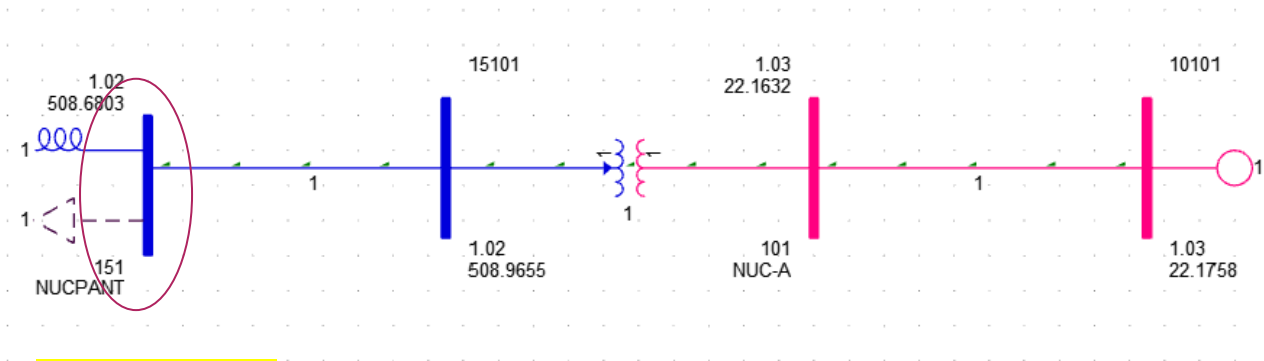


Voltage Droop Control In PSS®E

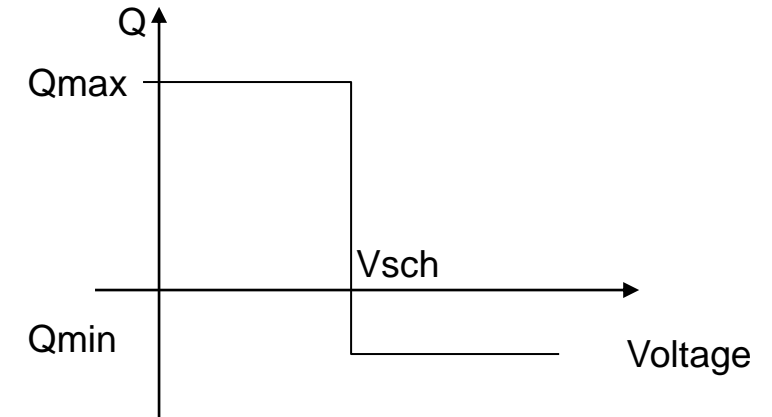
Feng Dong
Feng.Dong@siemens.com

Existing Generator voltage control

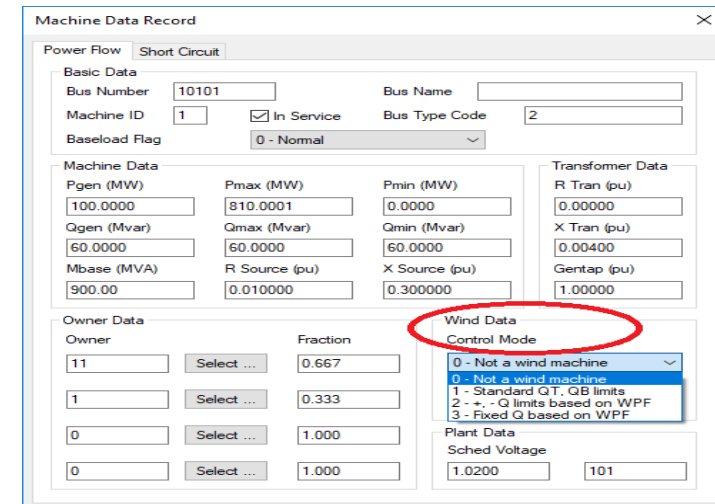
- Generators control voltage at local or remote bus to a 'setpoint' by adjusting the reactive power output between Q_{max} and Q_{min}



Controlled bus



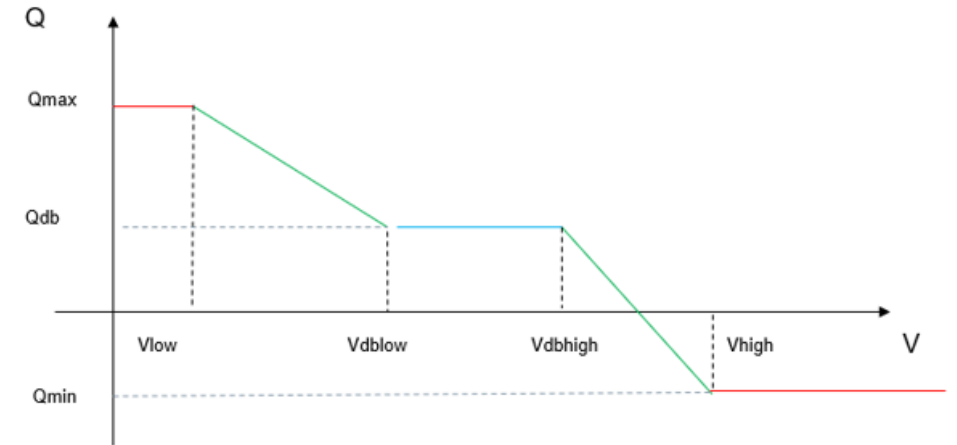
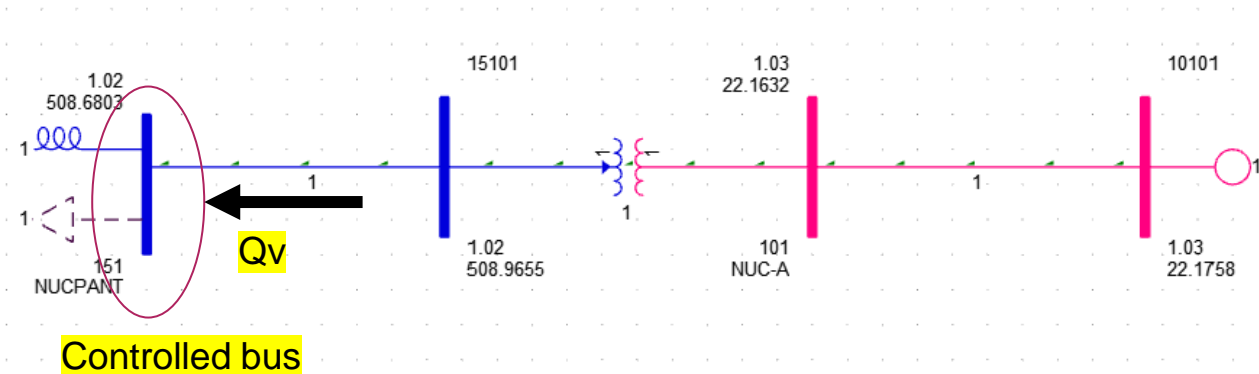
- Wind generators can have Q limits based on pf, or constant Q output



Voltage Droop Control

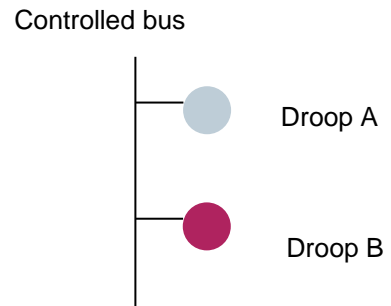
Q_v , the reactive power injection to the controlled bus, is the function of the voltage at the controlled bus:

$$Q_v = \begin{cases} Q_{max}, & V \leq V_{low} \\ Q_{db} + (V - V_{dblow}) * \frac{Q_{max} - Q_{db}}{V_{low} - V_{dblow}}, & V_{low} < V \leq V_{dblow} \\ Q_{db}, & V_{dblow} < V \leq V_{dbhigh} \\ Q_{db} + (V - V_{dbhigh}) * \frac{Q_{db} - Q_{min}}{V_{dbhigh} - V_{high}}, & V_{dbhigh} < V \leq V_{high} \\ Q_{min}, & V \leq V_{high} \end{cases}$$

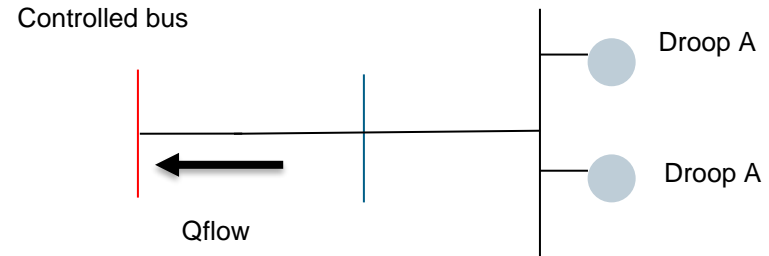


Voltage Droop Control

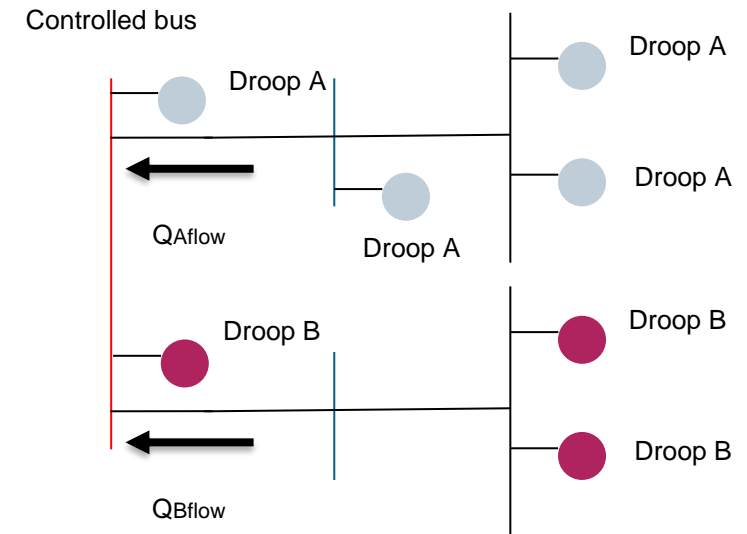
Valid droop control schemes



Scheme 1



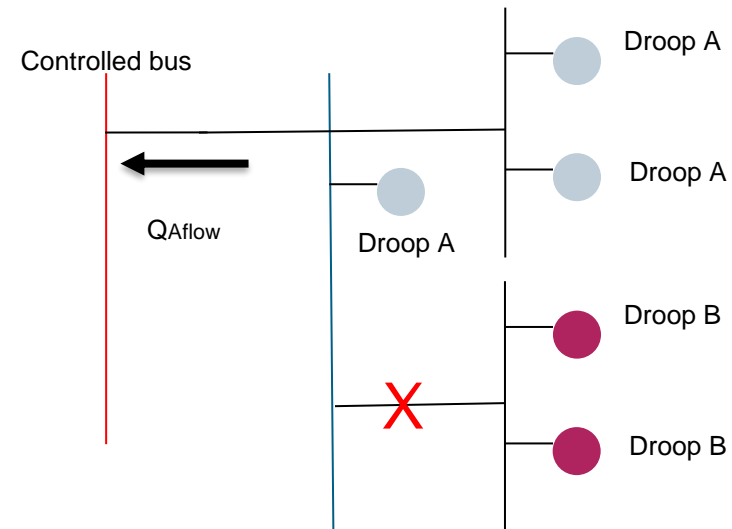
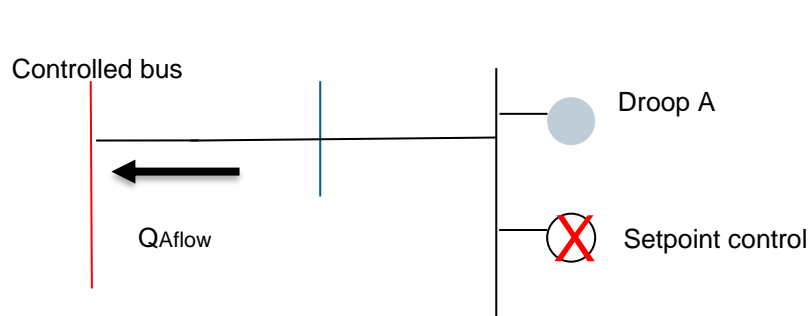
Scheme 2



Scheme 3

Voltage Droop Control

- Invalid Droop control scheme:
 - the measured reactive power flow is used by two or more groups of generators within different droops
 - The measured reactive power flow is not controllable
- The existing voltage control is enforced when droop control scheme is invalid



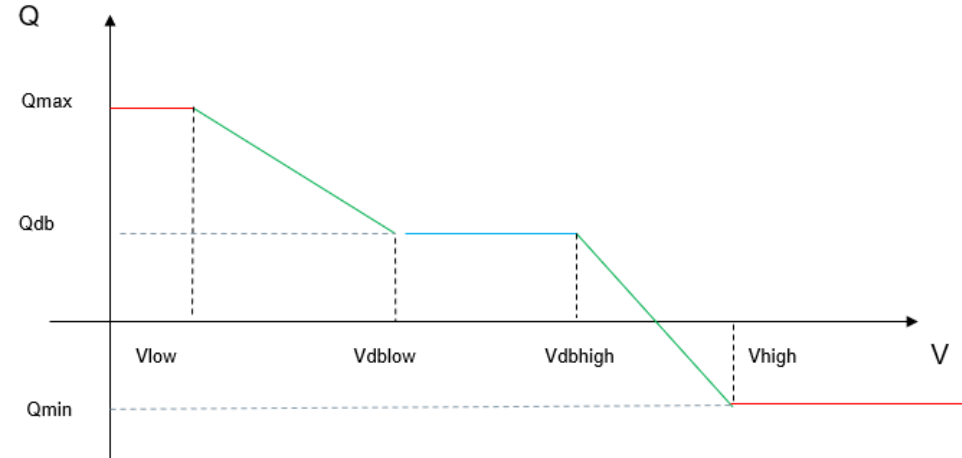
Voltage Droop data record

Voltage Droop record

```
"Droop":{  
  "fields":["DroopName:string","Status:int", "Regbus:int","Qmax:real", "Qdb:real", "Qmin:real",  
            "Vlow:real", "Vhigh:real", "Vdblow:real", "Vdbhigh:real"],  
  "data":[  
    ["A", 1, 0, 50.0, 10, -50.0, 0.94, 1.04, 0.97,1.01],  
    ["B", 1, 0, 50.0, 0, -50.0, 0.95, 1.05, 0.98,1.02] ]  
}
```

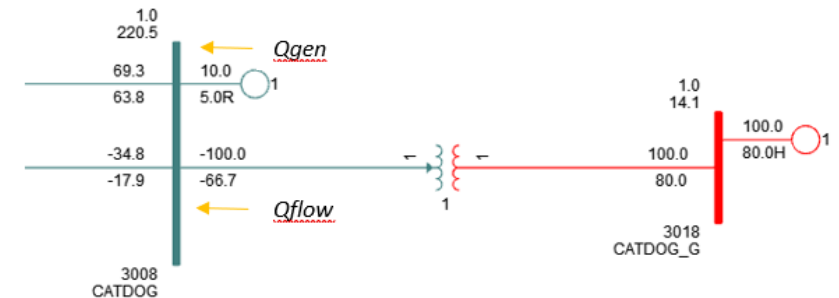
Voltage Droop field in Generator record

```
"generator":{  
  "fields":["ibus", "machid", "droopname:string"],  
  "data":[  
    [9, "1", "B"],  
    [107, "1", "A"] ]  
},
```



PSS®E Droop Modeling Highlights

- Available in PSSE®E 35.2
- Voltage droop control topology and data validation
- The reactive power Q at the controlled bus includes:
 - the sum of reactive power flows on the branches connected to the controlled bus
 - The reactive power outputs of generators at the controlled bus



- The reactive power outputs of generators in the same voltage droop control group are proportional to RMPCT
- Individual generator Q limit is honored.

Benchmark Case Demo