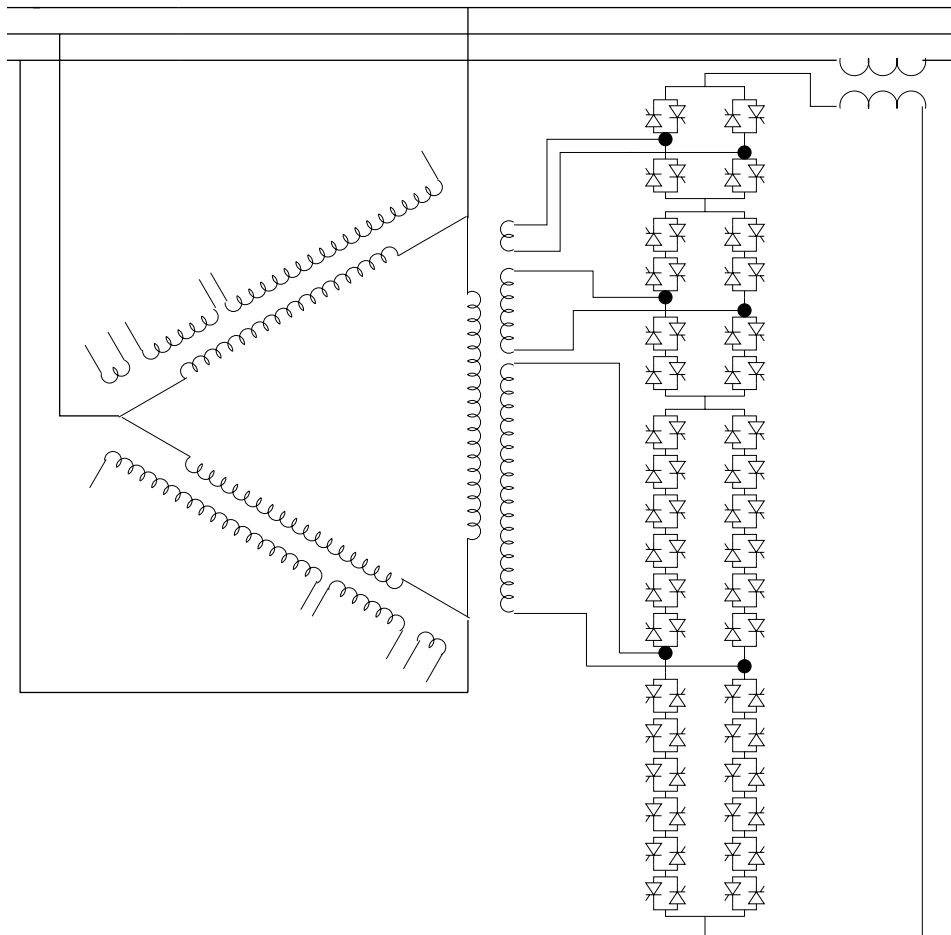
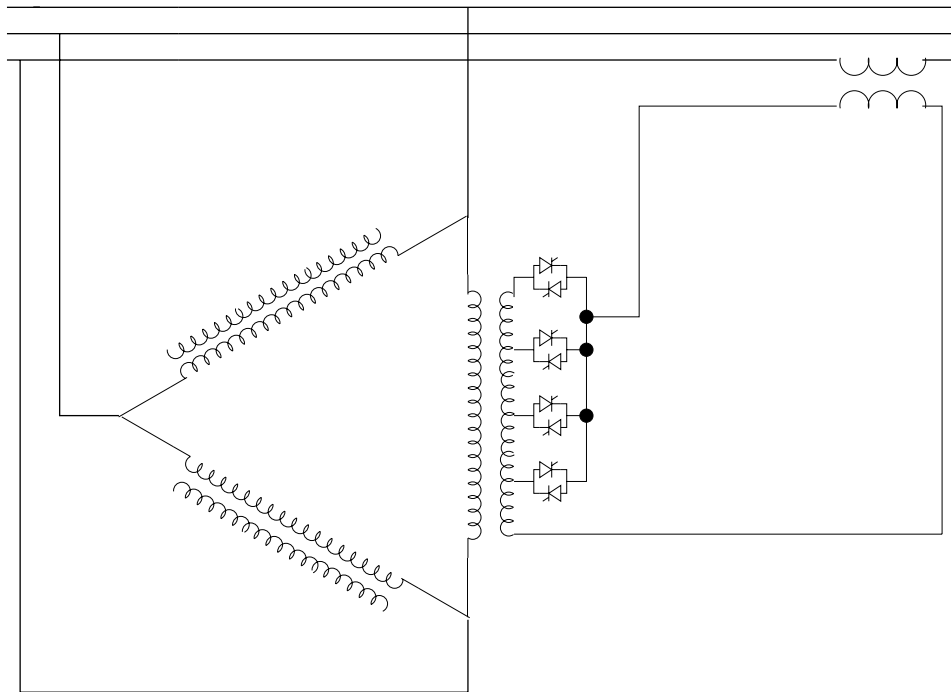


Phase Shifter Options

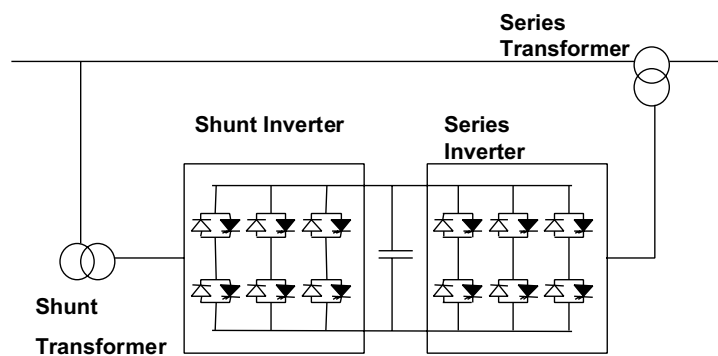
1. Phase shifting transformer with thyristors replacing switches on mechanical taps. The phase shift is varied in discrete jumps as sets of thyristors are switched on or off. The conduction angle for the thyristors will always be 180° .



2. Thyristor controlled phase angle regulator with vernier control. The thyristors are now allowed to vary the conduction angle anywhere between 0 and 180° . Now we have the added problem of harmonic generation however.

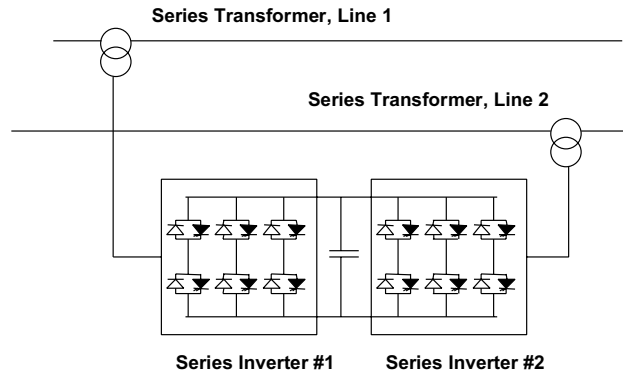


3. Unified power flow controller (UPFC). The UPFC usually consists of two voltage source converters connected to a common dc bus. One converter is shunt connected, as in a STATCOM, the other is connected through a series transformer as in an SSSC. The common dc bus allows the ability to circulate power between the converters, allowing the series converter to inject a voltage at an arbitrary phase angle. The UPFC is essentially a phase shifting transformer with the power converters replacing the taps.



4. Interline power flow controller (IPFC). The IPFC usually consists of one or more voltage source converters, connected into one or more ac lines. All of the converters share a common dc bus. One

option is to have one of the VSC's shunt connected and the rest series connected. Another is to have all of them series connected. In either case, it is possible to control the series converters to inject a series voltage with an arbitrary phase angle as in a phase shifter.



5. Hybrid phase shifter. The hybrid phase shifter can be based on a combination between a conventional phase shifting transformer and a power electronic based phase shifter. One option is to replace the connections to one of the winding segments with a PWMAC converter, and injecting the voltage from that in series with the voltages from the conventional taps. The PWMAC converter will allow continuous range of operation between the fixed taps.

