CPT SpeedTorq® is an evolution of the CPT SpeedStart® product developed to address P2, P3 and P4 driveline electrification architectures potentially in conjunction with P0 engine mounted, belt-driven integrated starter generators (see CPT SpeedStart® product brochure).

The key e-Motor features are:

- Belt / Chain / Gear / Shaft-Driven depending on installation
- Integrated control and power electronics with options for secondary device control
- Liquid cooling of motor and electronics for extended duration operation; engine coolant, secondary coolant circuit, or oil cooling possible
- Advanced control capabilities include:
  - Mild-hybrid functionality
  - Advanced torque profiles for low speed motoring
  - Torque vectoring (with secondary actuation)
Specific performance requirements can be achieved with electromagnetic or electronic configurations and different control strategies and/or calibrations. The following data is typical within a similar mechanical and electronics package.

<table>
<thead>
<tr>
<th></th>
<th>ST-POC</th>
<th>ST-NG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Voltage</td>
<td>48V</td>
<td>48V</td>
</tr>
<tr>
<td>Low Speed Motoring Torque</td>
<td>40 Nm</td>
<td>80 Nm</td>
</tr>
<tr>
<td>Continuous Motoring</td>
<td>4.0 kW</td>
<td>6.0 kW</td>
</tr>
<tr>
<td>Peak Motoring</td>
<td>7.0 kW</td>
<td>15 kW</td>
</tr>
<tr>
<td>Continuous Generating</td>
<td>5.5 kW</td>
<td>7.0 kW</td>
</tr>
<tr>
<td>Peak Generation</td>
<td>10 kW</td>
<td>20 kW</td>
</tr>
<tr>
<td>Rated Efficiency</td>
<td>80%</td>
<td>88%</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>20,000 RPM</td>
<td>15,000 RPM</td>
</tr>
</tbody>
</table>
Architectures & Applications

P1 Hybrid

P2 Hybrid
Optional second clutch to allow starter removal

P3 Hybrid
Optional second clutch

P4 Hybrid
Characteristics

Thermal Management

CPT SpeedTorq® requires liquid cooling to provide a stable thermal environment for the motor windings and electronics. Depending on the driveline architecture, different liquid coolant can be used including:

- Full functionality with engine coolant up to 105°C and progressively derated performance to 120°C
- Lower temperature coolant (e.g., integration into a power supply coolant circuit) may extend the functional performance of the unit
- Oil coolant from the transmission or axle, subject to operating condition considerations

Mechanical Integration

The modular construction of CPT SpeedTorq® facilitates integration of alternative front cover attachment locations (e.g., mounting unit to transmission or rear axle) and the use of alternative torque transmission elements including:

- Pulley and belt
- Sprocket and chain
- Splined shaft
- Shaft and gear

Depending on many engineering considerations including thermal management and electronics location / integration, full integration of the motor / generator and rotor assembly into the housing of the transmission or axle may be feasible.

Software and Control

Beyond the 48V mild hybrid functionality associated with a P0 engine mounted unit, CPT SpeedTorq® delivers 4 quadrant control (motoring and generating in clockwise and anti-clockwise direction) and smooth, low speed motoring. The low speed torque ripple effect experienced with all Switched Reluctance Motor (SRM) technologies can be controlled in CPT SpeedTorq® by current wave form control; this utilises the powerful microprocessor combined with the power electronics configuration and advanced control algorithms.

Control and Power Electronics

CPT’s control electronics include a multi-core processor to meet the most demanding control and functional safety requirements envisaged with 48V driveline electrification. Auxiliary device actuation and control is possible with additional digital and analogue signals.
Features & Modes

Generation
High power and efficient generation of continuous electrical energy over a wide speed range.

Recuperation
Recuperation is the capture of kinetic energy lost during deceleration of the vehicle. This is particularly beneficial for higher power, higher mass vehicles.
Switched Reluctance Machines (SRM) are especially suited to hybrid applications as they enable high efficiency harvesting of kinetic energy over a wide operating speed range. The advanced thermodynamic design and cooling strategy used in CPT’s e-Motor also enables high levels of recuperated energy to be harvested over extended durations, typically 20-30 seconds and on a more frequent basis compared to other e-Motor technologies.

Motoring
The high levels of recuperated energy harvested by CPT’s e-Motor can be re-used to supplement the torque output of the conventional Internal Combustion Engine (ICE) in the following ways:
• Transient torque assist:
  • Reduce fuel consumption and emissions during acceleration events
  • Enhance driveability for down-speeding / down-sizing
• Cruising / sailing
• Electric drive for e-Parking, e-Crawling, etc. with ICE declutched
• Torque vectoring (may require activation of a clutch / gear system)
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.