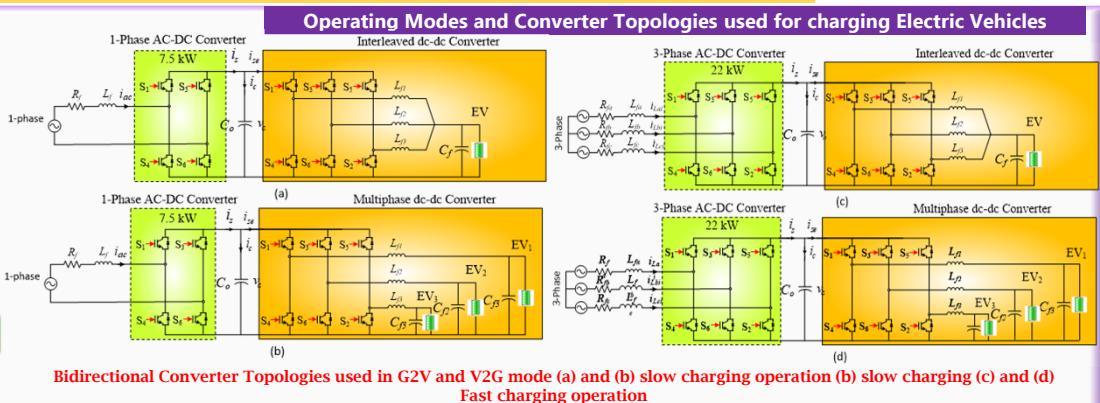
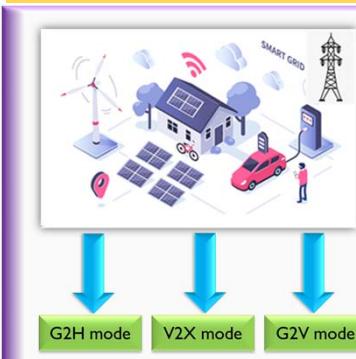


Abstract: The research work deals with implementation of various chargers used for electric vehicles in the scenario of Qatar. These chargers are categorized as slow, fast and superfast chargers. The electric vehicles not only lead to reduction in carbon foot print, in addition to this, the V2X mode of operation of EVs implemented with the help of bidirectional converter is used to provide ancillary services in the system such as shaving peak and valley in load demand, frequency and voltage regulation, balances the supply and demand for active power and reactive power, compensates grid current harmonics, improve power quality, provide reactive power compensation and improve system stability. Due to above mentioned advantages, V2X mode of operation will be explored in this research work.



Modeling of 1-phase AC-DC Converter

Inner Plant Block Diagram

$$v_{ac} \rightarrow + \xrightarrow{\frac{1}{sL_f + R_f}} i_{ac}$$

Outer Plant Block Diagram

$$i_s \rightarrow + \xrightarrow{\frac{1}{sC_o}} v_o$$

Modeling of Converters

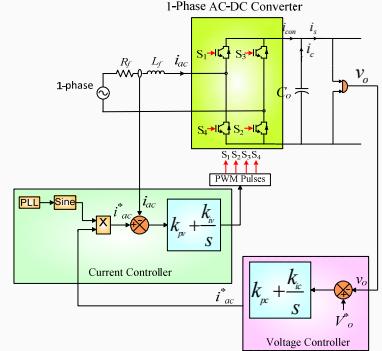
Design of Inner Loop Controllers of PWM rectifier

$$i_{ac}^{ref} \rightarrow + \xrightarrow{k_{pc} + \frac{k_{ic}}{s}} \frac{1}{1+sT_d} \xrightarrow{\frac{1}{sL_f + R_f}} i_{ac}$$

Design of Outer Loop Controllers of PWM rectifier

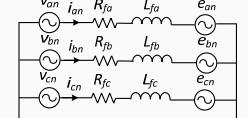
$$v_o^{ref} \rightarrow + \xrightarrow{k_{pv} + \frac{k_{iv}}{s}} x \xrightarrow{i_{ac}^{ref}} \text{Inner Current Control Loop} \xrightarrow{i_{ac}} S_{ab} \xrightarrow{i_s} \frac{1}{sC_o} \xrightarrow{v_o}$$

Control scheme of Single phase AC-DC Converter



Modeling of 3-phase AC-DC Converter

$$L \frac{d}{dt} \begin{bmatrix} i_{an} \\ i_{bn} \\ i_{cn} \end{bmatrix} = -R \begin{bmatrix} i_{an} \\ i_{bn} \\ i_{cn} \end{bmatrix} + \begin{bmatrix} v_{an} - e_{an} \\ v_{bn} - e_{bn} \\ v_{cn} - e_{cn} \end{bmatrix}$$



$$L \frac{d}{dt} \begin{bmatrix} i_d \\ i_q \end{bmatrix} = \begin{bmatrix} -R & -\omega L \\ \omega L & -R \end{bmatrix} \begin{bmatrix} u_{di} \\ u_{qi} \end{bmatrix}$$

Outer Plant Block Diagram

$$u_d \rightarrow + \xrightarrow{\frac{1}{sL_f + R_f}} i_d$$

$$u_q \rightarrow + \xrightarrow{\frac{1}{sL_f + R_f}} i_q$$

Design of Inner Loop Controllers of PWM rectifier

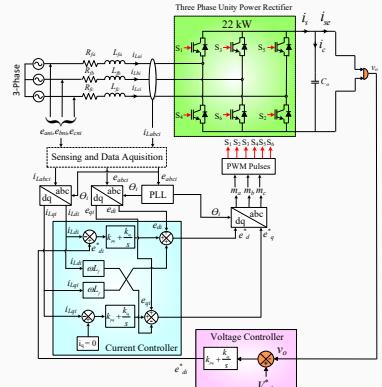
$$i_d^{ref} \rightarrow + \xrightarrow{k_{pc} + \frac{k_{ic}}{s}} \frac{1}{1+sT_d} \xrightarrow{\frac{1}{sL_f + R_f}} i_d$$

$$i_q^{ref} \rightarrow + \xrightarrow{k_{pc} + \frac{k_{ic}}{s}} \frac{1}{1+sT_d} \xrightarrow{\frac{1}{sL_f + R_f}} i_q$$

Design of Outer Loop Controllers of PWM rectifier

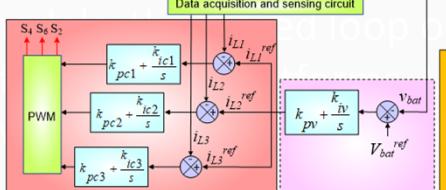
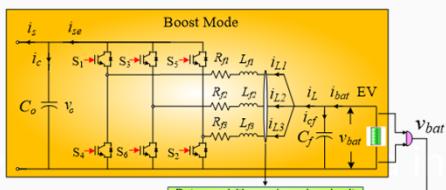
$$v_o^{ref} \rightarrow + \xrightarrow{\text{Outer voltage Controller}} i_d^{ref} \rightarrow \text{Inner Current Control Loop} \xrightarrow{i_d} S_{ab} \xrightarrow{i_s} \text{Outer Plant} \xrightarrow{v_o}$$

Control scheme of three phase AC-DC Converter

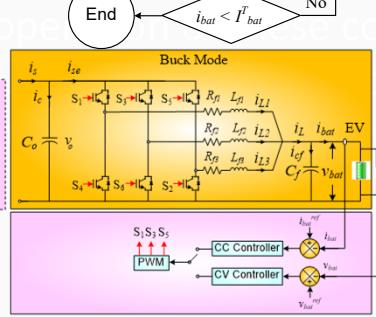
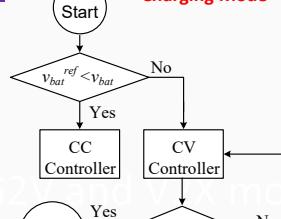


Modeling of Interleaved DC-DC Converter

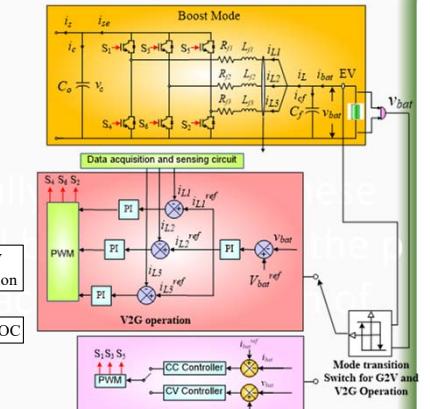
Discharging Mode



Charging Mode



Operation of System in G2V and V2G mode



Conclusion: The modeling of the various converter used in G2V and V2X mode is successfully carried out. Using these models, the closed loop operation of these converters will be studies with the help of simulation platforms. Using these simulations, the ancillaries services provided by the system will be implemented.