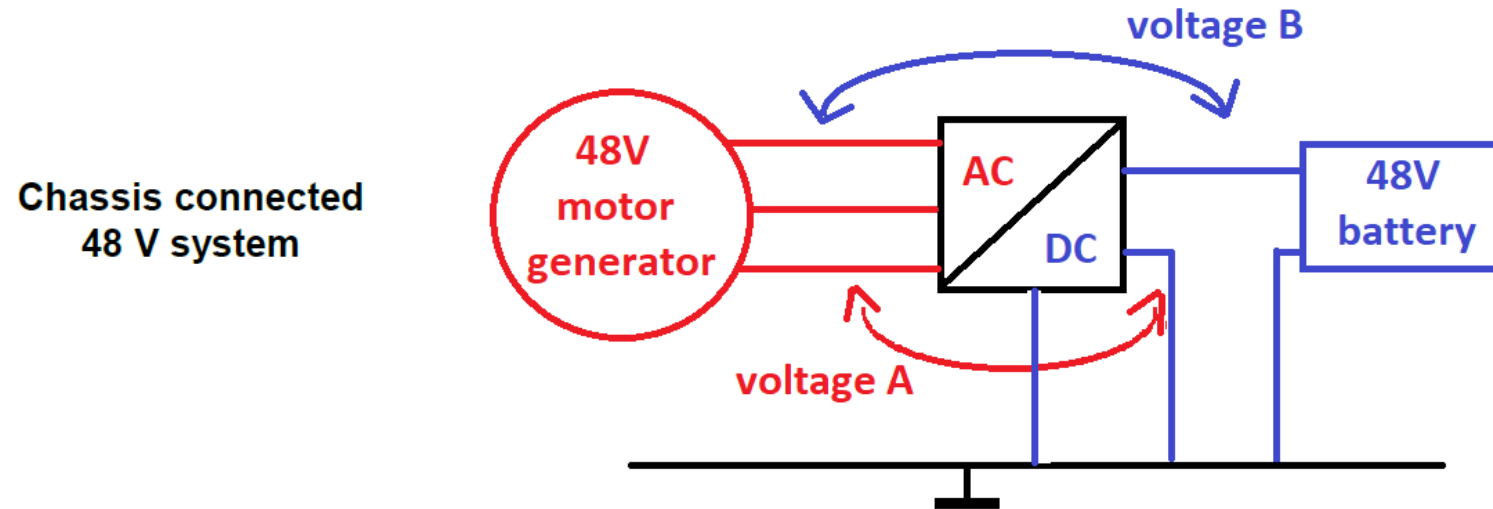
- Current version of the introduction of the “specific voltage condition” in ECE-TRANS-WP.29-GRSP-2020-06e, chapter 2.42 can be a risk for especially 48V air cooled components like e.g. 48V motor generators which are sold from various suppliers and are in series since years with different OEMs.
- Although this was not intended (according to discussions with experts from e.g. OICA), the currently proposed text of paragraph 2.42 48V air cooled components can be interpreted in a way that it do not fulfil the “specific voltage condition” even if it is connected to chassis ground. The reason is, that it is not clear if the voltages between “a DC life part and an AC life part” have to be interpreted as a composite voltage or ‘pure’ AC voltage. Especially the use case, which is possible according to the current text of paragraph 2.42 has not been considered and evaluated sufficiently: “AC condition between a DC life part and an AC life part” (e.g. the B+ bolt of a 48V motor generator to a phase of the same device). If the voltage is a composite/mixed signal, it is > 30 V AC (rms) and the “specific voltage condition” is not fulfilled.
- If the “specific voltage condition” is not fulfilled the new “water isolation resistance test” applies. Air cooled 48V Motor Generators are expected not to pass this test.
- Already with the old (R100-2), less stronger specification there have been a remaining (actually occurred) risk, that the specification can be mis-interpreted in a way, that 48V air cooled Motor Generators can’t meet it. But the isolation resistance test (w/o water) can be passed.
- CLEPA proposes to add a 2nd footnote to paragraph 2.42 regarding the (correct) interpretation of composite voltages, to avoid any mis-interpretation.

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Concern / CLEPA Evaluation

- The following figure is based on document “EVS-08-06e_48V_Integration_in_GTR_20_EVS.pdf” from 48 V System – Integration in GTR EVS, Input for OICA / GTR EVS-Meeting, OICA proposal version 2-2, May 25th 2015; see also “EVS-06-24e_OICA-proposal_Amendment_to_GTR_EVS.pdf” from 6th EVS-gtr meeting Seoul, Nov. 2014).



* Voltage B between a DC live part (e.g. B+ bolt of an 48V Motor Generator (MG)) and an AC live part (e.g. phase of an 48V MG) has been not considered so far in the referenced document (see above). Voltages A and B can be evaluated as composite/mixed voltage and would in that case be $> 30V$ AC (rms), which would be in conflict with the “specific voltage condition” in ECE-TRANS-WP.29-GRSP-2020-06e, paragraph 2.4.

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Detailed Explanation of Voltages A / B

Explanation of Voltages A / B using a 3 phase example looking at one representative point P1. This valid also for other phase numbers.

T3 open, T4 closed
 → P1 is connected directly to ground
 → Voltage A = Ground
 → Voltage B = B+

T3 closed, T4 open
 → P1 is connected directly to B+
 → Voltage A = B+
 → Voltage B = Ground

T3 open, T4 open
 → Parallel circuit
 → $\text{Ground} \leq U_{P3-P2} \leq B+$
 → $\text{Voltage A/B}_{\text{max}} = U_{P3-P2}$
 if symmetric $\text{Voltage A/B}_{\text{max}} = 0.5 * U_{P3-P2}$

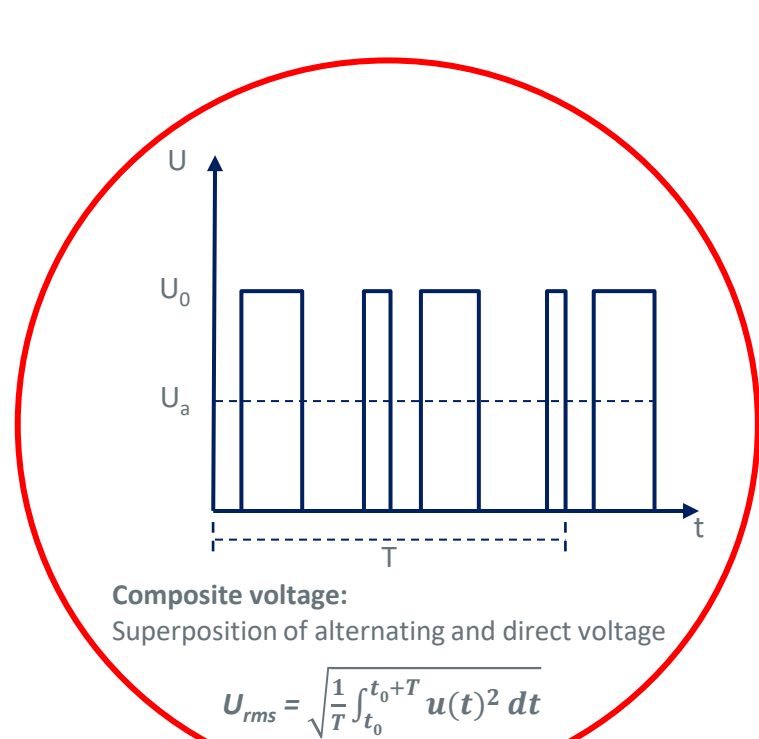
Voltages A and B are pulsating / switched DC voltages with $U_0 \leq B+ \leq 60V$

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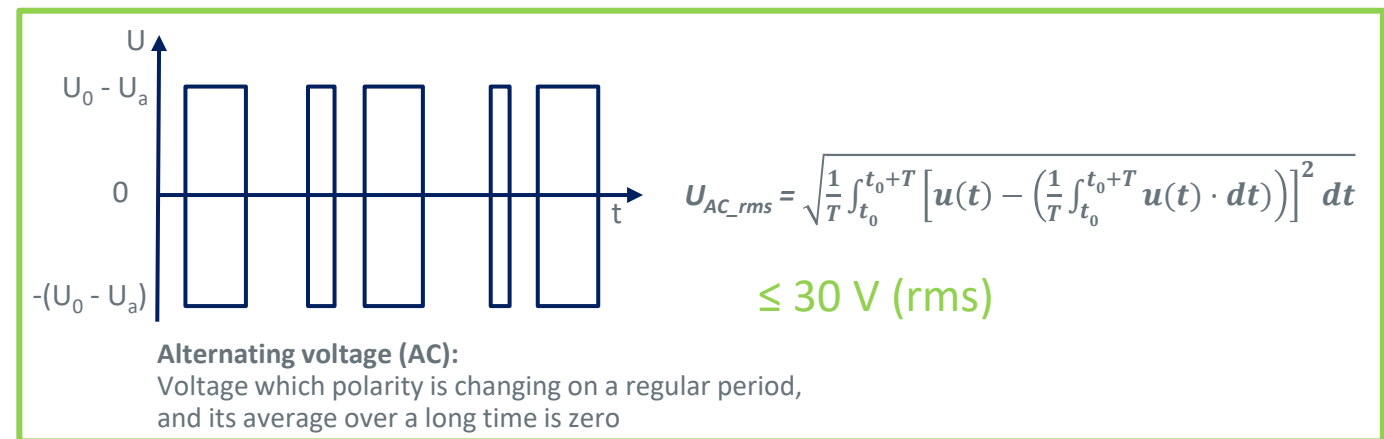
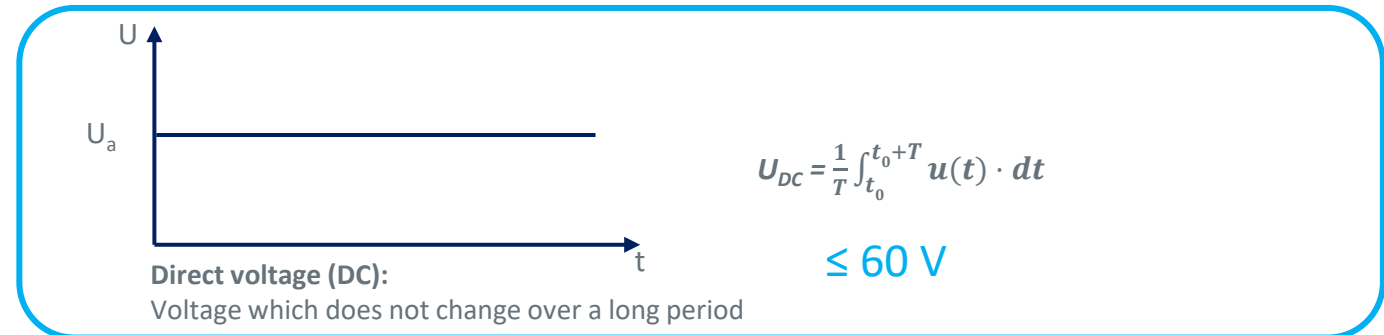


Composite, AC & DC Voltages in 48V Systems

- **Key issue: Interpretation of the “red signal”:**
 - Composite AC would be a problem
 - Pure AC with DC offset evaluated separately (blue/green) OR pulsating (switched) DC with DC threshold



can be $\geq 30V \leq 60 V$ (rms)



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CLEPA proposal

- Approach:
AC is interpreted as a pure AC “alternating around ground w/o DC offset” according to scientific understanding of AC. There have to be added a 2nd note in paragraph 2.42 to make this crystal clear. To be noted the feedback from Japan, to delete the first sentence originally proposed by CLEPA : AC „Voltage AC (rms)“ is an AC without DC offset, which means its average over a very long time is zero (no composite signal).
- Amend paragraph 2.42 to add a new footnote 2, as follows:
"Specific voltage condition" means the condition that the maximum voltage of a galvanically connected electrical circuit between a DC live part and any other live part (DC or AC) is ≤ 30 V AC (rms) and ≤ 60 V DC.
Note 1: When a DC live part of such an electrical circuit is connected to chassis and the specific voltage condition applies, the maximum voltage between any live part and the electrical chassis is ≤ 30 V AC (rms) and ≤ 60 V DC."
Note 2: For pulsating DC voltages (alternating voltages without change of polarity) the DC threshold shall be applied.
- Amend also GTR20 paragraph 3.42 accordingly