

Reactive Control in Wind Parks

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**Siemens Wind
Turbines - Americas**

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What Are Common Reactive Control Requirements in the US?

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Existing:

- Voltage Regulation
 - Transmission Voltage
 - Medium Voltage
- Reactive Power Control
 - Transmission Voltage
 - Medium Voltage
- Power Factor Control
 - Transmission Voltage
 - Medium Voltage
- Reactive Control without Active Power Production
 - Voltage Regulation
 - Reactive Power Control
 - Transmission Voltage
 - Medium Voltage



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What Are Common Reactive Control Requests in the US?

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- **Line drop compensation**
 - POIs often on transmission system, miles from park
- **Capacitor switching by park controls**
 - Integrated voltage/reactive regulation
- **Zero droop voltage regulation**
 - Sometimes requested at both high and low sides of park transformer

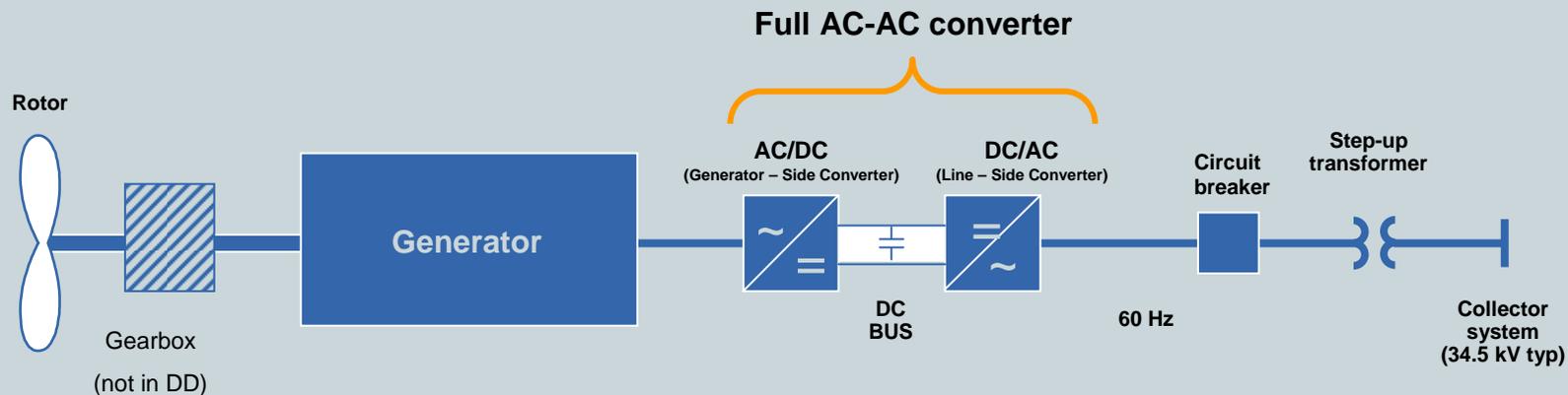


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Type 4 Variable Speed Full Converter WTG

Basic operation – typical configuration

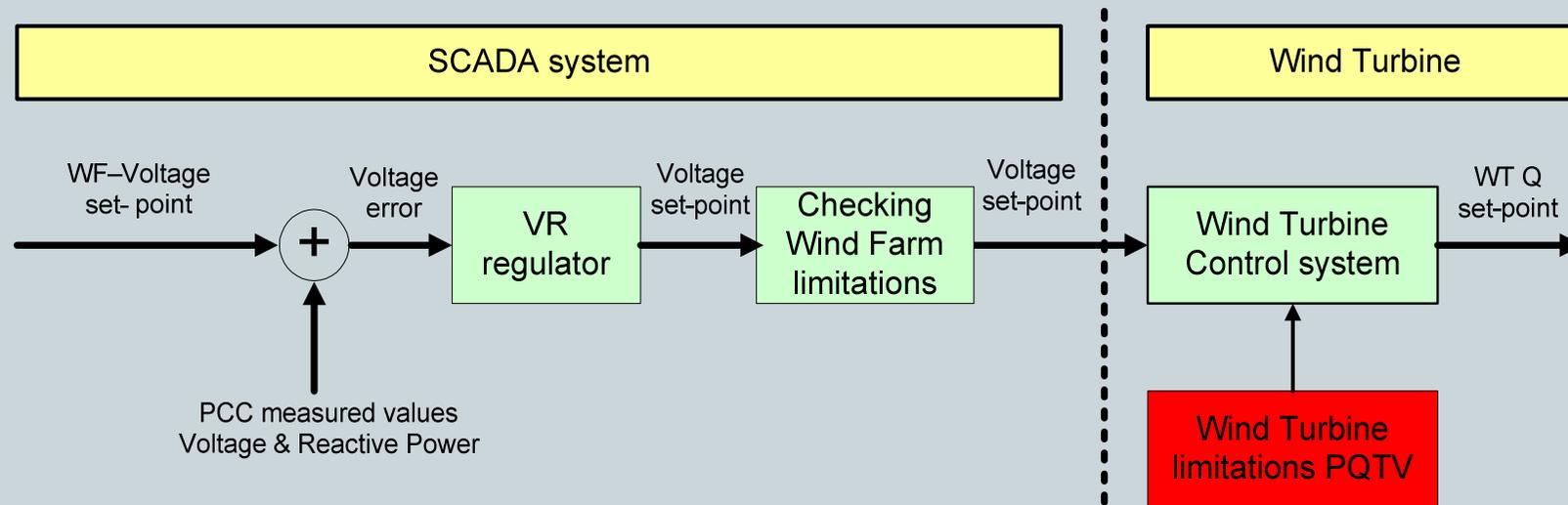
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- Rotor drives gearbox in geared systems. Gearbox eliminated in DD (direct drive); rotor directly drives low-speed, multi-pole generator
- Generator converts mechanical power to AC electric power. Generator can be asynchronous, permanent magnet or synchronous for geared system, pm or synchronous for DD.
- Generator-side converter converts AC electric power to DC
- Line-side converter converts DC to system-frequency AC (50 Hz or 60 Hz, as appropriate) and provides voltage regulation capability, either with or without active power production.

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Reactive Power Control - Voltage Control



- Distribution of voltage set-points
- Wind turbine limitations secured by the embedded WT control system – PQTV (Power, Reactive Power, Temperature, Voltage)

Voltage Control – Reactive Droop

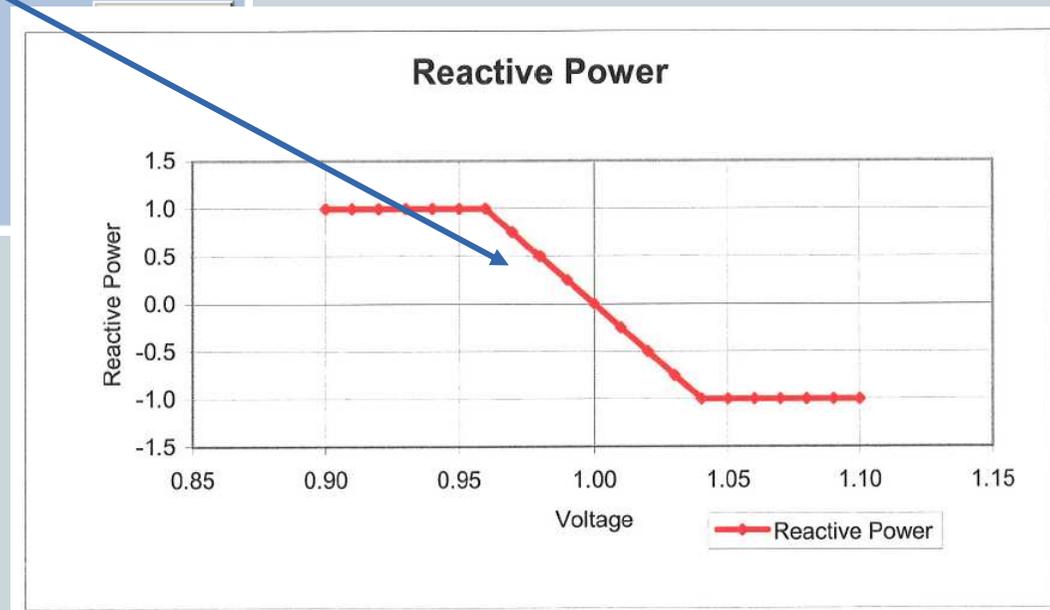
User Interface

Park Pilot Parameters

Voltage Control Show Graph

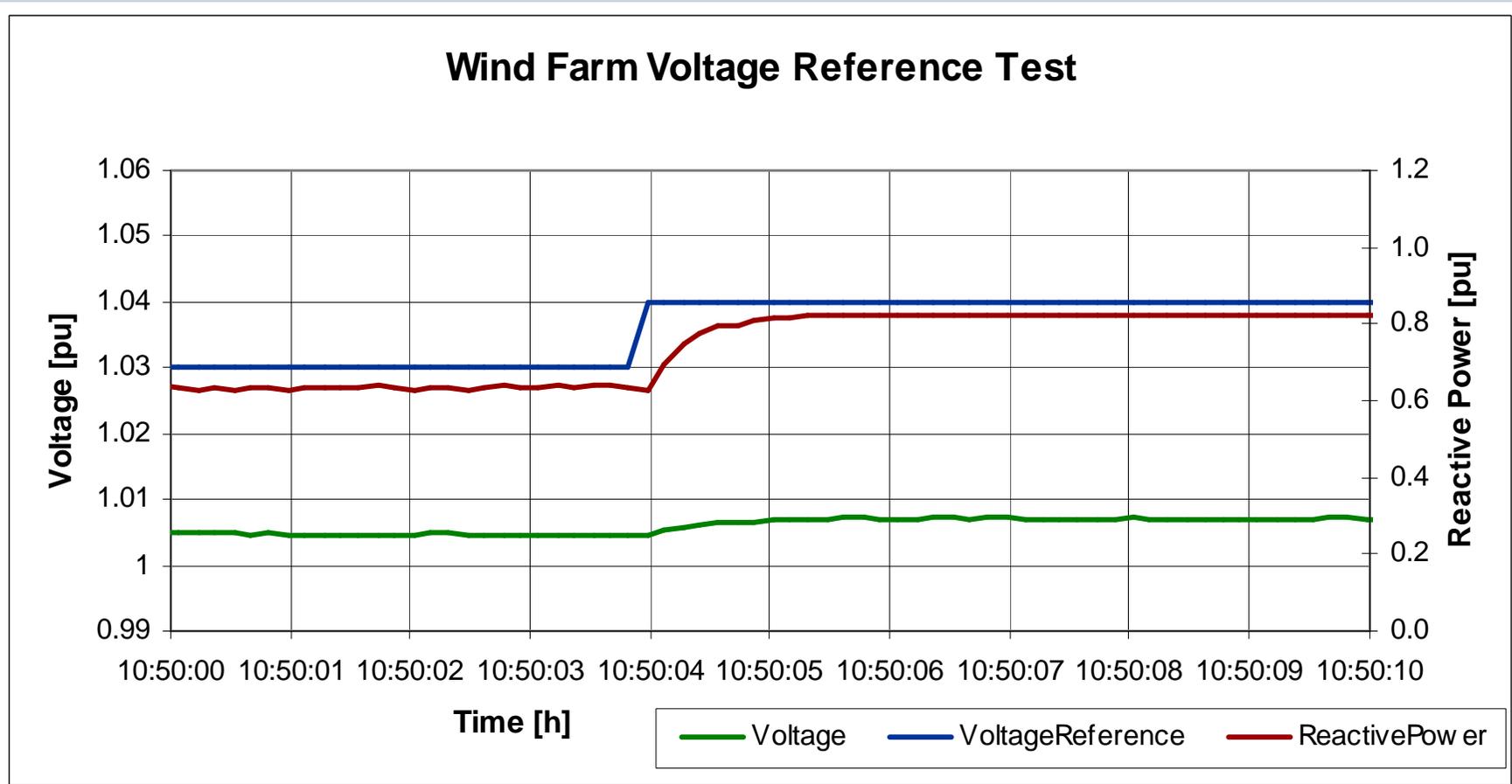
Kp :	600	[0/00 / p.u.]	Edit
RateNeg :	1000000	[0/00 / s]	Edit
RatePos :	1000000	[0/00 / s]	Edit
Ti :	2	[s]	Edit
Droop Compensation :	Yes		Edit
Droop Gain :	0.04	[p.u. / p.u.]	Edit
Rated Reactive Power :	8	[MVar]	
Rated Connection Point Voltage :	33000	[V]	
Turbine Voltage Min :	950	[0/00]	
Turbine Voltage Max :	1050	[0/00]	
Voltage Reference :	1	[p.u.]	

Droop of 4 %



Recommended Droop of 2% to 7%

Voltage control – response to change in reference



Voltage control test (V in blue, Q in red)

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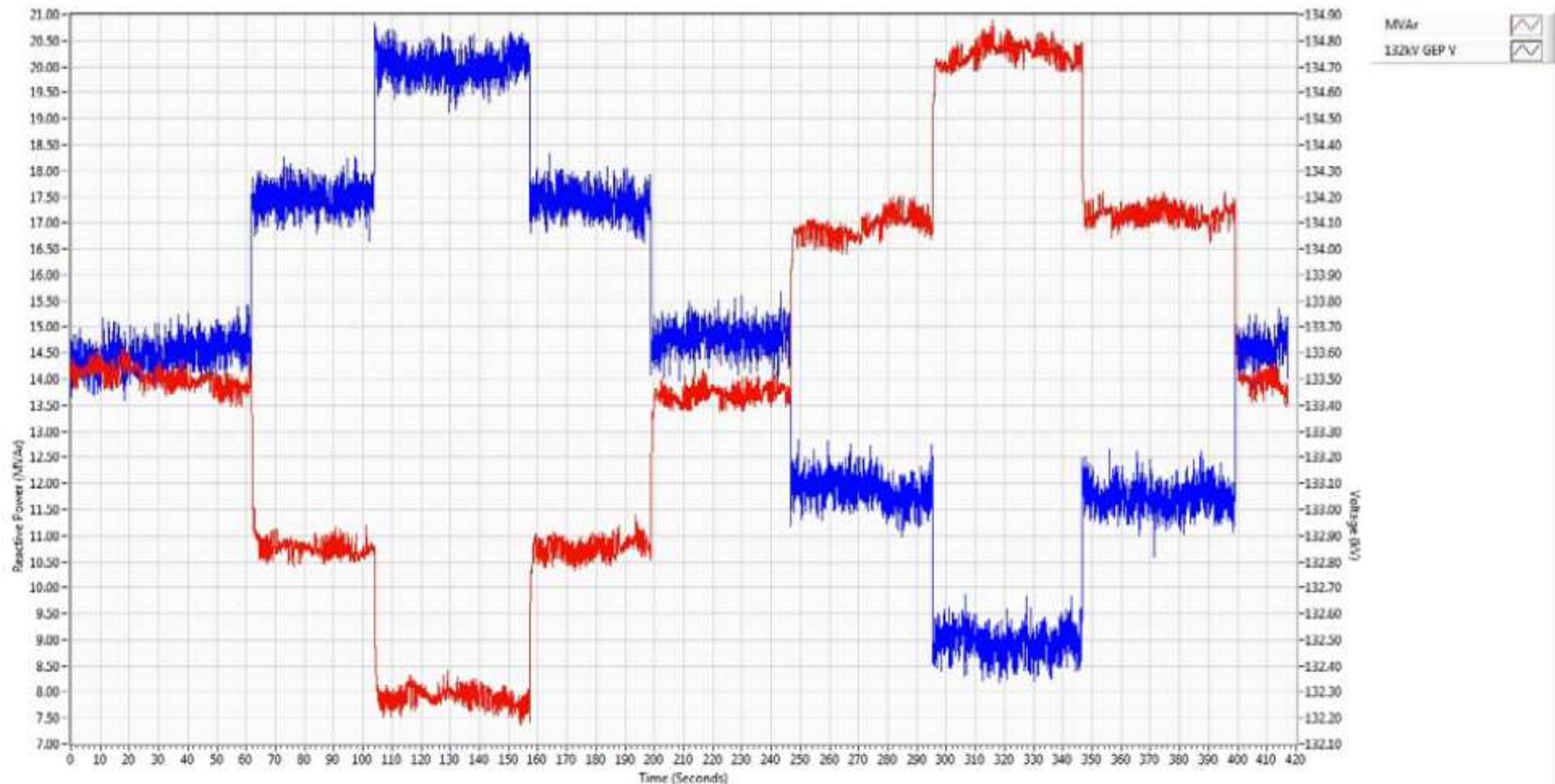


Figure 5 – Exported MVar and 132 kV voltage for 275 kV to 132 kV transformer tap changes

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Summary – How Siemens WTGs provide Power Control **SIEMENS**

(existing and anticipated)

<i>Capability</i>	<i>Now</i>	<i>Soon</i>
Voltage Regulation with reactive droop		
Medium Voltage		
Transmission Voltage		
Reactive Power Control		
Power Factor Control		
Reactive Control without Active Power		
Zero-droop voltage regulation		
Capacitor switching in park controls		
Line drop compensation		

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Questions?



Thank You!

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