

Breathe Easy.

low emissions

high mileage

fun to drive

The solution is here.

Electrical Assist



High Mileage. Low Emissions. Better Performance.

Introducing the Electrical Assist System, the first phase of a configuration for the improved efficiency of today's automobiles. Electromotive, Inc. has developed a power train system that combines gasoline and batteries, and operates independently of the OEM control system. This innovative technology takes an existing internal combustion engine (ICE), merged with an electric motor-battery combination, to form a new concept in automotive propulsion. The result: a vehicle with improved fuel economy and reduced tail pipe emissions. In addition, the seamless transitions in the engine provide a dramatic improvement in performance making it fun to drive.

The second phase of an Electrical Assist is a Hybrid Electric Vehicle (HEV). When the OEM engine controller becomes fully integrated with the Electrical Assist motor controller, a pure hybrid is created and can further increase the gains in emissions reduction, better mileage, and increased driveability.

Solving the problem at the source

The problem with an ICE's emissions, mileage and driveability are all found at the source of the torque, or combustion chamber. Air and fuel are required to make torque. With so many transient peak torques needed to move the large mass of a vehicle during a driving cycle, the emissions and mileage suffer greatly. Driveability is also at a disadvantage when the ICE is undersized for the mass of the vehicle, or under the strain of reducing emissions.

Engines that produce an increase in miles per gallon are vital to a hybrid electric vehicle. CIDI engines are the most promising of this category, although they appear to be delayed in development. Electromotive offers an alternative solution to meet the near term and long term goals of the HEV program. By installing an Electrical Assist system on a state of the art, spark ignited engine, the following things will be achieved:

- ◆ tail pipe emissions are significantly reduced
- ◆ super smooth running engine
- ◆ vehicle driveability greatly enhanced
- ◆ seamless power flow
- ◆ peppy performance - makes it a fun car to drive
- ◆ low cost and reliability

Battery state-of-charge is computed continuously to provide real-time data to the Electric Assist controller. Optimum power production and charging rates are then mapped from empirical data throughout the engine's operating range. Industrial capacitors, installed in parallel with the batteries, increase the effective battery power and protect the batteries from high power transients.

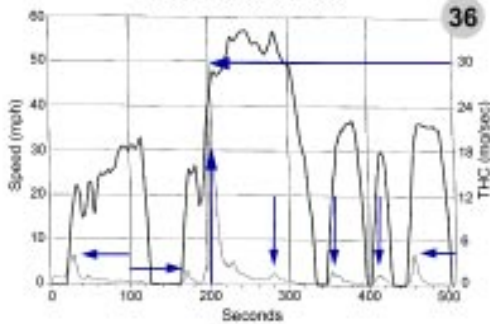
Integration of the electric and ICE power by the Electromotive controller, in effect, makes the motor appear "virtual" to the system. Changes in the ICE produce responses from the electric motor. These, in turn, are balanced against thermodynamic changes to the ICE. It is through this feedback that the electric motor load-levels the ICE. The outcome is a smooth powering of the vehicle by power sources whose shifts in load sharing are imperceptible to the driver.

Putting it to the test

Electromotive has proceeded with testing, on many different applications, using Electrical Assist over the years. Third party testing has been performed on a 1993 Honda Civic VX. The current configuration takes advantage of minimal weight increase and the use of cost effective materials at the time of testing.

No Electrical Assist, 36 mg/s THC Scale

Hot 505 THC and Speed vs. Time
Vehicle #475/0001 Test #12853



The following test was performed at an EPA retest facility in Springfield, Virginia. The test consisted of a FTP hot 505 in the baseline mode (Electrical Assist off) and a FTP hot 505 with the Electrical Assist activated. The tests were performed on the same day and no modifications were made to the engine OEM control program from stock.

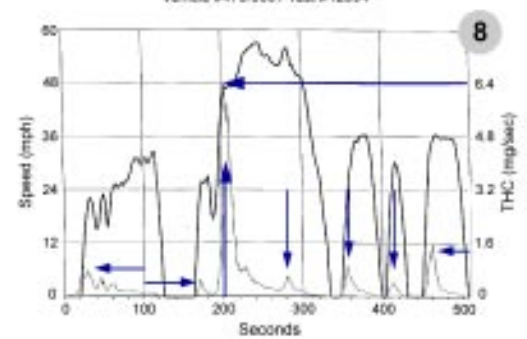
| | CO | Nox | HC | CO ₂ | Fuel Economy |
|----------------------------------|--------|------|------|-----------------|--------------|
| EPA Baseline | 1.675 | .854 | .18 | 177.7 | 49.4 |
| With Electrical Assist Activated | .309 | .581 | .059 | 148.3 | 59.8 |
| Percentage | -81.5% | -32% | -67% | -16.5% | +22% |

Conclusions:

- ◆ The peak transient emissions were dramatically reduced.
- ◆ The low-end, off throttle response is smoother and faster.
- ◆ Further emissions reduction and mileage increase are obtainable with full integration of OEM Engine Control and Electrical Assist Controller to make a true hybrid.

Electrical Assist On, 8 mg/s THC Scale

Hot 505 THC and Speed vs. Time
Vehicle #475/0001 Test #12854



Did you know...

- ◆ The maximum percentage of recovered regenerated energy is 50% of what actually is used.
- ◆ Better BSFC is obtained at higher power level, but is poorer at low power levels.
- ◆ Generating electricity to charge the battery needs to be done at medium or higher power to levels.
- ◆ The use of a small amount of electricity to augment the ICE while idling is the most energy efficient.
- ◆ Tail pipe emissions are reduced as a result of using the electrical motor to load level the engine.

The Leader in Engine Control Technology

Electromotive, Inc. was founded in 1981 and has become a pioneer in advanced technology systems for enhancing the performance of power trains. EMI was the first company to develop and produce a direct fire, distributorless ignition system. This unique technology, utilizing the patented HREIC (High Resolution Engine Ignition Chip) was subsequently licensed to two major automobile manufacturers.

In 1987, Electromotive combined a new fuel injection system with the highly successful ignition system, creating the most progressive engine management products available. Winning race after race, Electromotive products have become the choice for successful race car drivers.

Innovation through research and development is the core of Electromotive. The R&D facilities at Electromotive include a complete emissions lab, both EPA and CARB certified. Located in Manassas, VA, our establishment stands on 4.5 acres with 51,000 sq. feet of office and manufacturing space.

For over 20 years, our founder, Alexander Long, has been formulating and building hybrid electric vehicles. The current technology of Electrical Assist is not just a hybrid vehicle, but a new concept in engine control technology.

Sharing the opportunity

The race is on and Electromotive wants to put you in the winners circle. Hybrid electric vehicles are the most viable in near term solution to reducing emissions, improving fuel economy, and satisfying the public's desire for a fun vehicle to drive.

The Electrical Assist system is now available to automobile manufacturers and other OEM's for new vehicle production. Electromotive does not intend to build vehicles, but wishes to perpetuate its technology through licensing opportunities. A patent was filed with the U.S. Patent Office in October 1996 and a copy will be made available to interested parties.

If you would like to be on the cutting edge of this new technology, we encourage you to become partners with Electromotive. For more information about licensing opportunities, contact us at the address below. We invite you to visit our facility to see, drive and experience vehicles equipped with Electrical Assist and complete hybrid electrical systems.



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