

037 4WD-H Project



The Lancia 037 4WD-H – Four wheel drive Hybrid

1-INTRODUCTION

For the occasion of the Rally Legend 2010, Beppe Volta presented the restored LANCIA DELTA ECV1 (1987) . This official Abarth test-vehicle was powered by an innovative, patented TRIFLUX engine, mounted on a modified Lancia Delta S4 rally chassis. The ECV1 had been conceived as an evolution of the S4 for use in the Group B category of World Rally Championship, after appropriate development. The restoration of this unique prototype was an affectionate tribute, and the testimony of a bond for those who were present and linked to the epic Lancia Rallying period; Miki Biasion, Claudio Lombardi, Sergio Limone, Carlo Demichelis and, in particular, Beppe Volta with his team who had to reconstruct many of the missing ECV1 components.

The great media success of this initiative motivated this group of "veterans" to study initiatives aimed at the future, not just as a celebration of a glorious past. Stimulated by the developments in the automotive hybrid field and its applications not only in production but also to competition vehicles, and driven by the creative forces that had brought them together to design cars like the Delta S4 with its mixed boost engine, and the unique Triflux engine in the ECV, the team began designing a 4WD rally car with full-hybrid capabilities; the Lancia 037 4WD-H. But, lacking the skills and the "mechatronic know-how", the team approached Prof. Stefano Carabelli, founder of the ACTUA company, a spin-off of Politecnico di Torino, which develops technologies aimed at energy efficiency and with high expertise in the field who led a team of young, motivated and enthusiastic engineers.

The project also received the interest of Oerlikon Graziano, a leading company in transmission design and production, who agreed to participate with the design and supply of the drivetrain components and to contribute financially to the project. Finally, the contribution of the companies Moog for the design and construction of the electric motor and RGM for the supply of the modules of power electronics were decisive in completing the component design and assembly, for the 037-4WD-H project.

2 - Vehicles with hybrid propulsion

In the field of production cars, the hybrid is now well established. This innovative solution was introduced in the mainstream to the creativity and vision of Toyota, with their Prius model and has now been imitated by almost all major manufacturers.

There are several Engineering Solutions in production or under development, but they all fall into two main configurations:

HYBRID PARALLEL:

the electrical motor intervenes to "assist" the conventional IC engine (in parallel)

HYBRID SERIES:

the drive is provided directly by the electric motor and the IC engine is used to recharge the batteries.

In the field of competition vehicles the adoption of any technology is linked to the technical regulations.

In fact, in the strictly regulated F1, only the KERS system is permitted, which allows a small electric assist, activated manually by the driver. In the field of Sports Prototypes, technical regulations has allowed more sophisticated projects such as those proposed by Toyota and Audi for the 24 hours "Le Mans" race. The layout is of a rear mid-mounted IC engine, and a front electric propulsion used "intermittently", four-wheel drive is possible only for brief periods in straight-line acceleration and (possibly) out of corners.

This solution is useful proposition for track-racing but not in the unpredictable driving conditions on normal roads and rallies. Incidentally, the closeness of the requirements for a rally-car and normal production road-car, allows technology transfer from rallying technologies into road vehicles.

In rallying 4WD is needed in all situations; this was the basic concept of our project that instilled the team to transform the legendary original RWD Lancia Rally 037 donor vehicle into a hybrid vehicle with four-wheel drive.

3 – Transformation of the LANCIA RALLY 037 into the 037 4WD-H

The Lancia 037 Rally has earned its place in the history as the last challenge of the RWD rally-cars against the new breed of 4WD vehicles.

The Lancia 037, thanks to its agility, low weight, and rapid acceleration from the supercharged engine, delayed the complete disappearance of competitive RWD rally-cars for a couple of years.

The Lancia 037 required 4WD to remain competitive: The aim of this project was to investigate a new life by equipping it with an electric drive on the front axle.

The Lancia 037 Rally base-vehicle transformed into the 037 4WD-H project.

The start-up of the project took place in May 2012 and all the partners (Oerlikon-Graziano, Actua, Volta Racing, Moog, RGM) worked hard on achieving their goal; the presentation of the completed vehicle at the Rally Legend 2012, an event which is important to us as the team hopes to find on that occasion, as happened for the ECV1, friends and fans who appreciate these achievements and will motivate the team into further developing the vehicle through STEP 2.

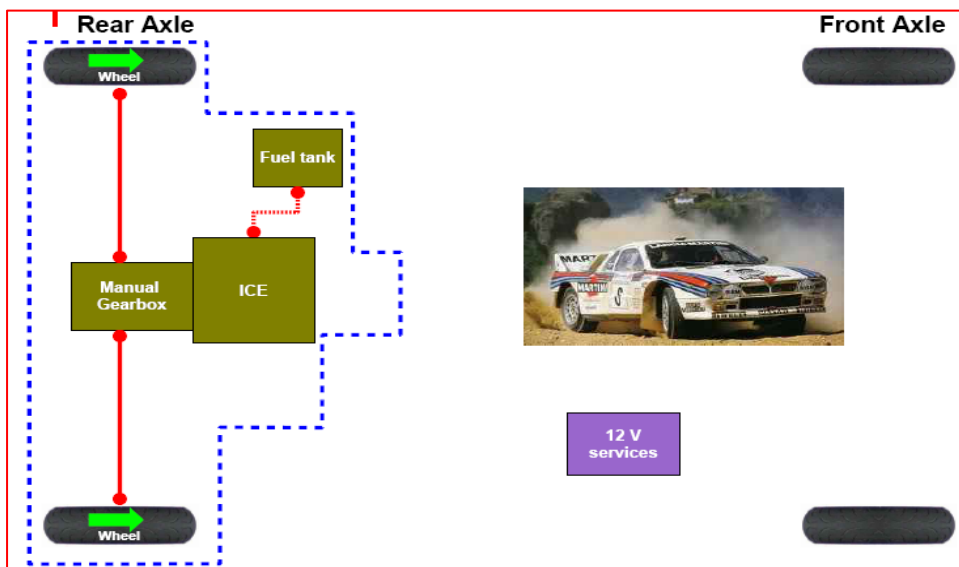


FIG.1 : Lancia Rally 037. Original RWD Layout base-vehicle

Fig.1 shows the layout of the original Lancia Rally, with rear-wheel drive IC engine in the rear central position. The project to transform the layout into a four-wheel drive hybrid powertrain is performed in two steps.

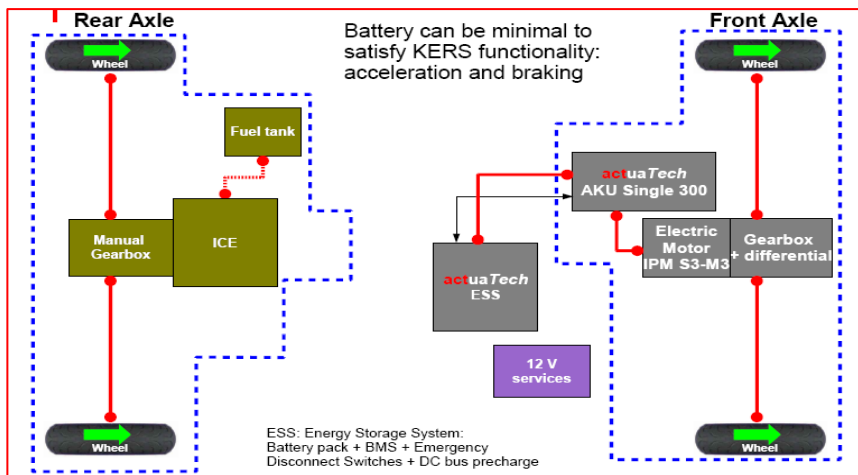


FIG.2 : Layout - 037 4WD-H STEP 1

In the first step (Fig. 2); the front axle is equipped with a "transaxle" consisting of electric motor, gearbox, differential - which was specially developed to transmit over 2000 Nm at the wheels. The electric traction is independent of the IC engine driving the rear axle. The torque at the front axle is balanced with that at the rear axle by an electronic control unit as a function of the condition of acceleration/braking, steering angle, pressure in the IC engine intake manifold. The electric motor is powered by batteries, 4WD traction is permanent, the autonomy is limited by the installed battery capacity. This solution is useful for the development of the vehicle but not definitive, the vehicle is presented at the Rally Legend 2012 in this STEP 1 configuration.

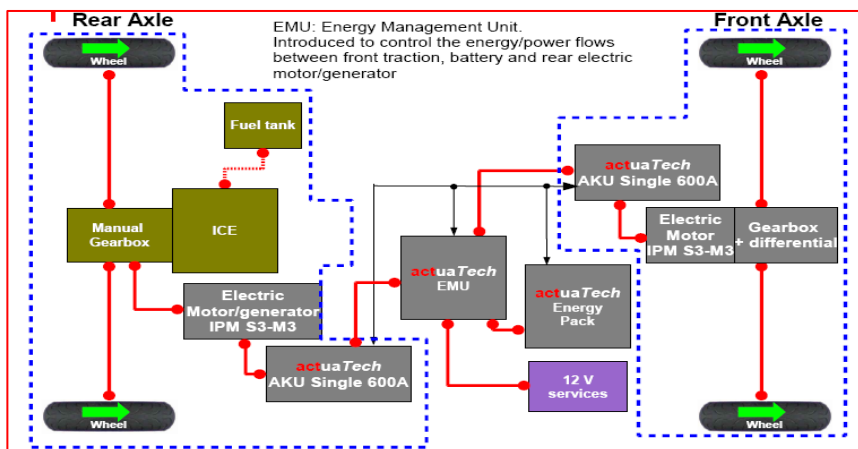


FIG.3 : Layout - 037 4WD-H STEP 2

The final configuration that will allow the use of four-wheel drive without limits of autonomy is represented in Fig.3. In this configuration the IC engine is fitted with an additional e-motor which will function as a generator, charging the batteries OR as an e-motor capable of increasing the drive to the rear axle. The strategy of generation or drive will be selected, depending on the operating conditions of the vehicle and the charging status of the battery, and will be managed by the control unit indicated by the abbreviation Actuatech EMU in Fig.3. In particular, the control unit will manage the electrical energy flows between the front and rear and minimize the battery capacity requirement, in this way it is possible to decrease the weight and increase reliability of the battery pack.

LANCIA 037 - 4WD-H Project



The 037-4WD-H project detailed above is made possible thanks to the expertise and know-how of the following companies and engineering centers "network" with:

The technical coordination of Ing. Claudio Lombardi
(Technical Director and then Director General Lancia and Abarth Racing from 1982 to 1991),

Expertise of Prof. Stefano Carabelli
(CEO of Actua and lecturer at the Polytechnic of Turin),

The contribution of Beppe Volta, who built the car and the following sponsors:



Thanks to the following technical sponsors provided equipment/parts:



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