In addition to the characteristics evident at 12V, the focus of 48V functionality is low engine speed motoring and regenerative braking:

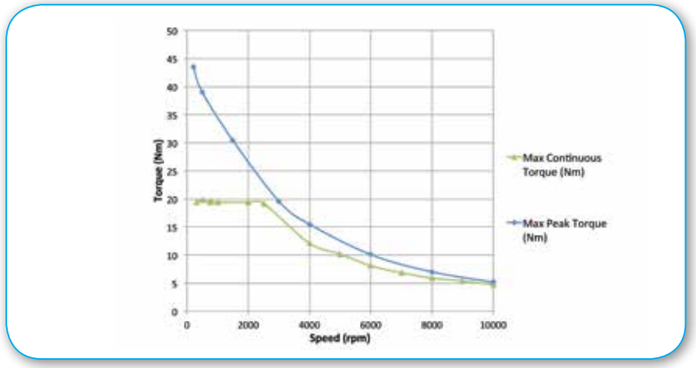
Motoring (Cranking/Boosting)

Torque assist is utilised to facilitate engine down-speeding and down-sizing. The level of continuous torque available at low engine speeds introduces all electric drive capability during parking and low speed manoeuvering.

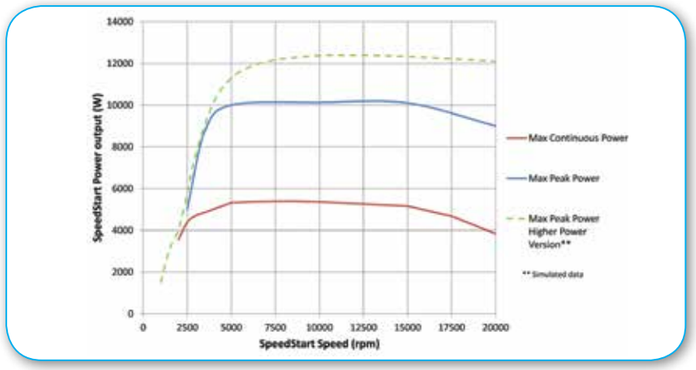
Recuperation (Regenerative Braking)

Recuperation is utilised to capture energy lost by deceleration of the vehicle.

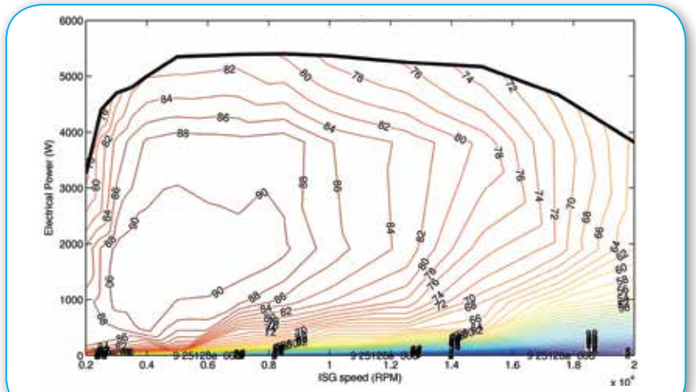
Regeneration events are typically of short duration but energy availability is very high. 48V SpeedStart offers high levels of efficiency to enable harvesting of such energy. SpeedStart's water cooling enables good thermal management, a key consideration for longer periods of recuperation.



Motoring Performance (52V)



Generating Performance



48V SpeedStart Generating Efficiency at 48 volts (%)

Controllability

The Switched Reluctance motor technology incorporated within SpeedStart offers comprehensive control capability which can be calibrated to achieve:

- Belt pre-tensioning
- E-drive
- Torque smoothing/shaping.

For further details, please email: **info@cpowert.com**

www.cpowert.com

CPT SpeedStart®

Integrated Starter Generator

Switched Reluctance (SR) Technology

CPT SpeedStart B-ISG was designed to use SR motor technology from the outset. During back to back comparisons with Permanent Magnet (PM) machines, the SR package came out on top in almost every aspect. Working with SR specialists of world class design and manufacturing experts, the motor has matured through development to a very robust automotive unit.

The SR technology offers simple motor construction, accurate control and high power density/efficiency over a wide speed range. This SR technology and innovative software controls allow CPT SpeedStart to achieve the class leading "Driver Change of Mind" and "Torque Shaping" performance. Low inertia and zero generation capability are also inherent characteristics.

CPT SpeedStart® System Description

A Belt-driven Integrated Starter Generator (B-ISG) system, including all control and power electronics in a single housing. CPT SpeedStart is a liquid cooled Switched Reluctance machine, coupled to state of the art electronics, providing premium performance with a high and efficient power output at 12V and 48V.

At 12V the CPT SpeedStart B-ISG offers excellent engine stop-start functionality featuring outstanding "Driver Change of Mind" performance, with response times less than 10ms to get 90% of maximum torque, combined with efficient power generation over the full engine speed range. At 48V the machine becomes even more capable, combining start-stop performance and efficient generation with high levels of recuperation, to recover more kinetic energy through regenerative braking, as well as higher levels of motoring performance or electrical torque assist. The level of low engine speed torque assist together with the flexible control strategy introduces possibilities for all electrical traction, or e-drive.

CPT SpeedStart	12V Performance	48V Performance
Start time to idle (750rpm)	<400ms*	<400ms*
Nominal cranking power	2.4kW	4kW
Machine stall torque (Cold)	72Nm @ -10°C	>>70Nm
Continuous generation power	2.7kW	>5kW
Peak generation power	3.0kW	8-10kW
Low engine speed generation power	2.0kW	>3.5kW
Typical generation efficiency (VDA)	80%	85%
Rotating Inertia	0.0027kgm²	
Operating Speed	2,000 - 22,000 rpm	
Liquid cooled from engine circuit	105°C**	

* *Often defined by belt and tensioner characteristic.*
** *Maximum operating temperature for full functionality.*

For further details, please email: **info@cpowert.com**

Delivering CO_2 Reduction Technologies

CPT SpeedStart® Installation

- 4 Point Straddle or Pivot mounting configuration (depending on FEAD/belt tensioning solution). Customisation possible.
- Conventional multi-rib 'poly-V' belt though many others, including toothed belt, feasible.
- 2.5 - 3.0 x belt ratio common.
- Fully integrated electronics in rear of machine.
- Simple power connection and multi pin control connection.
- Engine coolant used to cool power electronics and windings.

2.0l Gasoline with Pivot Configuration

1.4l Gasoline with fixed Pivot Configuration

Liquid Cooling

High performance requires a guaranteed cooling medium, which ducted air cannot easily achieve when ambient conditions are extreme. CPT SpeedStart uses a patented liquid cooling system that maintains the temperatures of both the motor windings and the power electronics. Liquid coolant is required from the normal vehicle cooling circuit. For full operation, the system temperature should not exceed 105°C.

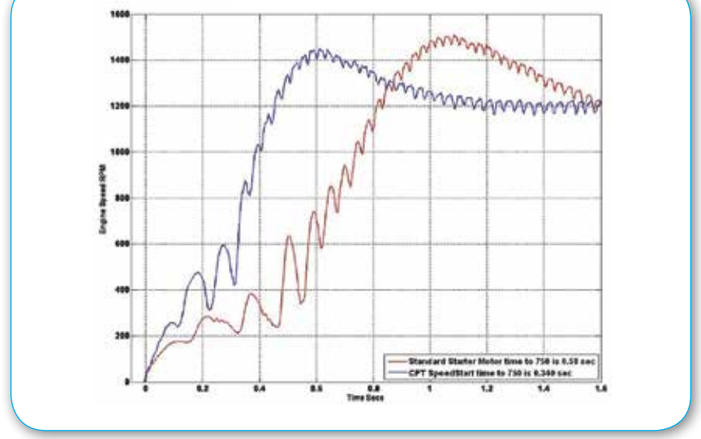
Liquid cooling offers several advantages over ducted or forced air:

- A very stable environment for power silicon devices
- Eliminates water and dirt ingress to rotor -unlike traditional air cooled alternators
- Packaging is simpler without the need to seek cool air from the front of the vehicle
- No internal fan therefore reduced windage losses and no fan noise.

12V Performance

Cranking

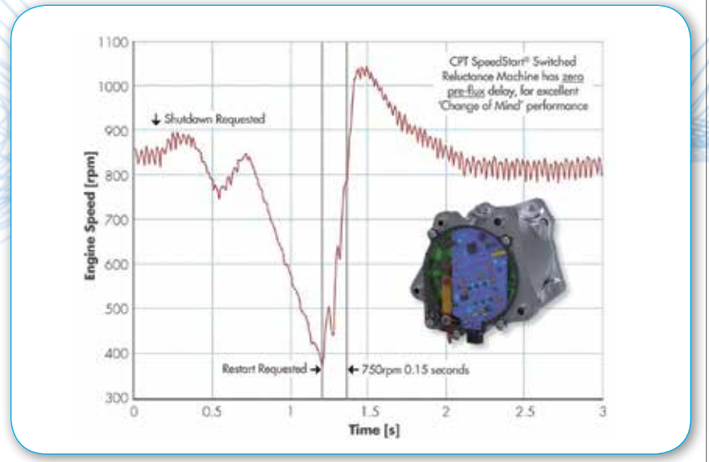
- Achieves idle speed in 0.34s compared with 0.58s with conventional starter motor (2.0l diesel without ECU synchronisation).
- Driver requires <0.4s to perceive start as "instant"
- Belt drive ensures 'comfort' start without engagement noise or harshness.



Comparison of CPT SpeedStart against Standard Starter Motor

Driver Change of Mind

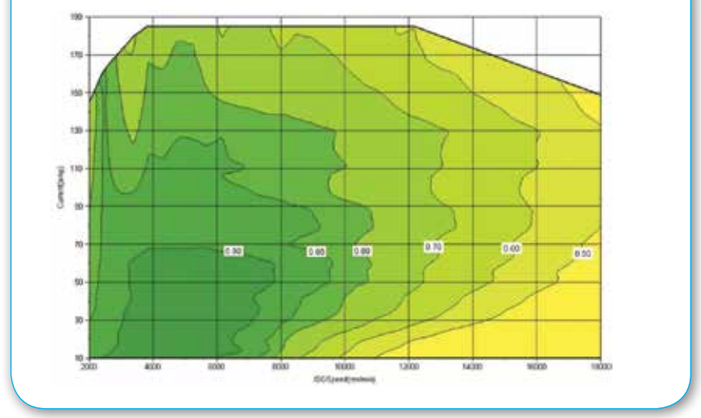
- No pinion engagement restrictions.
- Low inductance.
- No requirement to pre-flux coils. Current available in coils within 20ms – returns to idle speed in 0.2s.
- Facilitates 'Coast Down engine off' strategy.



Change of Mind

Generation

- Good level of efficiency over broad operating speed range.
- Highest efficiency at most common operating condition (low engine speed, low-medium current).



CPT SpeedStart Efficiency Plot (14.5V)