

Smart Voltage Reduction

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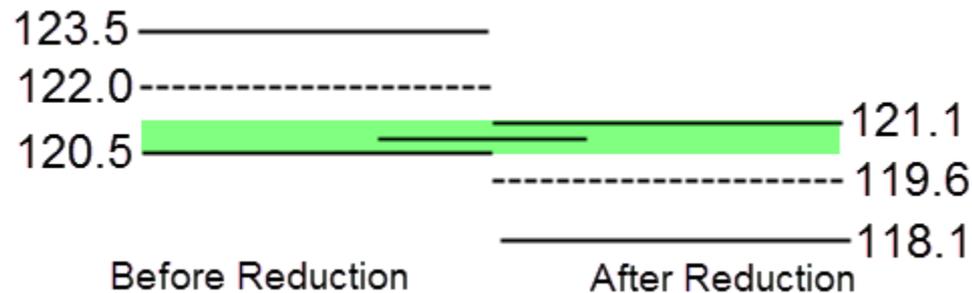
Beckwith Electric Company

Voltage Reduction in Modern Controls

- Voltage Reduction now changes bandcenter to induce controls to lower voltage instead of increasing sense voltage
- When control is required to reduce voltage upon entering voltage reduction, there is no time-delay.
- Because bandcenter is being altered, entering reduction does not always reduce voltage

Voltage Reduction

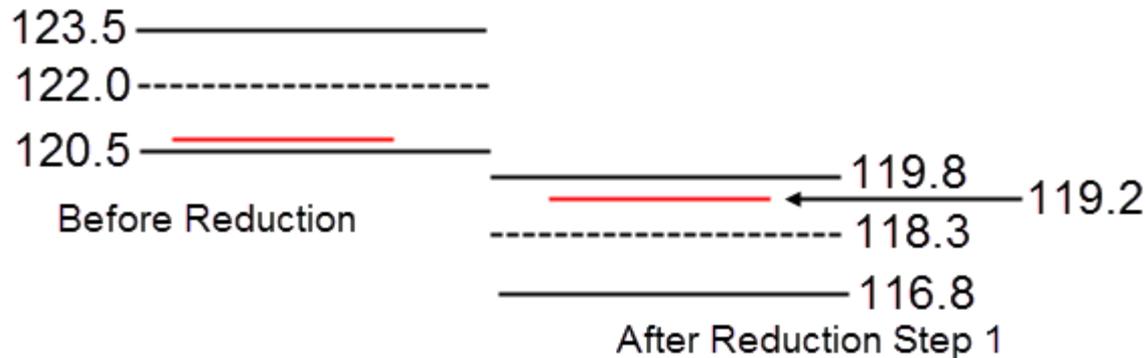
- Control set to Bandcenter of 122 with Bandwidth of 3
- Apply 2% reduction
 - $122 - 122 \cdot .02 = 119.56$ or 119.6



- If voltage was 120.7 before reduction, still in band on low side, control would not call for lower as 120.7 is still within band after reduction, now on high side of bandcenter

Voltage Reduction

- Apply Step 1 reduction of 3% or go Step 1 of 5% followed by Step 1 of 3%

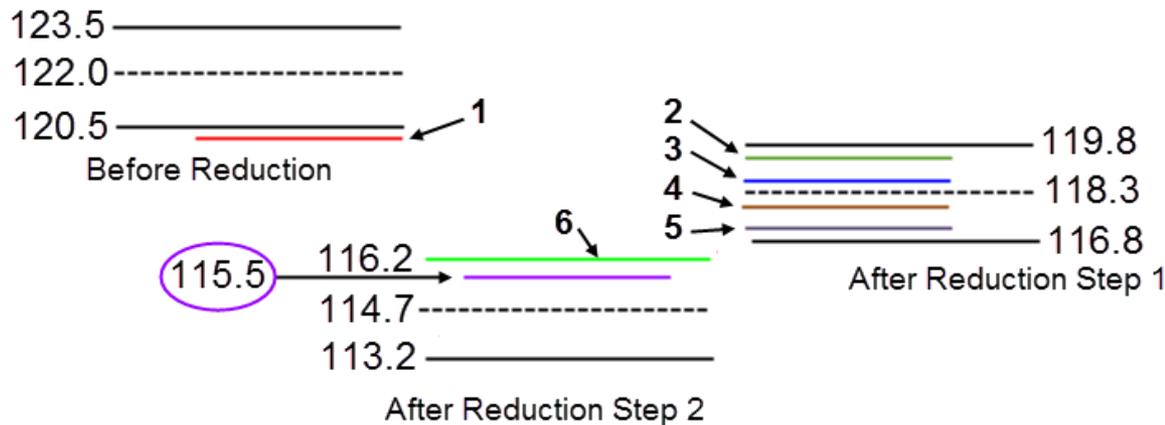


- Assuming 0.75 volts per tap, control would issue a lower to 120, a second lower to 119.2, and then would be in new band

Voltage Reduction

Apply a Step 1 reduction of 3% or go to Step 2 of 6% followed by Step 1 of 3%
Assuming 0.75 volts per tap, control would issue following commands:

- A first lower to **120**
- A second lower to **119.2**
- A third lower to **118.5**
- A fourth lower to **117.7**
- A fifth lower to **117.0**
- A sixth lower to **116.2**

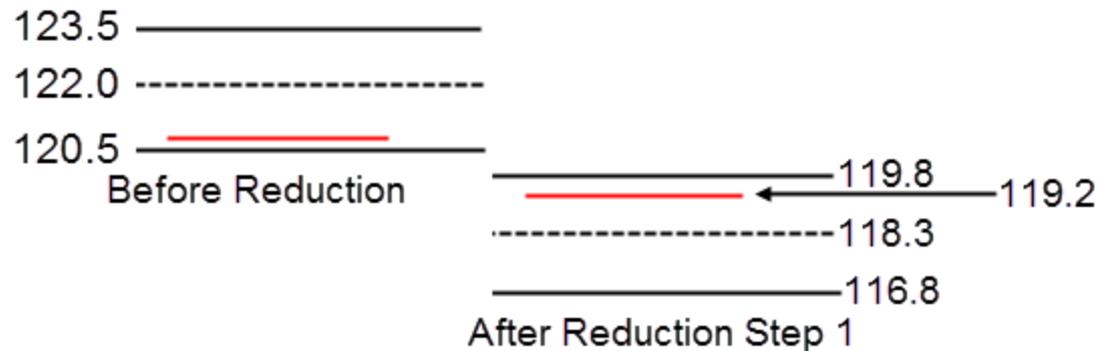


- A seventh lower of 0.75 volts, bringing voltage to new band at **115.5**

Going to Level 1 will now cause raise back to 116.2 and then another raise to 117.0

Smart Voltage Reduction Step One

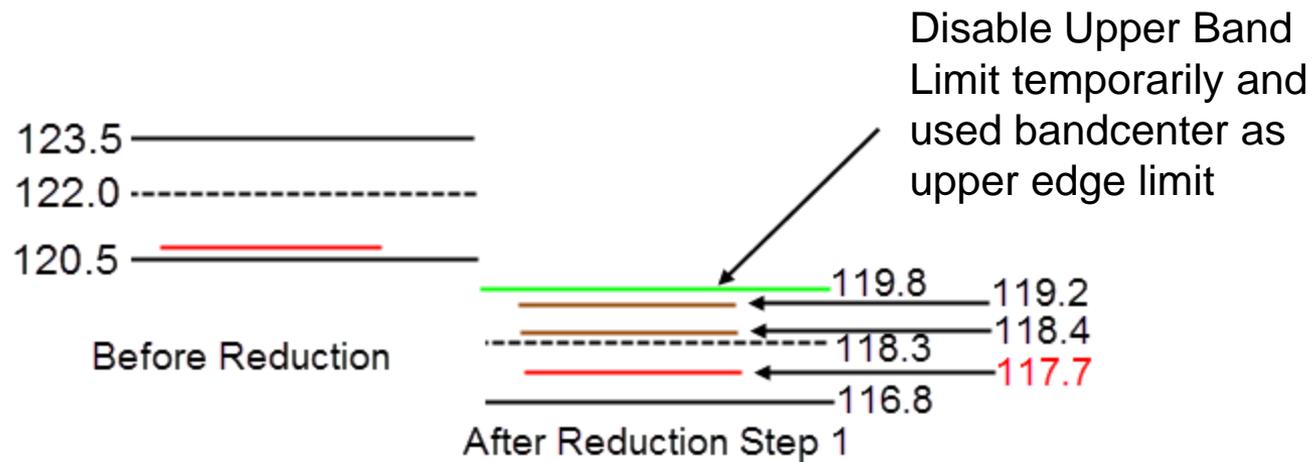
If goal of voltage reduction is to reduce voltage, voltage reduction should finish on lower end of band, not higher end



Current Way

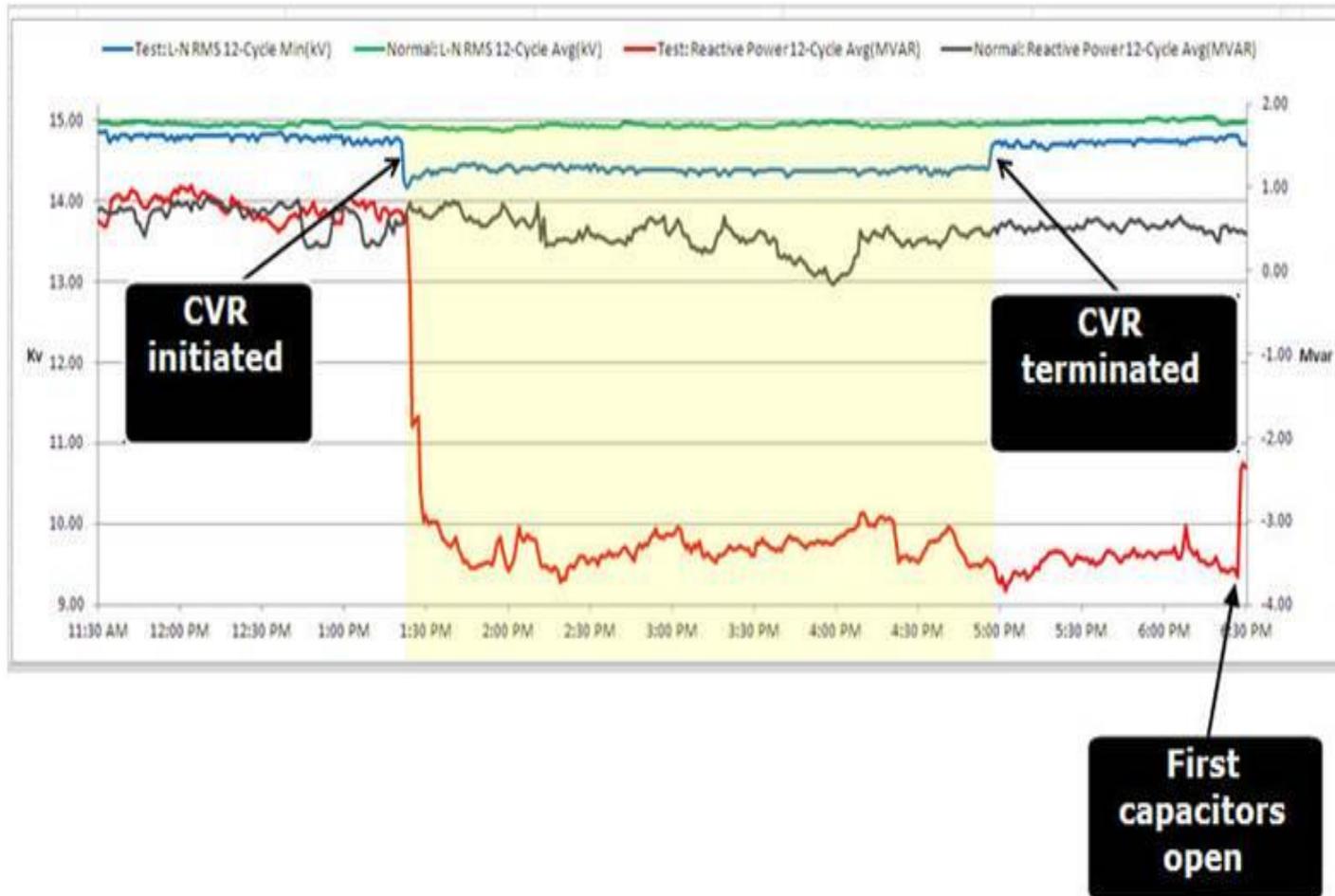
Smart Voltage Reduction Step One

If goal of voltage reduction is to reduce voltage, we want to finish reduction on lower end of band, not higher end



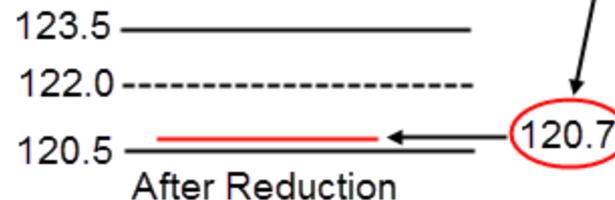
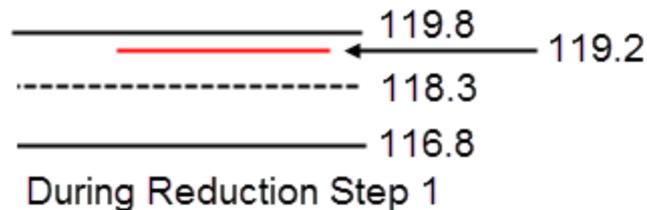
New Way

Capacitor Banks staying on too long after leaving reduction



Smart Voltage Reduction Step One

- Typically when entering reduction, all switched capacitors will close as voltage is reduced
- This may cause circuits to be leading when in reduction
- When leaving reduction, some of capacitors need to be switched off to get back to unity power factor

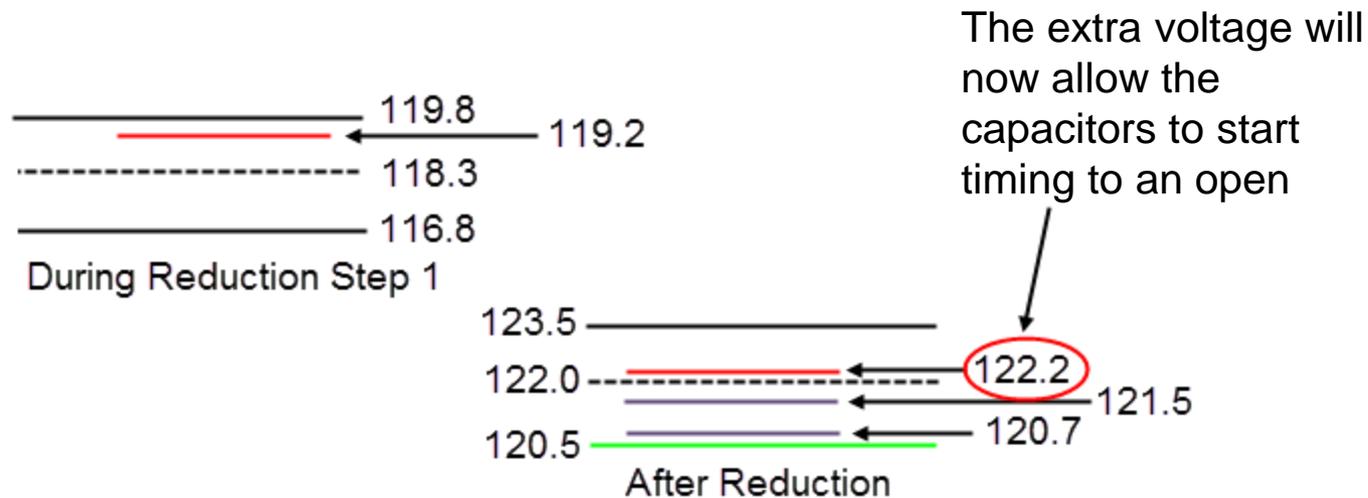


This voltage may not be high enough to have any voltage controlled capacitors induced to switch off

Old Way

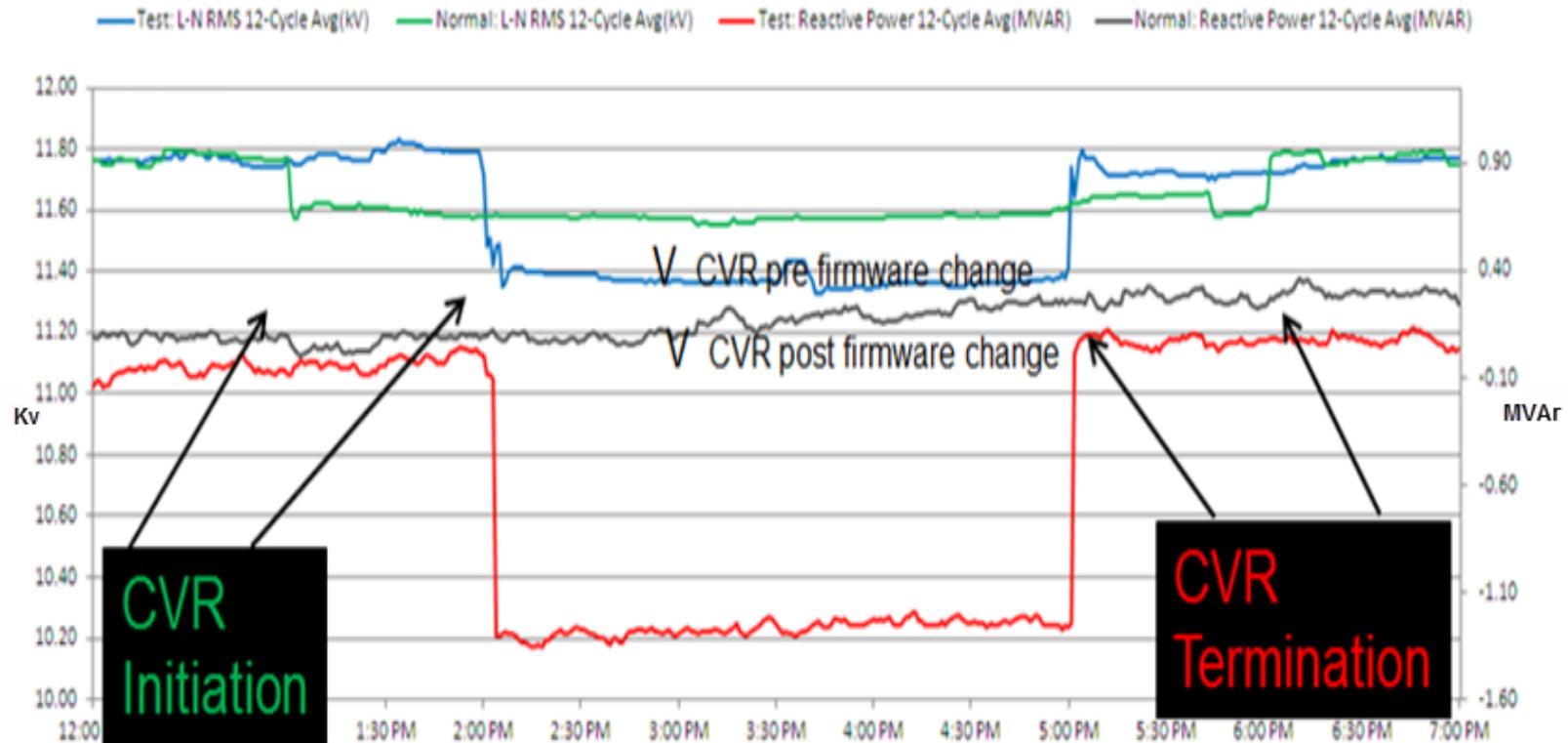
Smart Voltage Reduction Step One

- This time, lower band is temporarily disabled to force voltage to finish between bandcenter and high band edge
- Once voltage crosses bandcenter, lower band edge becomes active



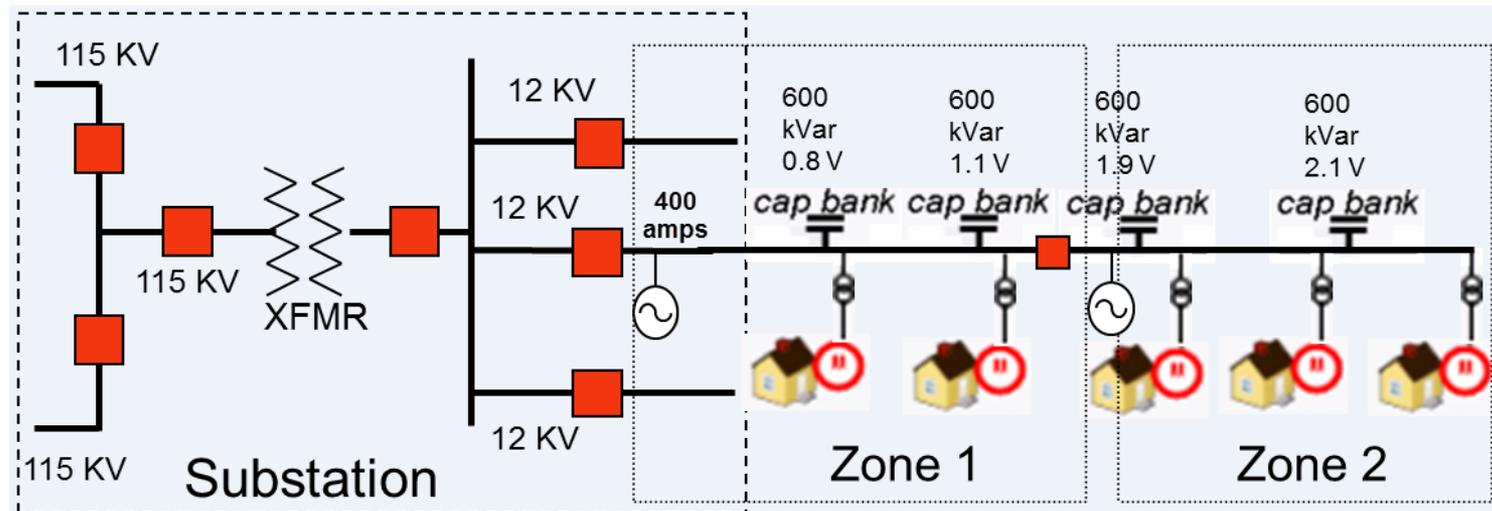
New Way

Capacitor Banks opening after leaving reduction



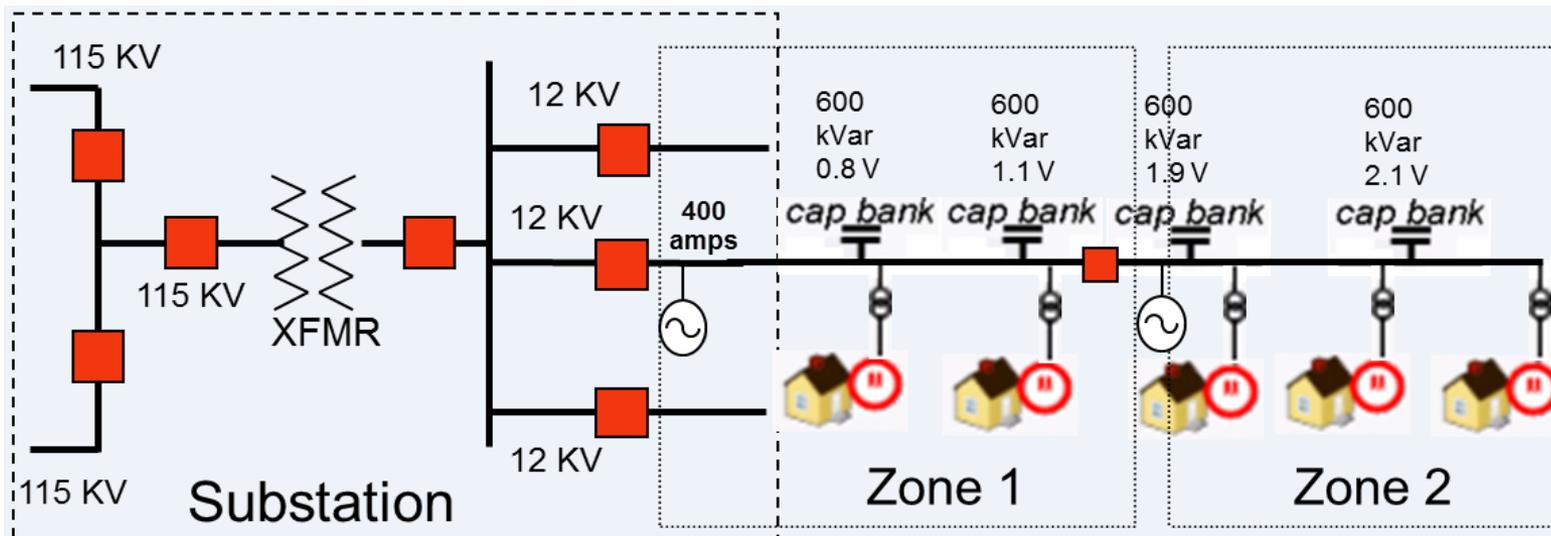
Smart Voltage Reduction Step Two

- Proper coordination with switched capacitor banks will maximize amount of reduction possible
- Majority of load on any feeder is at feeder; load drops further as distance from substation increases
- To achieve maximum benefit from voltage reduction, lowest voltage needs to be at location of highest current



Smart Voltage Reduction Step Two

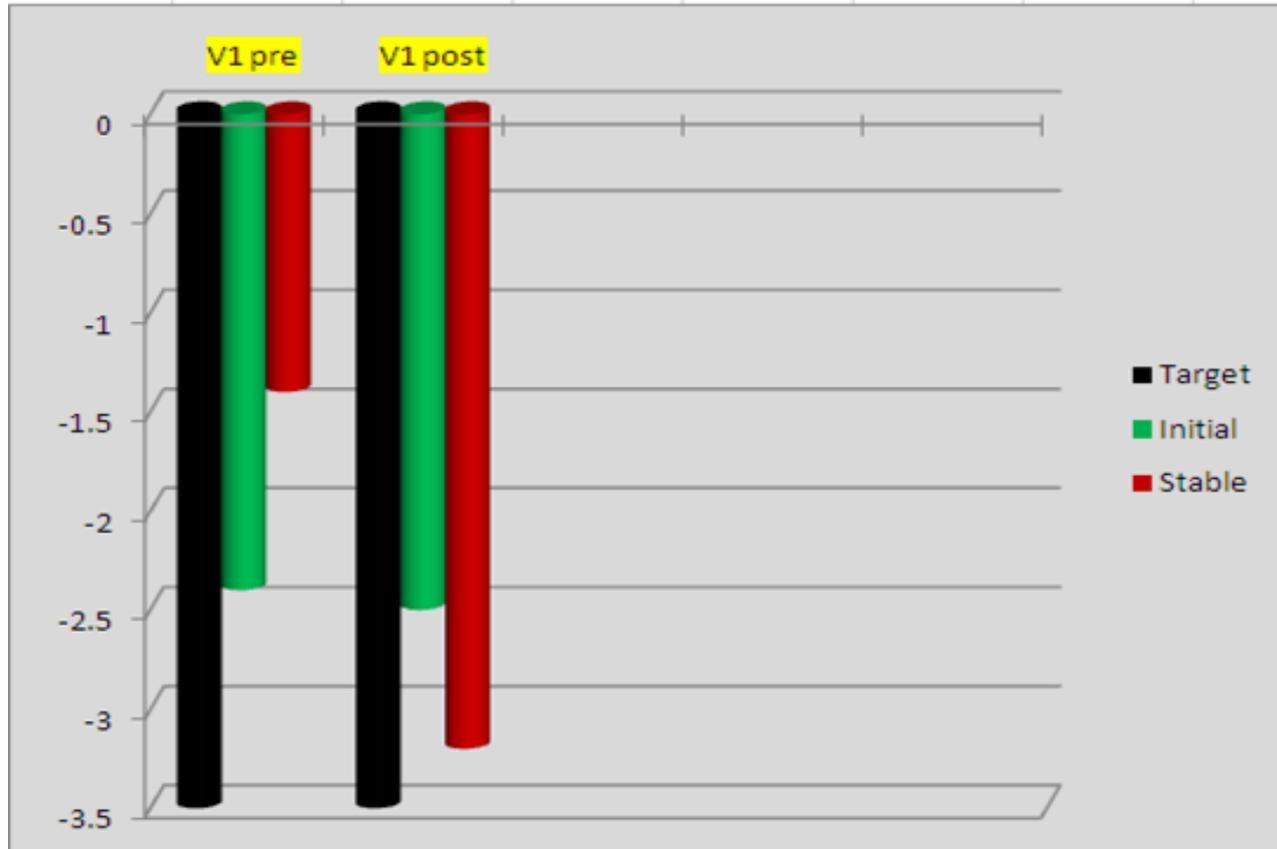
- Downstream capacitors, when closed, provide voltage support at end of circuit
- If regulator detects leading power factor, that is an indication that downstream voltage is higher than source voltage due to voltage rise of capacitor banks
- This allows regulator to reduce voltage even further



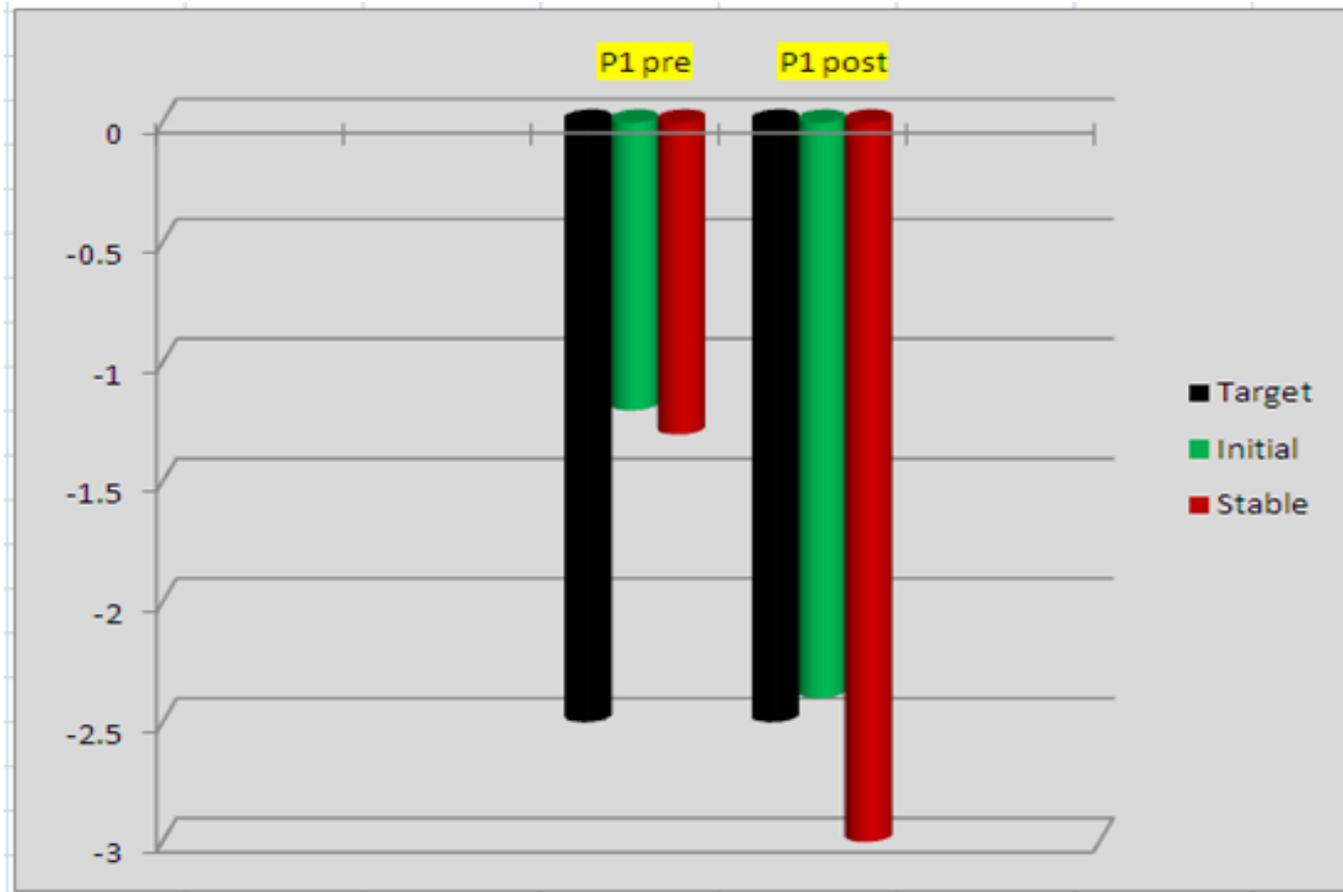
Positive Reactive Compensation

- Add setting so control uses a different value of X when in reduction
- Allows control to reduce voltage further as down-line capacitors close
- If capacitors are out-of-service, control will dynamically know not to lower voltage as much while in reduction
- No communications required

Before and After on LTC



Before and After on Feeder Regulators



Conclusion

- Step One adds to amount of reduction without need for capacitors by forcing voltage to finish in-band but between center and lower band, as opposed to center and higher band
- Step Two allows for even greater amounts of reduction when switched capacitor banks using voltage sensing are available
- Step Two will only reduce voltage further after capacitors close

Questions?

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