Controlled Power Technologies

COBRA FC
Water Cooled Electric Compressor
(Fuel Cell Air Supply)
COBRA (Controlled Boosting for Rapid response Applications) is a water cooled Switched Reluctance Motor (SRM) directly driving a compressor impeller. COBRA FC uses electrical energy generated by the Fuel Cell to supply air at a prescribed pressure to the Fuel Cell. The motor technology includes an integrated digital controller and has a low rotor inertia which allows rapid acceleration and excellent dynamic response.

Many motive power Fuel Cells typically require a specific flow of air as the essential oxidant in the Fuel Cell electro-chemical reaction. This has to be delivered continuously at a set pressure point to achieve the desired Fuel Cell system performance. COBRA's controllability and capability of quasi-continuous operation at high pressure and variable flow rates makes it the ideal match for a range of Fuel Cell applications.
Specification

Based on a 6/4 Switched Reluctance Motor (SRM)
- Standard C88 compressor for Fuel Cell applications. Other designs include C70 and C80 (see COBRA Product Brochure)
- Bespoke impeller designs for specific flow rates / pressure ratios feasible
- Range of voltage – 12V/24V/48V (custom electrical configurations can be considered)
- Flexible mounting strategy - Fuel Cell or structure mounted
- Designed to meet relevant ISO test standards

Liquid-Cooled System
- Extends duration of higher power events
- Provides a stable environment for power silicon devices
-Eliminates dirt and water ingress to rotor unlike traditional air cooled devices
- Simpler packaging without the need to seek cool air from the front of the vehicle
- Integrates to Fuel Cell coolant circuit
- No maintenance ‘sealed for life’ bearings

Low Inertia and High Speed
- Rapid transient response
- Controllable energy usage

Integrated Control & Power Electronics
- All electronics assembled into a sealed housing on the rear of the machine
- Significantly reduced electrical losses and improved EMC
- Monitors and controls against over speed & over temperature operation
- Communicates with vehicle and/or Fuel Cell systems over CAN
Benefits & Performance

Compact Design

- Single integrated unit incorporating all control and power electronics
- Direct drive of impeller
- Water cooled for thermal management

Fully Controllable

- CAN control protocols
- Integrates readily into a vehicle and/or Fuel Cell control system
- Readily controlled load and pressure variables

Acceleration to full speed:

- C88 – <997ms 70,000 RPM

<table>
<thead>
<tr>
<th></th>
<th>COBRA C88</th>
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<tbody>
<tr>
<td>Voltage Range</td>
<td>12V, 24V &amp; 48V</td>
</tr>
<tr>
<td>Peak Electrical Power</td>
<td>3.4 kW</td>
</tr>
<tr>
<td>Continuous Electric Power</td>
<td>1.4 kW</td>
</tr>
<tr>
<td>Peak Pressure Ratio</td>
<td>1.78</td>
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<tr>
<td>Peak Mass Air Flow</td>
<td>72 kg/h</td>
</tr>
<tr>
<td>Peak Compressor Speed</td>
<td>70,000 RPM</td>
</tr>
<tr>
<td>Machine Weight</td>
<td>8 kg</td>
</tr>
<tr>
<td>Machine Length</td>
<td>~ 192 mm</td>
</tr>
<tr>
<td>Power &amp; Control Electronics</td>
<td>Integrated into COBRA</td>
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</tbody>
</table>
Applications

COBRA requires power, coolant and CAN connections only. Sealed bearings provide flexible packaging solutions and less complex system integration.

One of the key elements for Fuel Cell operation is a controllable supply of air. COBRA is ideally suited to provide this requirement from a single compact and easy to integrate unit. This technology has been successfully applied to a number of PEM (Proton Exchange Membrane) Fuel Cells. It is also ideal for SOFC (Solid Oxide Fuel Cell) or any device requiring a continuous air supply. Currently, an air pressure ratio of up to 2:1 can be achieved at a flow rate of up to 0.027kg/s. The electrical power required to deliver this is less than 4kW. Development is on-going for higher pressure and flow variants.
COBRA FC Water Cooled Electric Compressor

COBRA C88

C88 – High pressure ratio, low flow. Applications Include:

- Fuel Cells
- Exhaust after treatment systems
  - post-DPF/SCR, EGR
- Air pressure up-lift

![Graph showing RPM vs Mass Flow kg/s for different lines: 3.5kW Line and 2.0kW Line.]
Founded in 2007, UK-based clean-tech developer Controlled Power Technologies (CPT) was acquired by Federal-Mogul Powertrain in 2017. The CPT product range with innovative electrification and hybridization systems enables the development of reduced-emissions powertrains with: 12V, 24V and 48V electric motor-generators for stop-start and mild hybridization applications, exhaust-driven electrification technologies, combustion engine e-boosting and fuel cell e-compressors.

As one of two independent divisions that constitute Federal-Mogul LLC, Federal-Mogul Powertrain designs, develops and manufactures original equipment engine components and sealing and systems protection products. Federal-Mogul Powertrain is committed to delivering superior quality through innovation and engineering excellence enabled by cutting-edge proprietary technologies. The division works in partnership with its customers to meet increasingly demanding targets for fuel economy and emissions performance without compromising affordability or reliability. As one of the leaders in the passenger car, light commercial, heavy-duty and off-highway markets, Federal-Mogul Powertrain also supplies related technologies to the power generation, aerospace, marine, rail and industrial sectors.