Controlled Power Technologies

COBRA
Water Cooled Electric Supercharger
COBRA (Controlled Boosting for Rapid response Applications) is a liquid cooled Switched Reluctance Motor (SRM) directly driving a compressor impeller. It uses stored electrical energy ideally harvested by regenerative braking to increase the supply of air to an internal combustion engine (ICE). The motor technology has a low rotor inertia which allows rapid acceleration and excellent dynamic response.

It supplies instantaneous on-demand air and is an enabling technology for a number of CO₂ and emission reducing air loop solutions for ICEs. Its rapid response and dynamic control also improves air-fuel ratio control, avoiding transient smoke limits and reducing smoke opacity.

The increased airflow delivered by COBRA can also improve engine response times and the use of liquid cooling for the motor and power electronics extends the duration of boosting events. These features support both engine down-sizing and down-speeding strategies.
Specification

Based on a 6/4 Switched Reluctance Motor (SRM)

- Range of standard compressors and volutes – C70, C80 & C88 (see ‘Fuel Cell’ 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 installation strategy - can be chassis or engine 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
- Simpler packaging without the need to seek cool air from the front of the vehicle
- Integrates to main engine coolant circuit (e.g. 90°C @ 6 l/min)
- No maintenance ‘sealed for life’ bearings

Low Inertia and High Speed

- Rapid transient response
- Energy usage can be optimised

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 control systems over CAN
Benefits

Engine Down-Sizing
• Maintain or increase transient torque availability
• Enables fuel economy improvements with smaller engine
  (eg: 6 cylinder to 4 cylinder)
• Addresses packaging constraints
• Improved air delivery control and less complex mechanical
  installation than multi-stage turbocharger and other sophisticated
  mechanical turbocharger solutions
• Potential 10-15% fuel economy benefit

Engine Down-Speeding
• Maintain or increase transient torque availability
• Alternative gear shift strategies for improved fuel economy
  (eg: bus automatic transmission)
• Potential 5% fuel economy benefit

Increased Performance
• Supports use of engine in diverse applications (eg: marine)
• Supports use of engine in diverse operating environments
  (eg: altitude)

Reduced Pumping Losses
• Reduces transient load on turbocharger and therefore reduces
  back-pressure on base engine
• Potential 3-5% fuel economy benefit

Reduced After-Treatment Loading
• Increased transient air supply improves combustion, reducing
  particulate emissions and associated loading on after-treatment
  system
• Enables reduced after-treatment system size and cost
• Extends service interval and reduces operating costs

Advanced Air Loop Concepts
• Enables pumped EGR system to support use of EGR over an
  extended engine speed range
• Supports cost effective after-treatment solution

Installation
• Electrical, coolant and CAN connections only
• Sealed bearings mean less complex system integration
Specific performance requirements can be achieved with alternative impeller designs, electromagnetic or electronic configurations and different control strategies and/or calibrations. The following data is typical within a similar mechanical and electronics package.

Acceleration to full speed:

- C80 – <350ms to 47,000 RPM,
  <650ms 54,000 RPM
- C70 – <450ms 70,000 RPM

<table>
<thead>
<tr>
<th></th>
<th>COBRA C70</th>
<th>COBRA C80</th>
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<tbody>
<tr>
<td>Voltage Range</td>
<td>12V, 24V &amp; 48V</td>
<td></td>
</tr>
<tr>
<td>Peak Electrical Power</td>
<td>8 kW</td>
<td></td>
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<tr>
<td>Continuous Electric Power</td>
<td>2.4 kW</td>
<td></td>
</tr>
<tr>
<td>Peak Pressure Ratio</td>
<td>1.43</td>
<td>1.38</td>
</tr>
<tr>
<td>Peak Mass Air Flow</td>
<td>425 kg/h</td>
<td>650 kg/h</td>
</tr>
<tr>
<td>Peak Compressor Speed</td>
<td>65,000 RPM</td>
<td>52,000 RPM</td>
</tr>
<tr>
<td>Machine Weight</td>
<td>8 kg</td>
<td>8 kg</td>
</tr>
<tr>
<td>Machine Length*</td>
<td>± 192 mm</td>
<td></td>
</tr>
</tbody>
</table>

*includes integrated electronics
Water Cooled Electric Supercharger Family

**COBRA C70**

- Applications Include:
  - TC or NA engines with a displacement of 2 to 7 litre
  - Mass flow range 100 – 300 kg/h

**COBRA C80**

- Applications Include:
  - As C70 but higher mass flow rates
  - Mass flow range 300 – 800 kg/h
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.