### ALLISON ELECTRIC DRIVES

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leaders in advanced hybrid technology

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### The Allison E<sup>P</sup> System. The right technology. At the right time.

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As we study our global need to reduce our dependency on fossil fuels and strive to improve our air quality, Allison Electric Drives is proud to bring a new product to the bus market with practical technology that provides tangible advancement and operating benefits.

The Allison Electric Drives E<sup>p</sup> hybrid propulsion system bridges the gap between traditional mechanical engine propulsion systems and zero-emission technologies.

The E<sup>P</sup> System can significantly lower vehicle emissions and improve fuel economy, while increasing bus acceleration and brake life. It is our collective responsibility to make the earth a better place than we came into it. The Allison Hybrid Electric Drives E<sup>P</sup> System exemplifies our efforts to preserve and improve the quality of our environment for future generations.



### EP SYSTEM COMPONENTS



The secret to the Allison Electric Drives  $E^p$  System lies in its simplicity. The system consists of six components:  $E^v$  Drive unit, DPIM, Energy Storage Unit, two System Controllers and a Range Selector.

System components are designed to fit in virtually the same space claim as a conventional drivetrain. This compact package easily installs in low- and high-floor bus chassis.

The following describes each component and its functionality.

#### E<sup>v</sup> DRIVE

The Allison  $\mathsf{E}^v$  Drive appears similar to the Allison Transmission B Series and is equipped with:

- Planetary gears and clutches
- Electronic solenoids and valves
- Two motors/generators

All components work together to create two continuously variable operating ranges.

The electric motor/generators act as variable clutches to accelerate, slow or hold planetary components. The E<sup>v</sup> Drive is truly an infinitely variable transmission with respect to torque and speed. It is a vehicle designer's dream come true.



INVERTER MODULE (DPIM) The Dual Power Inverter Module converts electrical energy into alternating current or direct current. The E<sup>v</sup> Drive motor/generators

DUAL POWER

motor/generators use and produce alternating current. The Energy Storage Unit can only store direct current. The DPIM converts electrical energy for easy transfer, storage and use.



The range selector is identical to the electronically controlled Allison Automatic range selector. The driver pushes D for "Forward" or R for "Reverse."

### SYSTEM CONTROLLERS

The E<sup>p</sup> System uses two System Controllers (Hybrid Control Modules). The System Controllers act like the "brain," processing information from system components and driver inputs. The System Controllers provide system command and control for precise vehicle propulsion and energy production. They include diagnostic and reprogramming features.

#### ENERGY STORAGE UNIT

Energy Storage Units supply electrical energy to the  $E^{v}$  Drive's electric motors. Units vary in design and size per vehicle type and vocation. Stored electrical energy is created during normal motor/generator operation and during regenerative braking. Energy Storage lessens the demands on the clean diesel, thereby reducing emissions, fuel consumption and noise.



Articulated buses need the very high efficiencies demonstrated in the E<sup>p</sup> System.

The two electrical motors combined with a very efficient mechanical path and energy storage allow efficient stop-and-go application as well as effective highway performance. The entire system is controlled by very developed energy management software.

# Transit, Suburban Coach and Articulated Buses

The Allison E<sup>p</sup> System can significantly enhance the performance of transit, suburban coaches and articulated buses operating in a variety of environments – whether it be stop-and-go city traffic, over the road or a combination of the two.

#### TRANSIT AND ARTICULATED BUS

Imagine standing at a bus stop and not smelling the pungent exhaust fumes of a transit bus as it accelerates from the curb. Imagine not hearing the familiar roar of the engine as the bus merges into traffic.

It's possible with the Allison E<sup>p</sup> System. The Allison E<sup>p</sup> System reduces emissions up to 90% as compared to conventional diesel-fueled buses, and it's practically silent when operating on pure electrical power.

The Allison E<sup>P</sup> System is much more efficient and economical to operate than alternative fuel systems.

Rest assured, you won't sacrifice passenger comfort for fuel economy or reduced emissions; the Allison  $E^p$  System provides a remarkably smooth ride.

#### SUBURBAN COACH

Out on the open highway, the Allison E<sup>p</sup> System accelerates with ease, to merge into traffic and then maintain appropriate road speed. With no sacrifice to fuel economy.

In fact, a bus equipped with the E<sup>p</sup> System and a smaller horsepower engine can out-accelerate a comparable bus equipped with a larger conventional engine and transmission propulsion system. And consume less fuel in the process. The blend of mechanical and electrical power provides seamless acceleration. While significantly reducing emissions.

The ride is quiet, smooth and quite comfortable. Regardless of road speed. Just what your passengers expect.

#### MORE EFFICIENT USE OF POWER

A few years ago, powering a 20-ton bus with a diesel engine designed for a three-ton pickup truck would have seemed impossible. With the E<sup>p</sup> System, it's simply a matter of making the best use of available horsepower.





During hybrid operation, emissions are reduced up to 90%, compared to conventional combustion engines.

Oxides of Nitrogen (NOx) up to 50% less

Particulate Matter (PM) up to 90% less

Carbon Monoxide (CO) up to 90% less

Hydrocarbons (HC) up to 90% less

% Reduction in Fuel = % Reduction in  $CO_2$ 

\*Demonstrated emissions operating a CBD-14 cycle at Southwest Research, Inc. using a Cummins ISB engine, DPF and ULS fuel.

# Architecture and Benefits

The Allison parallel system has two paths: a pure mechanical path and pure electrical path to achieve the highest energy efficiency for transit and coach duty.

The Allison E<sup>P</sup> System is very easy to integrate. It has roughly the same footprint as your current Allison Automatic. There are no expensive fueling stations to purchase and maintain, so there is very little alteration to your existing fleet infrastructure.



URBAN BUS EMISSIONS ON CBD-14 PM (g/mile) NOx (g/mile) NOX ALLISON E<sup>p</sup> System<sup>\*\*</sup> CNG DIESEL

Source – Allison E<sup>°</sup> System - Using DPF and ULS fuel at SwRI Department of Emissions Research - CNG - CARB HD Emissions Lab Report No. 01-01

- Diesel - NAVC HD Vehicle Testing Project

The Allison E<sup>p</sup> System provides significant emission reductions, as compared to alternative propulsion systems.

#### FUEL ECONOMY

The Allison E<sup>P</sup> System provides up to a 60% improvement in fuel economy.



Source: - Allison E<sup>P</sup> System - Using DPF and ULS fuel at SwBI Department of Emissions Research - CNG - NAVC HD Vehicle Testing Project - Diesel - NAVC HD Vehicle Testing Project

#### ENHANCED ACCELERATION

An Allison Hybrid Electric Drives E<sup>p</sup> System can significantly out-accelerate a vehicle equipped with a conventional drivetrain. And the acceleration is seamless.

#### GRADEABILITY

The E<sup>P</sup> System can easily meet or exceed APTA White Book Requirements.



- 2002 Allison SCAAN computer simulation

#### COST TO IMPLEMENT

A hybrid electric system has virtually no infrastructure costs. Compare this to implementing other alternative fuel systems, which can cost as much as \$15 million in facility modifications and equipment.

E<sup>V</sup> DRIVE OPERATION



At low speeds, acceleration is more efficiently achieved through the electric motors, but as road speed increases, the E<sup>v</sup> Drive blends the electric power with mechanical power. Higher road speeds are achieved through pure mechanical power.





## Easy to drive

The driver interface has not changed. To start driving the bus, the driver pushes D on the range

selector and releases the air brake. It's that simple. Your driver is ready to start your bus route.

# Product support

With over 1,600 authorized Allison Transmission distributors and dealers all over the world,

Allison is uniquely capable to support the Allison E<sup>P</sup> System. That commitment includes the parts,

service and in-depth expertise you have enjoyed for many years with Allison Transmission

products in the bus industry.



For more information, contact your local Allison Transmission representative.