IGBT Cold Plate Design & AC-DC Converter Packaging

Objective / Client Requirement:

- Design three converter models of varying lengths and IGBT counts, along with a cold plate for cooling IGBTs that also functions as a structural member.
- Cold plate: Must be manufacturable using conventional methods while avoiding long weld joints (no FSW or bolted/welded plates).
- Each IGBT dissipates 1000 W, with a maximum coolant temperature rise of ≤5 °C per inverter (when connected in series).
- Enclosure: Must be IP69-rated, securely mounting and supporting all converter components.

Approach:

- Proposed multiple design options, including:
  - Extruded cold plate channels with various cross-sections and flow diverters to create a zig-zag coolant path for improved heat transfer.
  - Cold plate with heat pipes, using bent copper tubes press-fitted into the plate.
  - Cold plate with copper coolant tubes directly press-fitted into the plate.
- Engaged with the client to review circuit diagrams, operating currents, and voltages of components to strategically position interconnected components, reduce copper length, minimize EMI, and improve DFA and maintenance access.
- Selected aluminum casting for the enclosure to meet IP69 requirements, ensuring durability and protection against water/dust ingress.

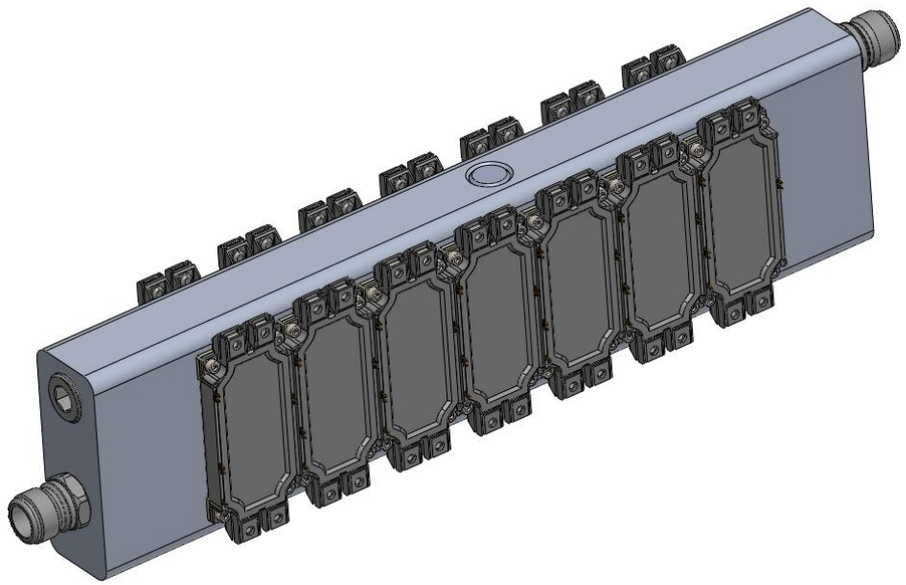
Solution:

- Developed an extrudable cold plate cross-section with machined flow diverters to create a zig-zag coolant path, improving heat transfer, eliminating long FSW welds, reducing weld joints by 60%, and improving leak-prevention and manufacturability.
- Conducted CFD analysis to validate coolant mass flow, Achieved ≤5 °C rise/converter (when connected in series) and 20% lower pressure drop.
- Designed laminated copper busbars, reducing length by 22% through optimized component placement and part commonization across variants. Minimized EMI by separating low and high voltage circuits.
- Lowered tooling cost by ~30% by implementing stackable clip-on plastic components adaptable across all converter models.
- Created an IP69-rated aluminum-cast enclosure to house capacitors, sensors, and other components, and performed modal analysis to ensure structural integrity.

My Role:

- Conceptualized design, created CAD models, and prepared GD&T drawings while collaborating with the client.
- Performed calculations for coolant flow rate, heat transfer, pressure drop, and busbar design.
- Conducted CFD thermal and free-free modal analysis to evaluate thermal and structural performance.
- Applied DFMA principles to streamline manufacturing and assembly.

- **Cold Plate For cooling IGBT :**



- **Ac to DC Converter:**