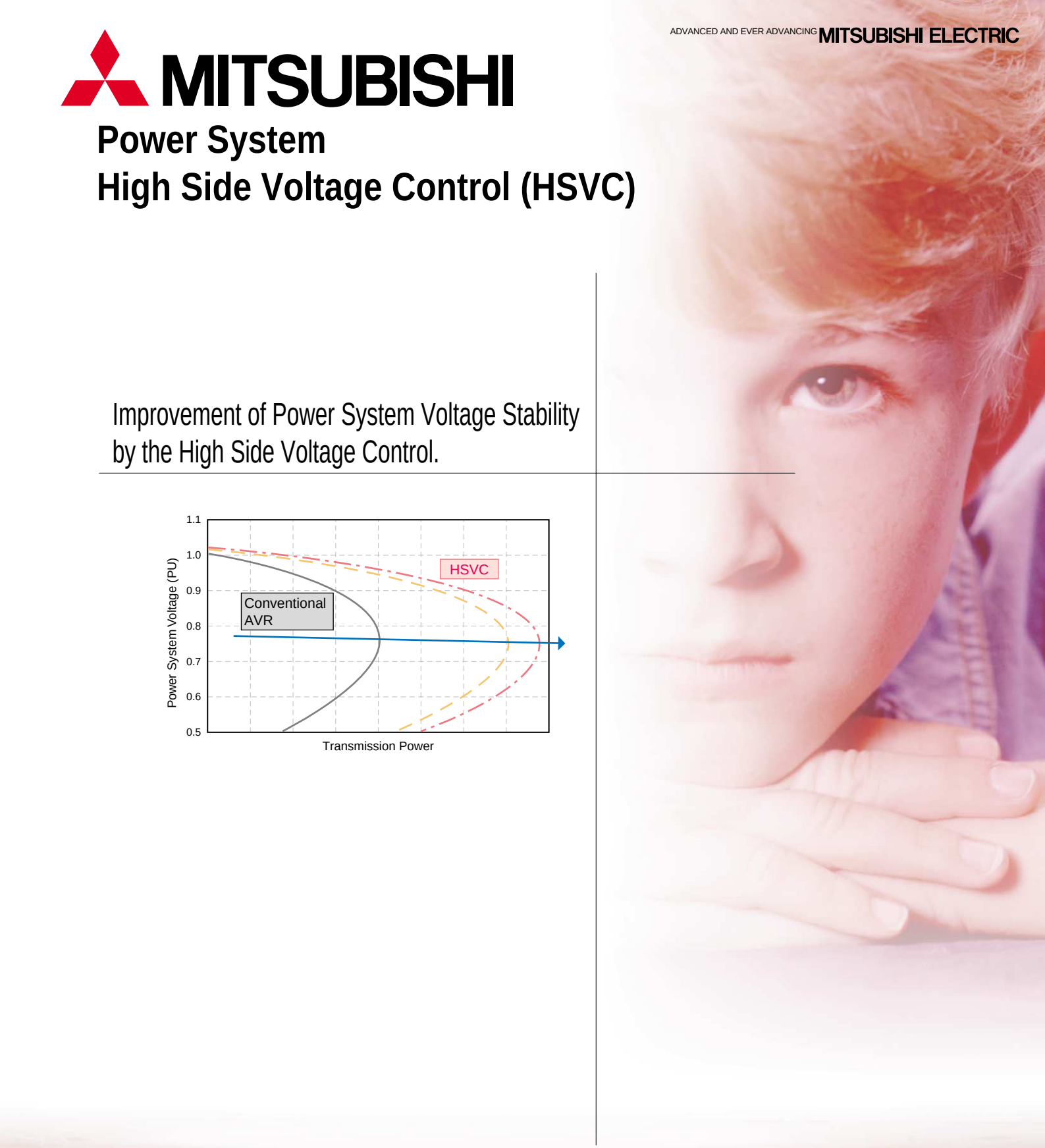
MITSUBISHI

Power System
High Side Voltage Control (HSVC)



Improvement of Power System Voltage Stability by the High Side Voltage Control.

New Generator Excitation Control System with the High Side Voltage Control for Improving Power System Voltage Stability

Purpose of HSVC

Long distance transmission system and large scale sending power

Increase of constant power load

→ Declining voltage stability → Installation of reactive power adjusting/voltage control facilities and transmission line → Increasing power equipment cost

Improving voltage stability

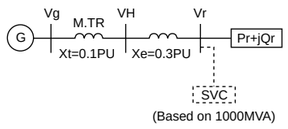
Decreasing power equipment cost

Application of HVSC	• Improved voltage stability by controlling high side voltage • Reduced the facility investment by means of the practical use of generation plant. • Integrated the function of HSVC into digital automatic voltage regulator (D-AVR). • Cooperated control with other reactive power adjusting/voltage control facility.

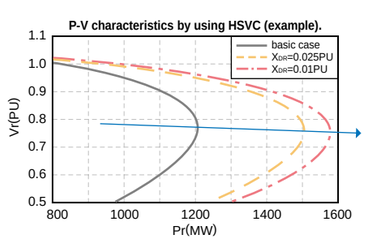
Valtage Stabilizing Effect

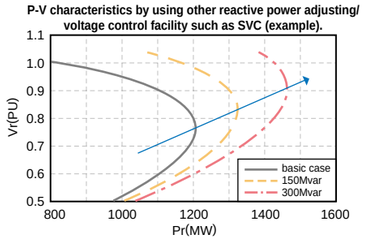
Evaluation Based on P-V Characteristics

Without adding other reactive power adjusting/voltage control facility such as static var compensator(SVC), HSVC can increase the allowable sending end power by the practical use of the reactive power supplying capability of generation plant, namely, decreaseing the value of voltage droop rate XDR. Additionally, the allowable sending end power can be increased even if the system voltage drops, since the 'nose' of the P-V curve goes out and down.



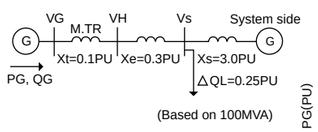
(Based on 1000MVA)



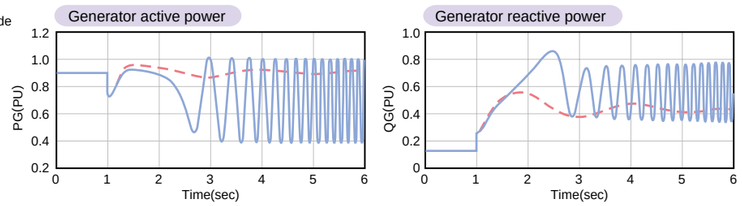


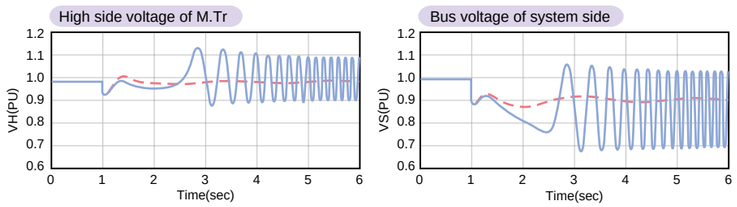
Evaluation Based on Transient Response

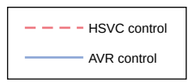
HSVC has excellent response characteristics to keep the system stability when the system requires reactive power abruptly at the receiving end.



(Based on 100MVA)







System Configuration & Control Principle

HSVC controls the high side voltage (VH) to be its target setting value (VHref), without voltage feedback signal from the high side of step up transformer (M.Tr).

[Basic Principle]
HSVC controls the generator voltage(VG) according to:

VG=VHref+(Xt-XDR)Iq.

Where,

XDR : Voltage Droop Rate (For insuring stable parallel operation)
Iq: Reactive current of generator (Q/VG)
Xt: Reactance of the step up transformer(M.Tr)

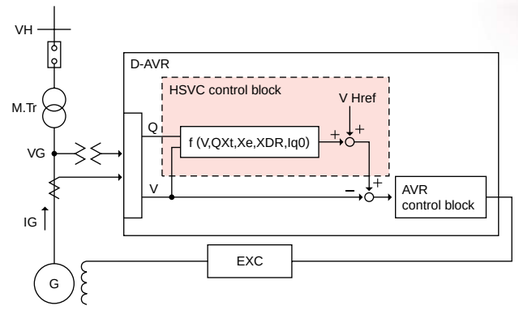
As the result, the high side voltage (VH) is kept to be:

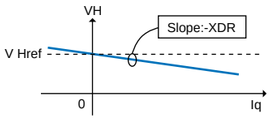
VH=VHref-XDR · Iq.

HSVC is of following options to be installed corresponding to various requirements, in addition to voltage control.

[Option]

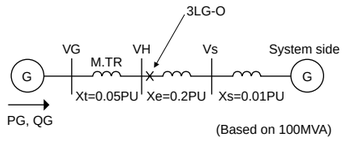
- Reactive current compensation function : Makes VH=VHref for any reactive current compensation reference value.
- Compensation follow-up control function: Revises the reactive current compensation reference value automatically corresponding to the variation of VHref.
- Automatic XDR compensation function: Compensates XDR automatically corresponding to the feedback signal of the tap position of M.Tr.
- Regulating function of HSVC response and stability characteristics
- Stabilizing function to suppress power oscillation



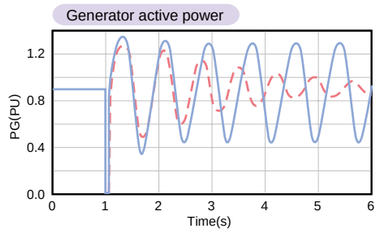


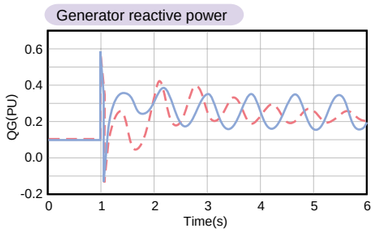
Stabilizing Effect of Power Oscillation

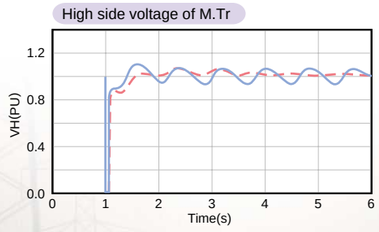
HSVC not only improves voltage stability, but also has good effect on suppressing power oscillation if a suitable phase compensation function is added.

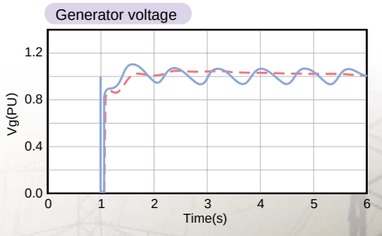


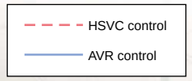
(Based on 100MVA)











MITSUBISHI POWER SYSTEM HIGH SIDE VOLTAGE CONTROL (HSVC)

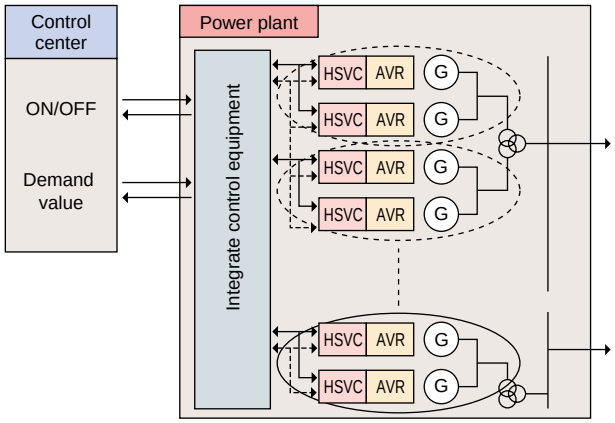
Superior Features of HSVC

- As a useful means for improving voltage stability, HSVC benefits from economy by making full use of the reactive power supplying capability of generation plant, compared with other reactive power adjusting/voltage control facilities.
- A feedback signal of voltage from high side of step up transformer(M.Tr) is not required.
- HSVC can be installed to digital automatic voltage regulator (D-AVR) as an option.
- The operation voltage of high side of M.Tr can be set to be a desired value.
- It is possible to operate in parallel with other generators due to the voltage droop chracteristics.
- It is possible to operate in parallel stably with the generator which uses different excitation method, because the HSVC is of response regulation function.
- The high side voltage value VH equals to its setting value VHref for any reactive current, by means of the reactive current compensation function.
- The voltage droop rate constant control can be realized, in despite of the variation of reactance value and the variation of voltage ratio caused by tap position change, by means of the automatic XDR compensation function.
- It is possible to suppress power oscillation by adding a phase compensation function.

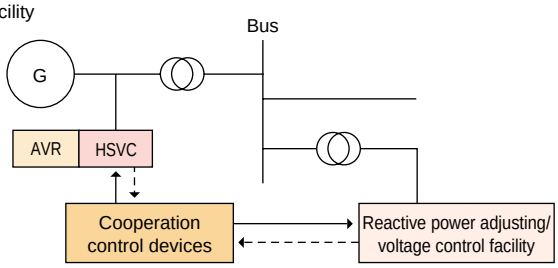
Example of Cooperative Control of HSVC and Other Control Devices

HSVC can also cooperate with other control devices as follows, corresponding to the requirements of operation situation.

- Cooperation control of HSVC and M.Tr tap control (For making full use of the reactive power supplying capability of generation plant)
- Cooperation control of multi power plant
- Cooperation control of HSVC and other reactive power adjusting/voltage control facility



Total controls system of Multi-generator



Cooperation control of HSVC and other reactive power adjusting/ voltage control facility.

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