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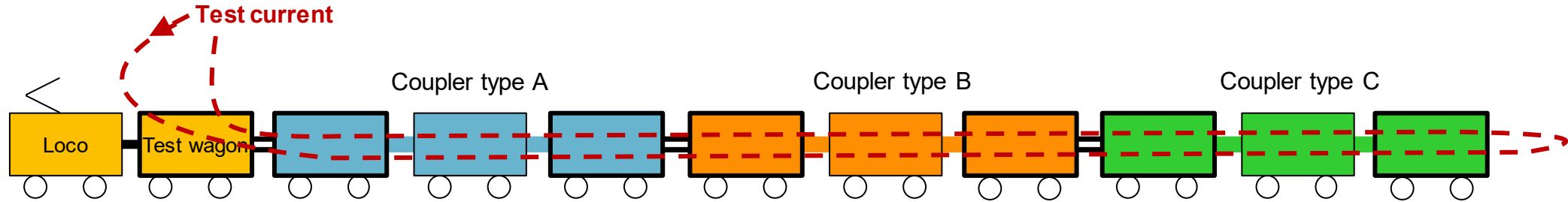
DAC4EU Power Supply Testing

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Electrical Resistance per Wagon

Design-relevant parameter for the power supply system

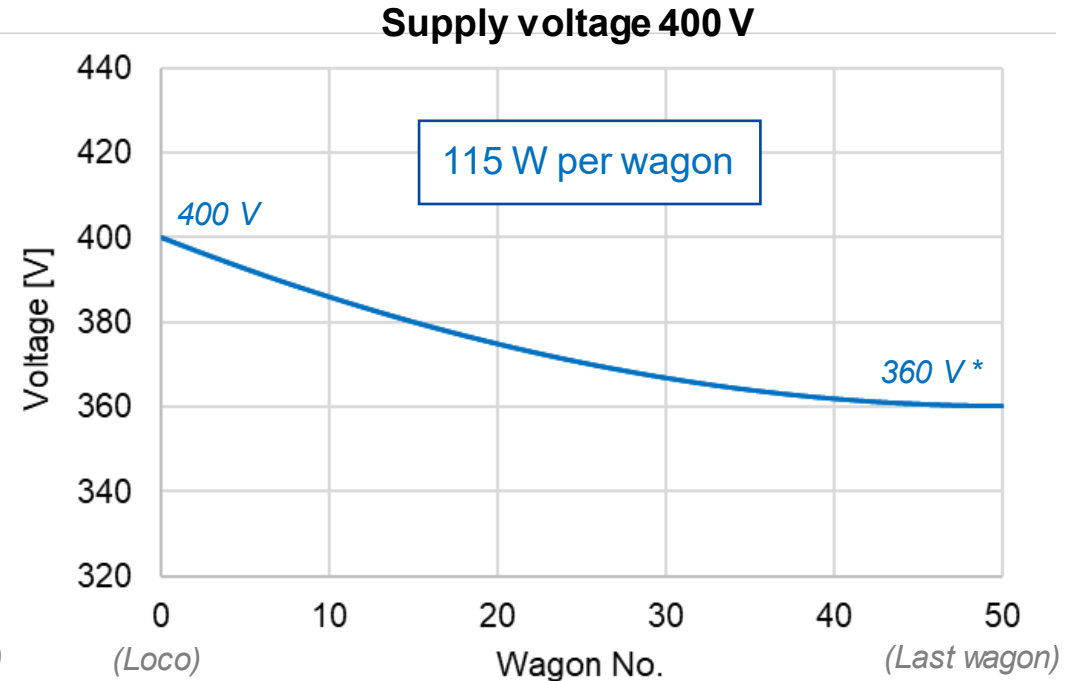
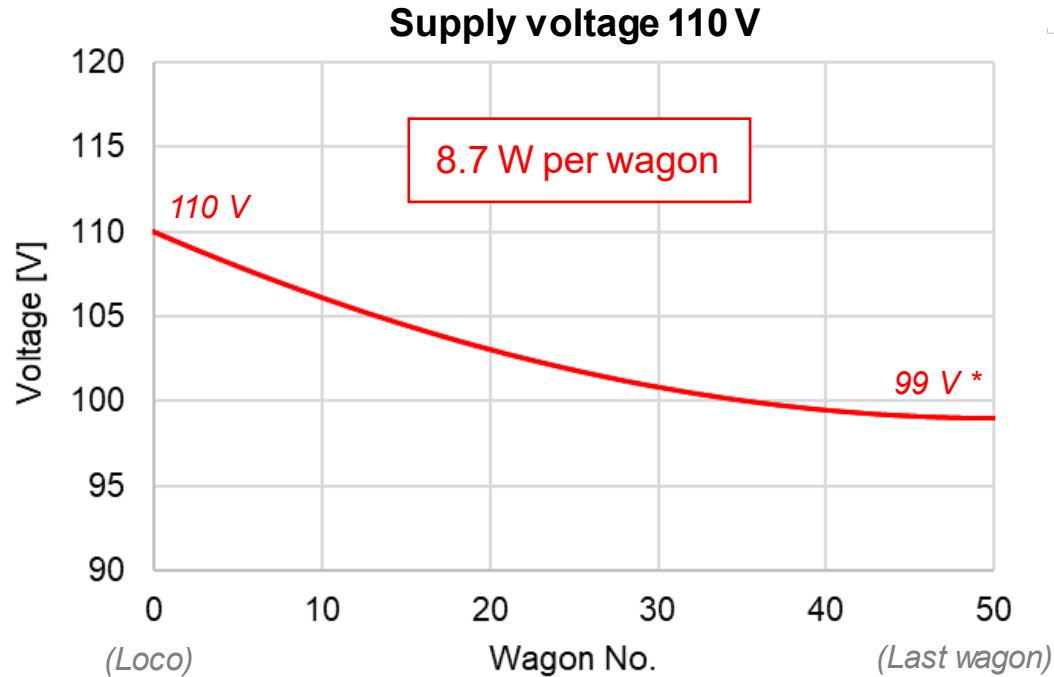


- Apply test current to wagon wiring and couplers
- Measure voltage drop at each coupler
- Calculate loop resistance of wagon including coupler
- Loop resistance depends on wiring cross section and wiring length: up to two times the actual wagon length!
- Resulting loop resistance is 100 mΩ per wagon including couplers and coupler contacts (cable cross section: 16 mm²)



Power per Wagon in Dependence of Supply Voltage

Wagon loop resistance: 100 mΩ, cable cross section: 16 mm²

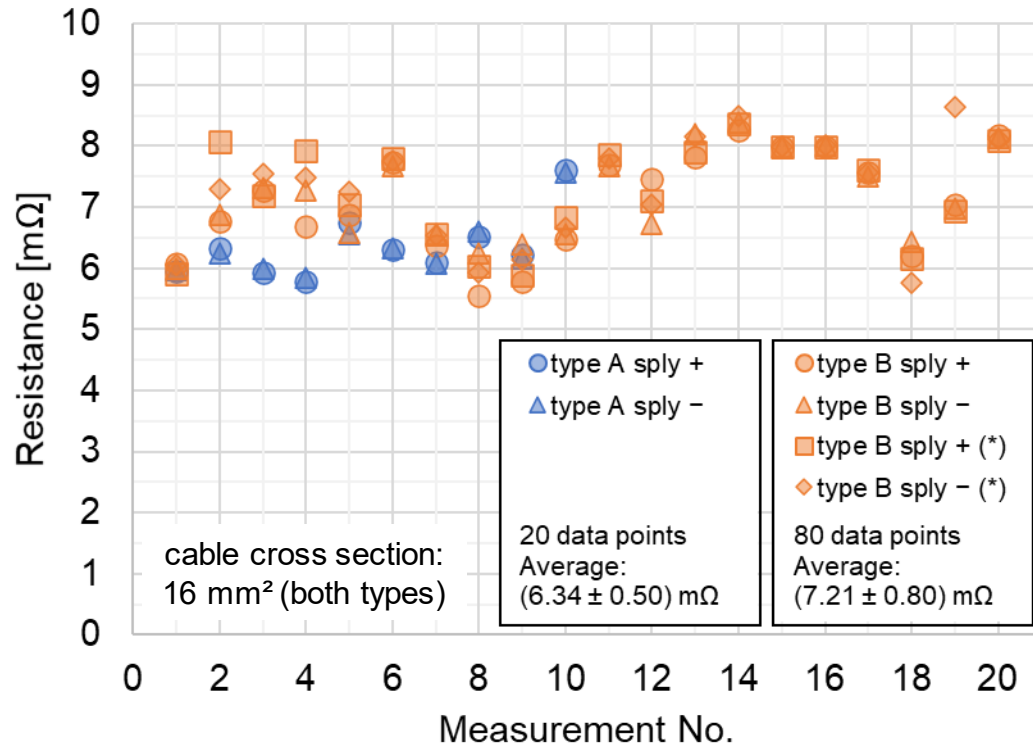


- Voltage decreases from loco to last wagon as a result of resistive losses in the wiring and couplers
- At the last wagon, at least 90 % of the supply voltage should be present*
- Higher supply voltage allows substantially higher power per wagon, and cable cross section may be reduced

* voltage at last wagon = min. 90 % of supply voltage (10 % voltage drop, cf. e.g. EN 50533:2011) in order to ensure safe short-circuit detection.

Electrical Resistances of the Power Supply Lines of the E-Couplers

E-coupler resistance including connecting wires between couplers and wagons



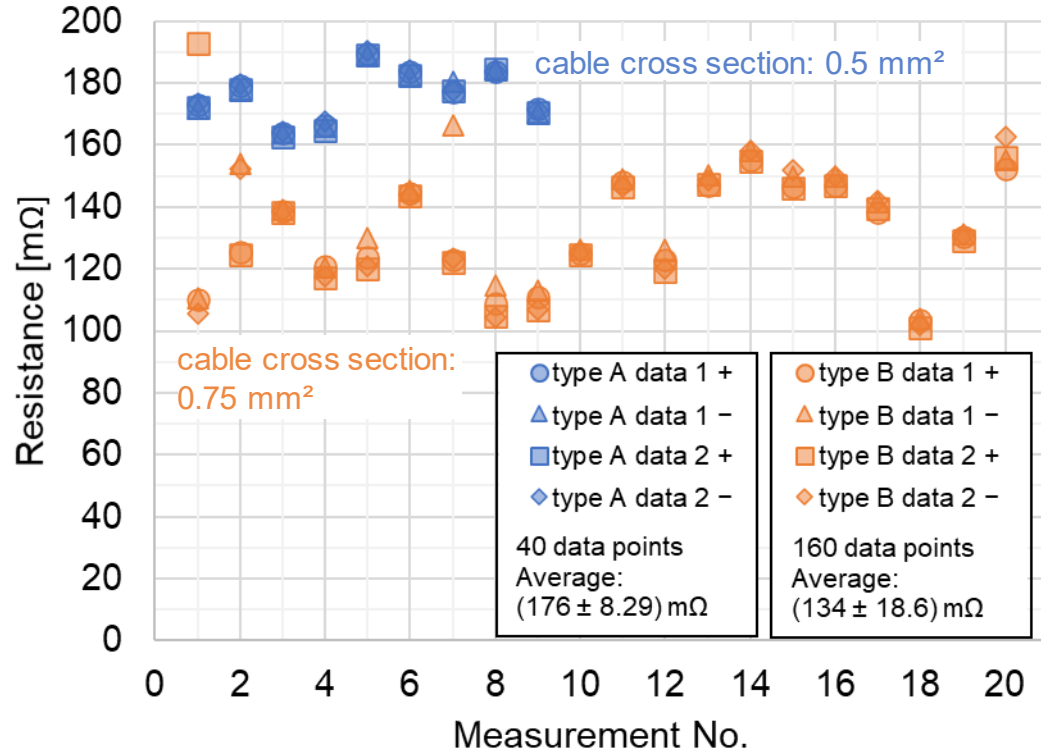
- Sample measurements of electrical contact resistances of power supply lines of coupler pairs type A and type B
- Measurements made at respective ends of supply lines of both couplers involved, thus results include lead resistances
- Each sample measurement includes the number of individual supply lines of the respective couplers, i.e. two for type A and four for type B couplers
- Number of sample measurements per coupler type is the result of availability of couplers during measurement campaigns

- Resistance values do not show time-dependent degradation during measurement period (January to October 2022)
- Supply line length variation explains resistance differences between coupler pairs (different measurement numbers)
- Deviations within the same coupler pair (e.g. type B, measurement no. 2, 4) indicate actual differences in individual contacts

* coupler type B: two wires per supply voltage polarity

Electrical Resistances of the Data Lines of the E-Couplers

E-coupler resistance including connecting wires between couplers and wagons

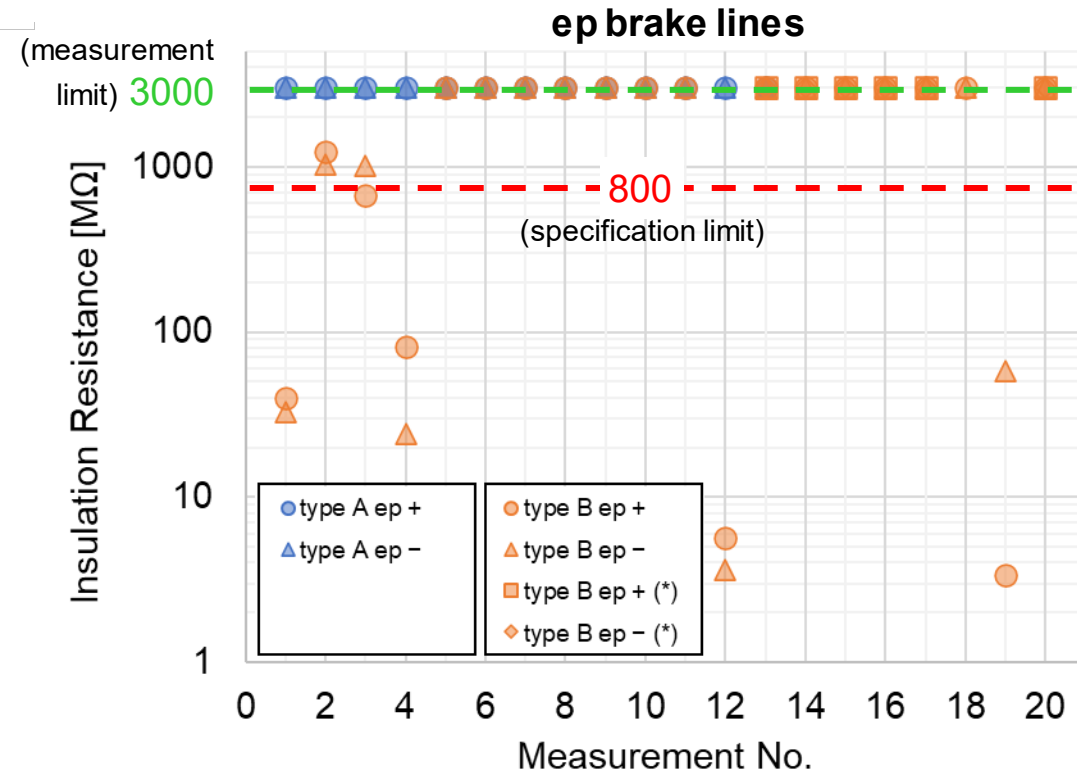
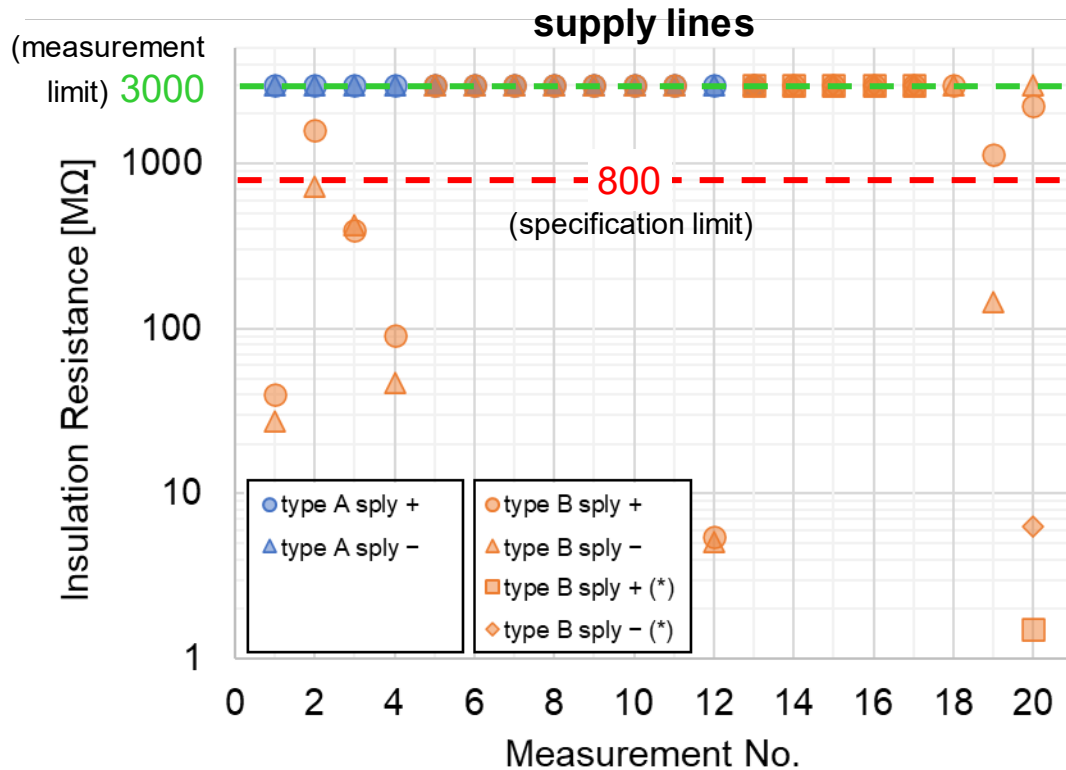


- Sample measurements of electrical contact resistances of data lines of coupler pairs type A and type B
- Measurements made at respective ends of data lines of both couplers involved, thus results include lead resistances
- Each sample measurement includes the four individual data lines of the respective couplers
- Number of sample measurements per coupler type is the result of availability of couplers during measurement campaigns

- Resistance values do not show time-dependent degradation during measurement period (January to October 2022)
- Data line length variation explains resistance differences between coupler pairs (different measurement numbers)
- Systematically higher resistances values of type A couplers are result of lower data wire cross section compared to type B
- Deviations within the same coupler pair (e.g. type B, measurement no. 2, 7) indicate actual differences in individual contacts

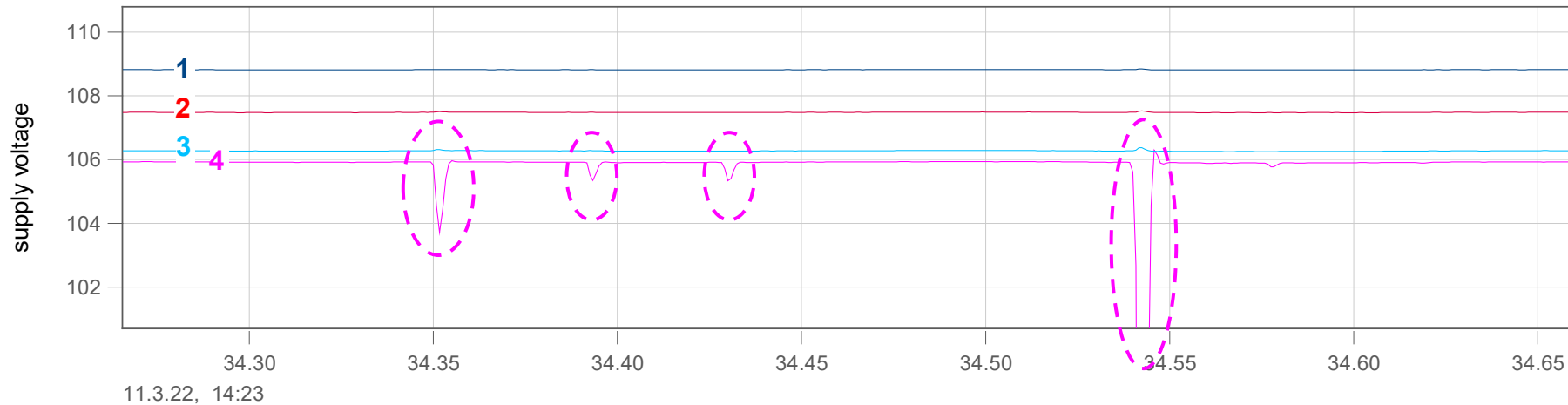
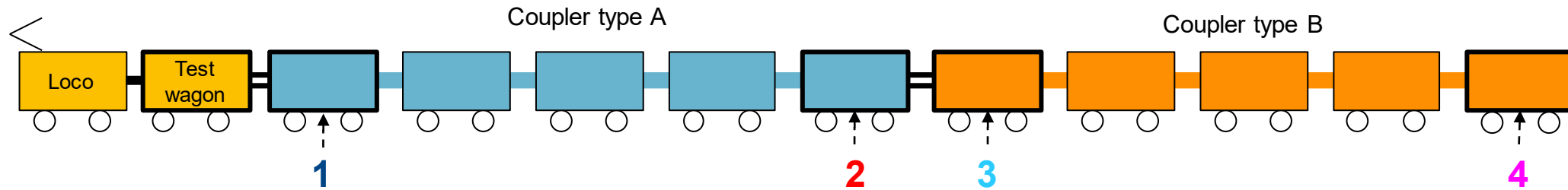
Insulation Resistances of the E-Couplers

E-coupler resistance including connecting wires between couplers and wagons



- Isolation resistance measured in coupled state, e-couplers electrically separated from wagons
- All type A e-couplers with insulation resistance equal to or above the measurement limit of 3 GΩ
- Some type B e-couplers with insulation resistance below the specification limit of 800 MΩ

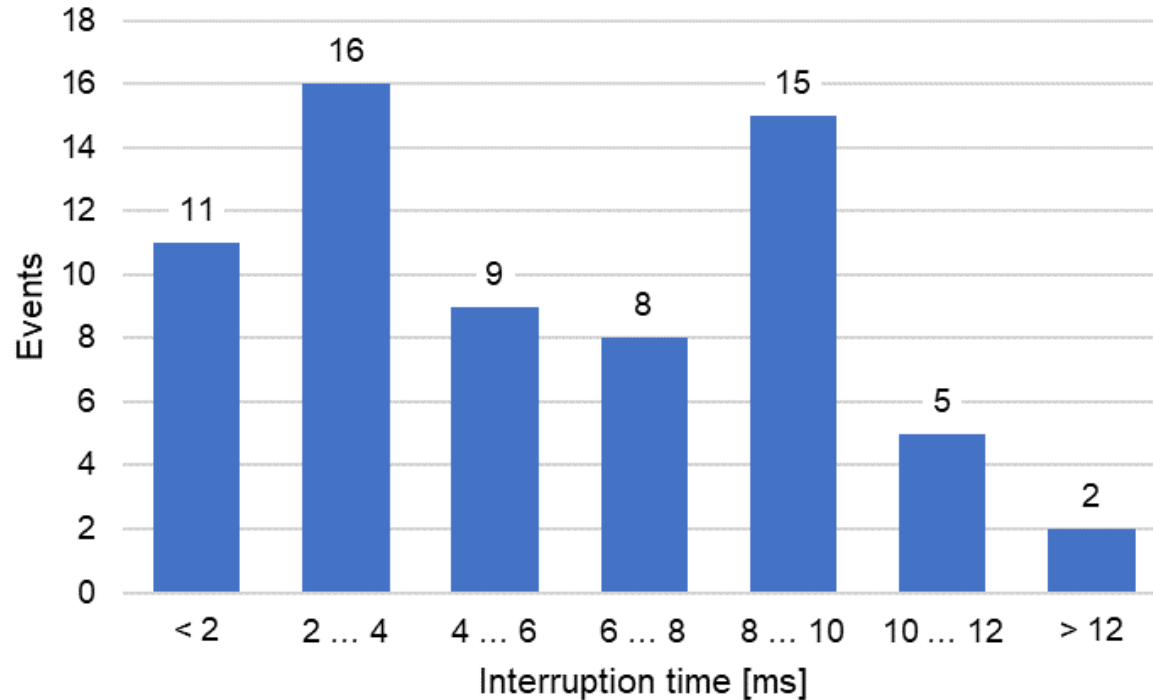
Monitoring of Supply Voltage and Current during Train Run



- Supply voltage interruptions at last wagon (4) with interruption lengths of about 10 ms
- Probably contact problem at one of the couplers between measurement point 3 and 4

Analysis of Interruptions during Train Run

Measured on the power supply line



Evaluation of a 10:05 h train run

- 64 interruptions on power supply line
- one interruption every 9:27 min
- average interruption duration: 5.87 ms
- shortest interruption:
- longest interruption: 15.83 ms

- Interruptions on power supply line can increase contact wear and impair power line communication
- Due to the mechanical similarity of the contact types, similar interruptions of the data contacts are to be expected
- Data contact interruptions can impact the reliability and stability of data communication
- Actual effects of interruptions on data communication parameters are investigated



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Thank you!

