15th March 2011

Oerlikon Graziano and Vocis Driveline Controls develop
step change in transmission technology for new Lamborghini flagship

Unrivalled shift times delivered by innovative ultra-compact, lightweight transmission

Torino – Italy, March 1st 2011 – The new Aventador, the next generation supercar from Lamborghini, will use an innovative 7-speed automated manual transmission (AMT) that delivers the fastest gear-shift of any road vehicle with synchromesh. At just 79kg, the new gearbox is substantially lighter than its predecessor yet provides an extra ratio, handles more torque and maximises cabin space by packaging into an exceptionally narrow transmission tunnel.

Lamborghini found the ideal partner for this challenging development in the Italian transmission specialist Oerlikon Graziano and their UK partner Vocis Driveline Controls, itself part-owned by Oerlikon Graziano. Vocis managing director Mike Everitt says that Lamborghini’s brief was clear: they wanted the driver to have a powerful, emotional link with the car, and that meant having shift speeds that were unprecedented.

“We were also asked to deliver class-leading weight and packaging without compromising durability,” says Claudio Torrelli, head of product development at Oerlikon Graziano. “It was the type of challenge that made us tear-up the rulebook and take a completely fresh approach.” To achieve the goals, the Oerlikon Graziano engineers worked as a single team with Lamborghini in a deep cooperation from day one.

The new, 6.5 litre Lamborghini engine delivers 700bhp (515kw) at 8,250rpm and 509lbft (690Nm) at 5,500rpm, which would normally require a substantial transmission. A conventional AMT, with external control systems, would not fit the available space, neither would a dual clutch transmission (DCT), which would need bulky wet clutches to meet the power handling requirements.
As creators of some of the most successful DCT systems in the world, the engineers at Vocis and Oerlikon Graziano knew that the crucial element in faster shifting is the ability to move into the next gear while the system is disengaging the previous one. For Lamborghini, they developed a transmission that applies this principle from the DCT, but with the lightweight and compactness that is possible with an AMT when no manual option is required.

A conventional AMT uses the established ‘H’ pattern gearshift of a manual gearbox, in which the various gears are selected by sliding selector rails that lie parallel to each other. The jump from one rail to another corresponds to the dogleg in the middle of the H and is called ‘cross-gate’ movement. Two actuators power the automatic shift; the actuator engaging the desired gear has to wait until the cross-gate actuator has selected the correct rail. Vocis and Oerlikon Graziano devised a strategy called independent shift rail (ISR) technology that eliminates this constraint.

In the ISR transmission, there is no cross-gate motion and consequently no cross-gate actuator. Instead, each rail is operated directly by its own actuator. One rail selects either 1st or reverse, one 3rd or 5th, one 2nd or 4th and one 6th or 7th. This means that no two sequential gears are on the same shift rail until the last change into 7th (top) gear. As a result, the system can begin to move the rail for the next gear while still withdrawing the previous one, allowing the shift to be accomplished faster.

The gearchange paddles are hard-wired into the Vocis-designed Transmission Control Unit (TCU), eliminating the time required for the CAN bus to poll the system. Very accurate measurement and control of the actuation current ensures precise and progressive control of the high-precision hydraulic valves, also specified by Vocis and designed uniquely for this application, that are critical not just to a fast change but also to shift quality.

Vocis points out that even with this new architecture, the ultra-fast shift speed would not be possible without careful optimisation of the entire system. “Control systems are often designed after the gearbox hardware. By designing ours in parallel, using a small, highly integrated engineering team, we were able to eliminate a lot of the traditional compromises on both sides,” says Everitt.
Packaging volume was minimised by refinement of every component and subsystem, including integrating the major hydraulic connections into the casing, developing a compact end-mounted valve block and using advanced analytical techniques to allow substantially reduced centre distances between the shafts and reduced clearances between the transmission and the vehicle body.

Lamborghini claims a 50ms shift time for the new transmission. “An outstanding result,” says Everitt “and the driveability is impressive too. It is often harder to get a nice mid-throttle change than one at full throttle. The new control system plays an important part in achieving this.”

The first transmissions were running in a vehicle only 16 weeks after the project go-ahead was given. Unlike many early prototypes, they were fully functioning and their performance gave Lamborghini confidence to send early engineering vehicles for demanding board-level evaluation. The programme was completed to the quality and durability standards required for all VW Group companies, helping the new Lamborghini become not just one of the fastest and most involving driving experiences available, but also one of the world’s most useable supercars.

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VOC6802 2.1ap 14-03-11
Prepared by Market Engineering, Europe’s leading communications agency for the automotive technology industry.
Vocis and Oerlikon Graziano have developed a transmission that combines principles from DCTs with the lightweight and compactness that is possible with an AMT when no manual option is required.

To help the new transmission fit very tight packaging requirements, Oerlikon Graziano and Vocis integrated the major hydraulic connections into the casing and developed a compact but fast and powerful end-mounted valve block.

Graziano’s Independent Shift Rail (ISR) technology helps to give the new transmission its class-leading speed.

The next generation of Lamborghini supercar, will use an innovative 7-speed automated manual transmission (AMT) that delivers the fastest gear-shift of any road vehicle with synchromesh.

More pictures of the Aventador are available from the Lamborghini press site: www.lamborghini.com/press/
About Oerlikon

Oerlikon (SWX: OERL) is a leading high-tech industrial group specializing in machine and plant engineering. The company is a provider of innovative industrial solutions and cutting-edge technologies for textile manufacturing, thin-film coating, drive, precision, vacuum, solar energy systems and advanced nanotechnology. A Swiss company with a tradition going back 150 years, Oerlikon is a global player with around 16,000 employees at 157 locations in 36 countries and sales of CHF 2.9 billion in 2009. The Company invests more than CHF 200 million annually in R&D, with over 1,200 specialists working on future products and services. The operative businesses rank either first or second in their respective global markets.

About Oerlikon Graziano

Oerlikon Graziano is the world’s leading specialist in the design, integration and precision manufacture of transmissions for high-performance road cars. The company is also a leading global supplier of transmissions, axles and driveline components for other demanding sectors including electric, off-highway and industrial vehicles. With facilities in every region, including the USA, China, India, Italy, Russia and the UK, Oerlikon Graziano can support customers locally with an appropriate level of technology from single gears through to complete driveline systems and vehicle integration. All activities build on Oerlikon Graziano’s innovative approach to design, rigorous test and development and world-leading expertise in high-quality, low-volume manufacture.

About Vocis

Vocis is a world-leader in the design, development and calibration of automotive driveline control systems and in the management of complex driveline integration programmes. It's specialists have delivered some of the world’s most demanding and prestigious transmissions at the leading-edge of power handling, refinement, packaging and efficiency. This expertise is also being applied to next-generation electric vehicles, where the company’s innovative two-speed transmission will provide a step-change in energy efficiency. Vocis is part-owned by Oerlikon Graziano, which provides a considerable range of complementary skills, allowing the two companies to deliver complete, turnkey transmissions from design concepts through to vehicle integration and calibration.