SE-24.3 Stability of Photovoltaic Inverters Reactive Power control by the distribution GRID voltage (A)

F. Baumgartner[1], T. Strasser[2], R. Bründlinger[2]
[1]ZHAW Zurich University of Applied Sciences, Winterthur
[2]AIT Austrian Institute of Technologie, Vienna

One of the main duties of the distribution grid in the coming years is to deliver power and stay within the permitted grid voltage levels, even during periods of high photovoltaic power feed into the grid. Further, costly hardware investments have to be evaluated economically and technically regarding the ability of voltage stabilization the grid code voltage levels.[1] An effective and low cost approach is the control of the reactive power Q(V) and the active power P(V) of the PV inverter, by means of the actual grid voltage measured by the individual PV inverter.[2,3] Thus, no additional hardware investment in ICT on the grid level is needed. The PV inverter settings of the static characteristics of the Q(V) and P(V) have to be in accordance with the electrical grid operating code. Additionally, the time constants (dead and delay time) of these Q(V) and P(V) control activities have to be specified to guarantee a stable grid operation. Today, this economically very attractive Q(V) method is not widely used in practice. To convince the distribution system operator DSO, more sophisticated tests, including feedback loops of the tap changer controller of the transformers close to the stability boundary, have to be performed. A report about such extreme laboratory tests are given in this paper.

Here the results and analyses of stability measurement in the laboratory of two PV inverters, powered by DC sources, emulating changing weather conditions, especially abrupt transient trigger by changing solar irradiance. Other transient inputs will be generated by different load, emulating EV charging stations. The transformers medium voltage on load tab changers in the lab will complete the total analyzed control loop. The most critical combinations and superimpositions of PV and load transients together with several critical settings of the involved time constants are tested by analyzing the response of the hardware in the loop. These sets of parameters will be attributed to a certain distribution grid category.

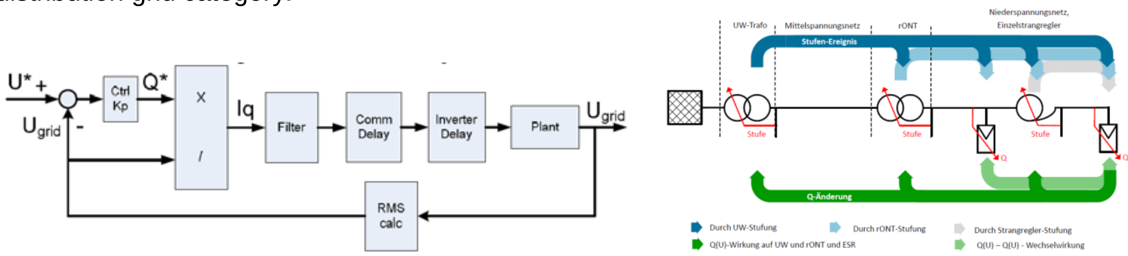

Fig. 1 Equivalent steady-state model for Q(V) [4] and control schema including the transformer [5]

It will be elaborated in the paper, if different appropriate settings of the parameters are needed for each category of distribution grids and type of the static Q(V) und P(V) characteristics. A set of stable parameters are given of the times constants of the controllers for each grid category including even the demand of highest EV charging transients.
Finally a suggestion will be given if these laboratory based parameter findings should be introduced into a general standardisation process.

References:
[1] F. Baumgartner, F. Carigiet, P. Korba; Swiss Federal Bureau of Energy, BFE-Contract No. SI/501370-01,“Projcet CEVSOL; public annual Report 2016, 2017
[2] F. Carigiet, M. Niedrist, C. Scheuermann, and F. Baumgartner, “Case study of a low-voltage distribution grid with high PV penetration in Germany and simulation analyses of cost-effective measures,” Prog. Photovolt. Res. Appl., 2015
[3] F. Carigiet, F. P. Baumgartner, P. Korba, M. Niedrist; “Optimisation of the Load Flow Calculation Method of Low-Voltage Distribution Grids”, 33rd EU PV Conference; Amsterdam, Sept 2017
[4] A. Constantin and R. D. Lazar, “Open loop Q(U) stability investigation in case of PV power plants,” in Proc. 27th Eur. Photovoltaic Solar Energy, Conf. Exhib., Frankfurt, Germany, 2012, pp. 3745–3749
[5] O. Marggraf, I. Berber, B. Engel; “ Sichere Netzintegration mittels Q(U)-Regelung und rONT im Praxistest “; PV Tagung Staffelstein, März 2018