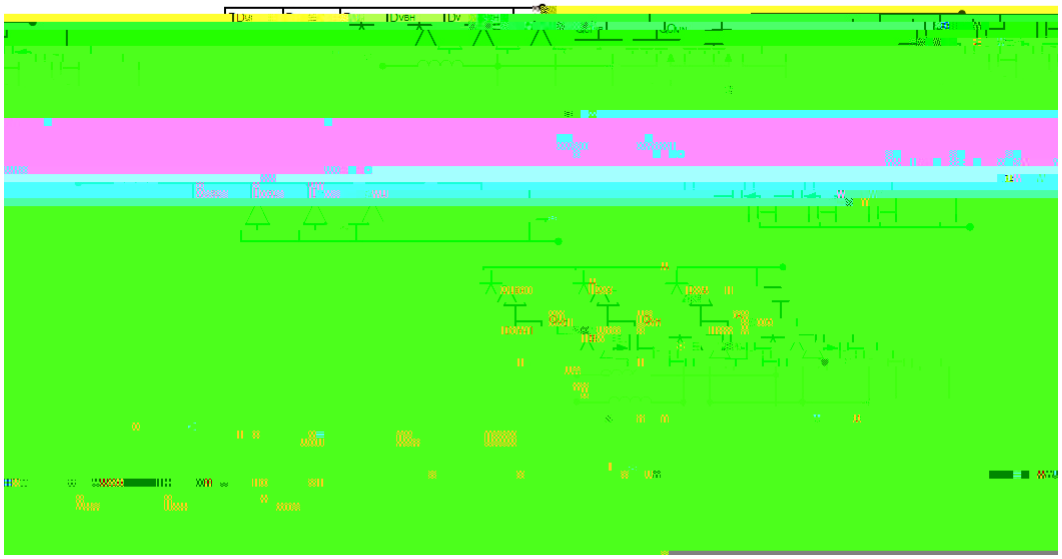

Figure 2. Typical Three−Phase Power Factor Correction (PFC) Boost Topologies for Fast DC EV Charging. T−NPC (top left), 6−switch (top right) and I−NPC (bottom)

An additional important factor that will influence the design and the voltage rating of the power devices is the number of levels in the architecture. The 6−switch topology is a 2−level architecture, normally implemented with 900 V or 1200 V switches for fast DC EV chargers. Here SiC MOSFET modules with low RDSon (6 − 40 mΩ) are a preferred solution, especially for higher power ranges above 15 kW per block.

Such integrations exhibit a superior power performance than discrete solutions, increasing

benefits. Firstly, it tends to keep the Electromagnetic Interference (EMI) spectrum of the converter tighter than in FM systems. Furthermore, the behavior of the system at low loads is easier to address with a fixed switching frequency.

Topology Variations

Multiple variants for the discussed topologies exist, bringing additional advantages and compromises. Figure 7 shows a common alternative of the full bridge LLC converter used for fast DC EV charging. In the phase−shift, the switches are under half of the input voltage and 600 V and 650 V break−down voltage devices are used. 650 V SiC MOSFETs, 650 V SuperFET3 Fast Recovery (FR) MOSFETs and 650 V FS4 IGBTs will help address different system requirements. Similarly, diodes and rectifiers for the primary side need blocking voltage ratings of 650 V. This 3−level architectures allow for a unipolar switching, which contributes in reducing the peak current and current ripples, which will results into a smaller transformer. One of the main downsides of this topology is the additional complexity level that the control algorithm requires, compared to 2−level version with fewer power switches. The DAB as well as the can easily be connected in parallel or stacked both on the primary side and on the secondary side to best suit the current and voltage needs of the fast DC EV chargers.

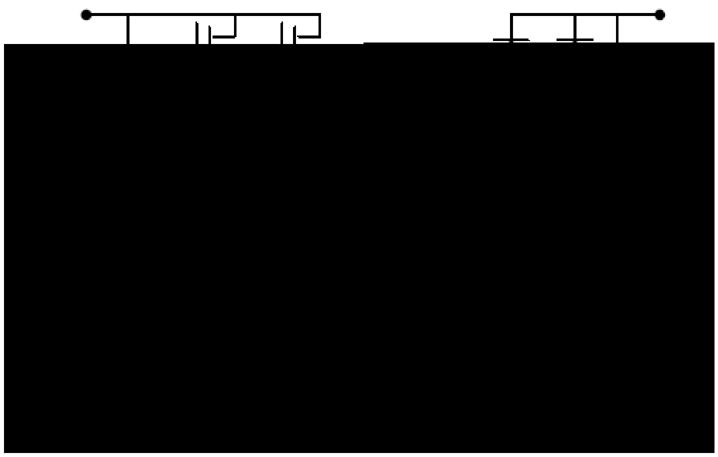

Figure 7. 3−Level Full Bridge LLC. This Variation is Stacked on the Primary Side

(only a half of the input voltage is applied to each transformer) and connected in parallel on the secondary side.

Secondary Side Rectification

Regarding the secondary rectification stage multiple solutions are possible as see in Figure 6 and all could be used with different topologies. For 400 V and 800 V battery levels and full−bridge rectification, the 650 V and 1200 V SiC Schottky diodes typically bring a unique performance−to−cost solution. Due to their zero reverse recovery characteristic, these devices significantly enhance rectification performance and efficiency compared to silicon−based alternatives, drastically reducing losses and the complexity of the rectification stage. Silicon−based diodes such as the HyperFast, UltraFast and Stealth could serve as an alternative in very cost constraint projects at the expenses of performance and complexity. Solutions with center−tap rectification (Figure 6) are not convenient for high voltage output rectification stages. Unlike in full−bridge rectification, where diodes withstand a reverse voltage equal to the output voltage, in center−tapped configurations the diodes withstand two times this