Determination of power grid parameters between two electric mobility charging stations by measuring current and voltage

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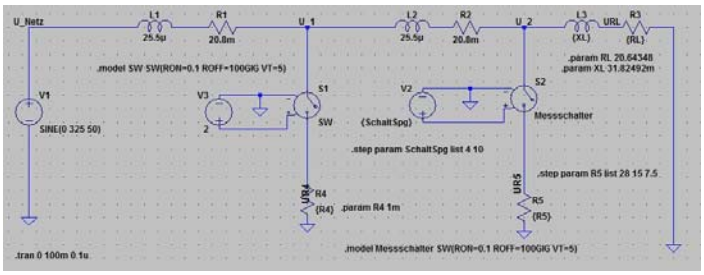
The power grid could be overloaded by switching on many controllable loads, such as charging electric cars, at the same time. Therefore it is interesting to determine the network parameters respectively the network status, to detect if the power grid is at risk of congestion. Therefore the network is simulated by using “LT-Spice” and it is recreated in the laboratory to get measured values under real conditions.

Method of resulution

- 2 charging stations (S1,S2) could be switched on and off
- Voltages as well as charging current could be measured (U1,U2,I1,I2)



- First charging station is constantly switched off
- Second charging station is switched on and off
- Voltage and charging current are measured for both cases

→Load current and the line impedance could be determined:

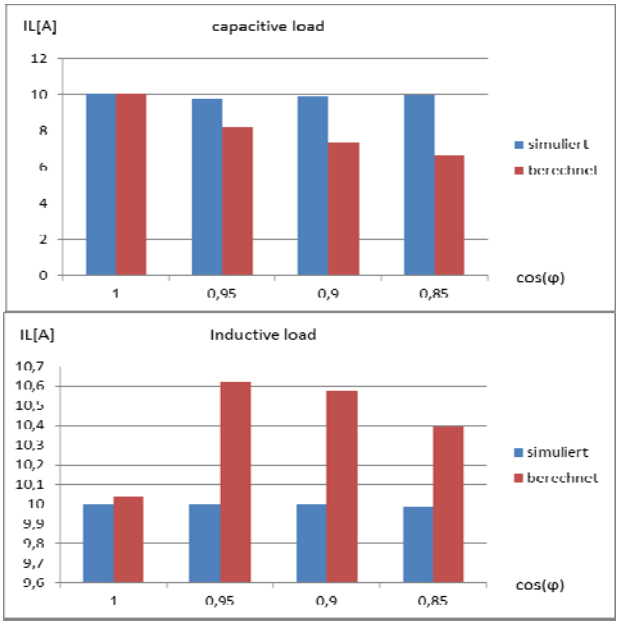
$$\Delta U_{12} = U_{12_{off}} - U_{12_{on}} \rightarrow Z_{12} = \Delta U_{12}/I_{2_{on}} \rightarrow I_L = U_{12_{off}}/Z_{12} \rightarrow Z_L = U_{2_{off}}/I_L$$

- Phase angle is unknown

→ amount is used instead of complex values

Simulation

- Circuit is realized with “LT-Spice” and simulated with different parameters for grid load
- Connection between charging stations:
- 100m long cable (“NAYCWY4X150/70 1kV-TT”)
- The relationship between real and imaginary part of the load is variated as well as the type of imaginary load
- For every set of parameters the current is simulated and calculated (method above)



The calculated current is higher than the simulated in case the load is inductive and lower if the load is capacitive. This is caused in the line impedance that just has an inductive component.

Implementation in the Laboratory

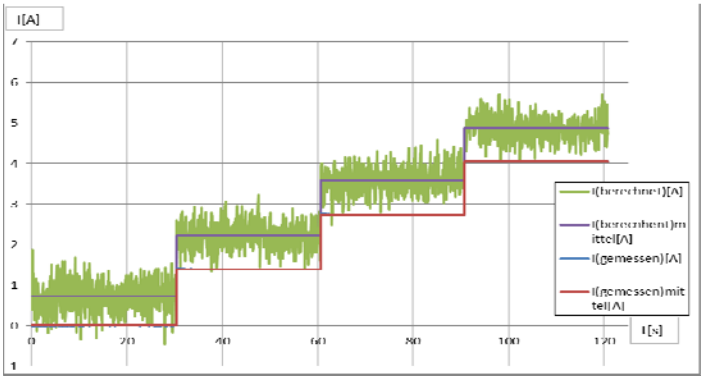
- Power supply: grid with transformer to control voltage
- Connection cable: parameters measured (5m)

R'	**27 mΩ/m**
C'	100 pF/m
L'	0,75 µH/m

- load of the grid and charging station is realized with the same adjustable resistor
- connection between the first charging station and the power supply left out
- Measurement voltages and current with LabView

Measurements in the Laboratory

- The needed values could be measured
- Calculations could be done
- Comparison of measurement, calculation and simulation



Iges[A]

Load	simulated	measured	calculated
0kW	0	0,01733961	0,72940087
1kW	1,44683	1,40614927	2,19945003
2kW	2,89119	2,75203451	3,56018932
3kW	4,33308	4,06364038	4,85719446

- calculated current is always about 0,7A above the simulated and the measured
- Reason: Using the amount instead of complex values
- Small differences between measured and simulated values
- Reason: Impedances of supply lines and different amplitude of voltage (not exactly the same)
- Voltage not constant in measurement (fluctuation of grid)

Conclusion

- Determining network impedances by measuring voltage and current at two charging stations is possible
- To calculate the impedances the phase angle is necessary
- Simplification (amount) is possible for purely real load
- Calculated load current higher than in reality

→ no problem in charging because possible calculated charging current is lower than it could be

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