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Control method and characteristics of Virtual Synchronous Generator

Kenichi Sakimoto(Kawasaki Heavy Industries)
Yuko Hirase (Kawasaki Technology)

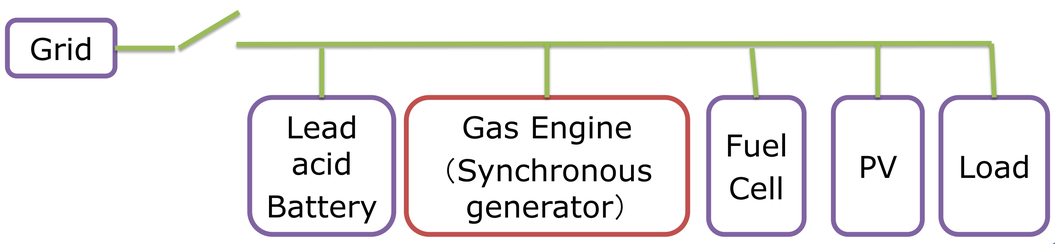
Introduction

Distributed generators connected to grid by inverters are installed in microgrid.

Some microgrid which can disconnect from the grid without interruption are demonstrated.

Example

NEDO microgrid demonstration in New Mexico



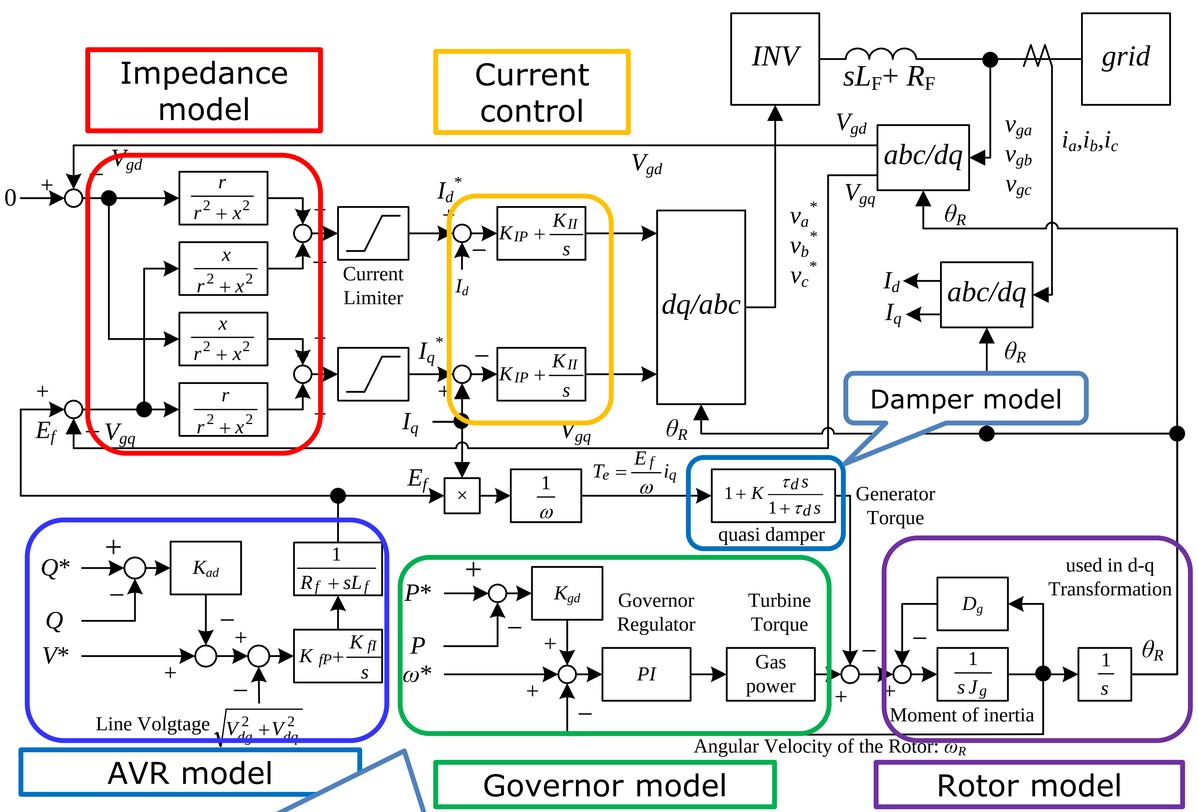
These Microgrids require the synchronous generators to operate since the synchronous generator maintained the microgrid voltage and frequency.

Virtual Synchronous Generator (VSG)

The VSG is an attempt to realize the characteristics of the actual synchronous generators.

Control method

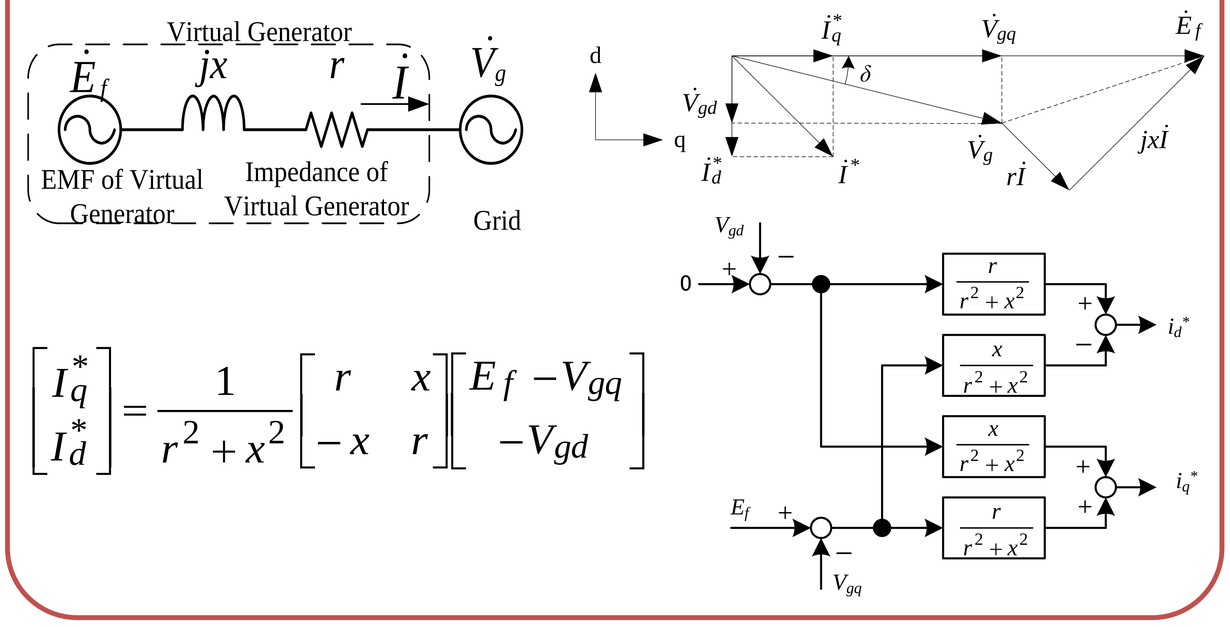
Proposed VSG is based on current controlled type inverter.



Governor and AVR model have droop characteristics

Impedance model

Impedance model simulates the impedance of a synchronous generators without transient impedance

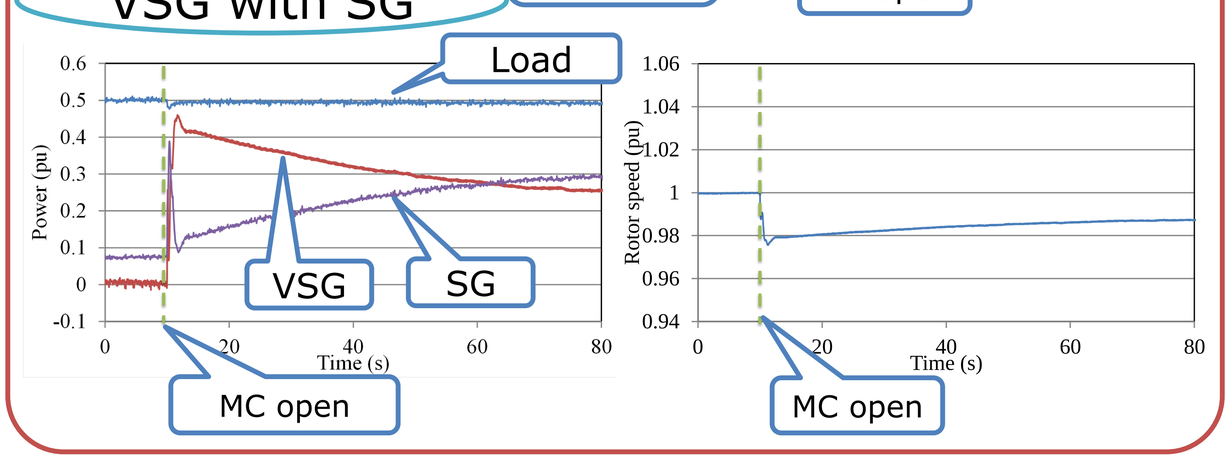


$$\begin{bmatrix} I_q^* \\ I_d^* \end{bmatrix} = \frac{1}{r^2+x^2}\begin{bmatrix} r & x \\ -x & r \end{bmatrix}\begin{bmatrix} E_f - V_{gq} \\ -V_{gd} \end{bmatrix}$$

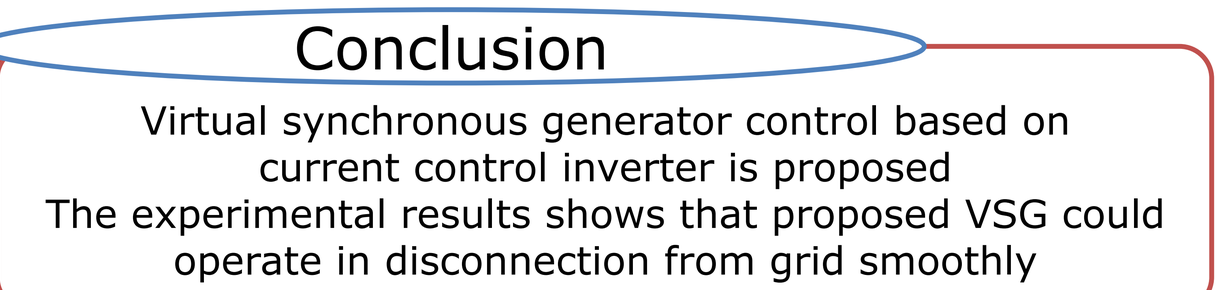
Experimental result

Microgrid consist of VSG and SG are connected to the commercial grid and disconnected from the grid by opening MC

Experimental system



VSG only



VSG with SG

Rotor Model

Generator torque and Motion equation of rotor is expressed as following

$$Te = E_f i_q / \omega \qquad J\frac{d\omega_R}{dt} = T_p - T_e - D\omega_R$$

Rotor phase Θ_R was used for dq transformation

Conclusion

Virtual synchronous generator control based on current control inverter is proposed

The experimental results shows that proposed VSG could operate in disconnection from grid smoothly