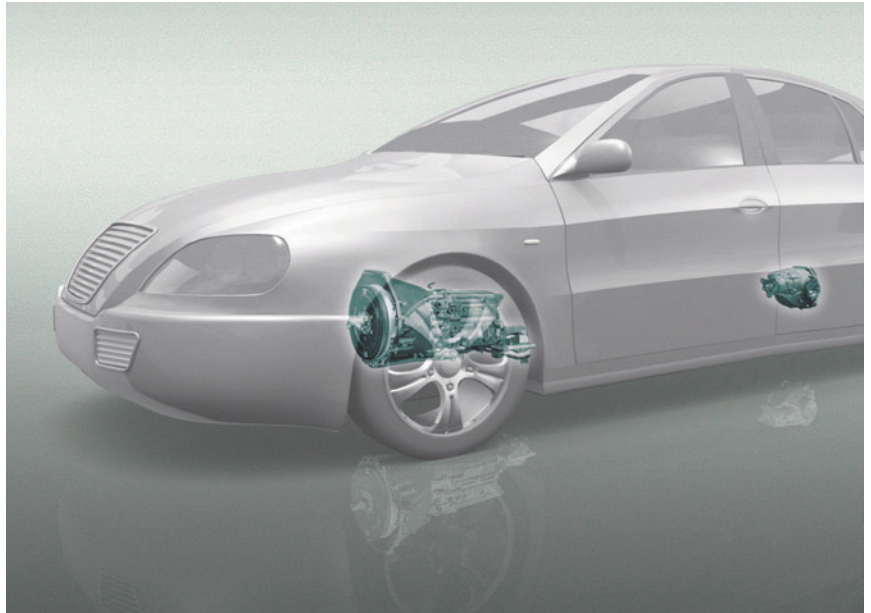


# ECU Software for Dry Dual Clutch has Stringent Requirements

## Integrated Diagnostic and Flash Solution with Script Control

**Dual-clutch transmission technology not only offers significant improvement in driver convenience and ride comfort at moderate added cost. At the same time, it also delivers excellent fuel economy. The design of a production version of the world's first 'dry system' dual-clutch transmission represented a special challenge for the ECU's electronics. Frequent flashing of the ECU is necessary in the development process, and this requires the use of rational flash methods and high-performance tools that are up to the task.**

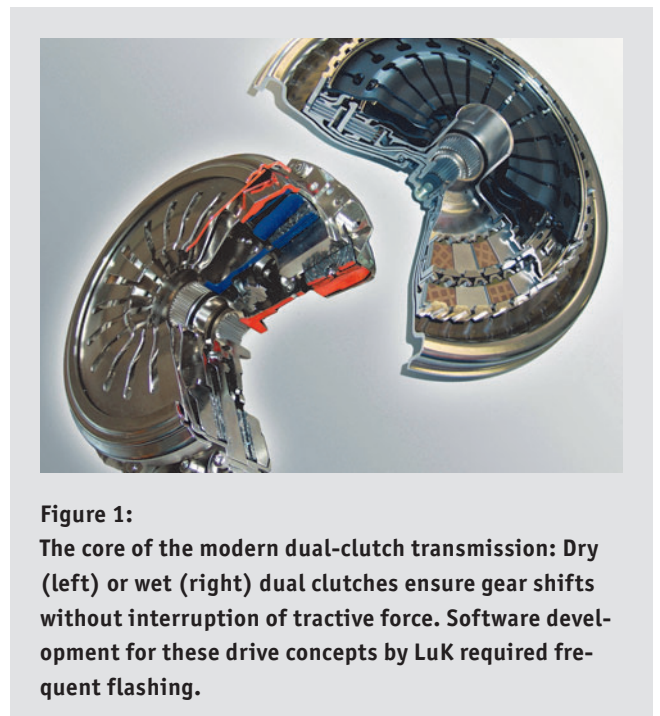


Automated transmissions combine the convenience of an automatic transmission with the cost advantages of manual transmissions. In conjunction with ECM (Electronic Clutch Management), dual clutch transmissions form the basis for modern drive concepts. While the ECM system handles electric motor actuation of the dual clutch, transmission control ensures that two gears are always engaged simultaneously. Usually gears 1, 3 and 5 are served by one transmission section, while the other section is responsible for gears R, 2, 4 and 6. Disengagement of one clutch and simultaneous engagement of the other clutch enables a nearly jolt-free gear shift – without an interruption in the propulsive force – to the next higher or next lower gear. The optimized shifting method requires just a few hundredths of a second to shift gears and offers better fuel economy than manual shifting.

### Greatest Efficiency with Dry Dual Clutch

The first 'dry' dual clutch was developed at the facilities of automotive supplier LuK in Bühl (Figure 1). This company, part of the Schaeffler Group and a specialist in clutch and transmission component solutions, has contributed to the advancement of automotive technology with all sorts of innovative developments. In 1965 it was the first company in Europe to introduce the diaphragm spring clutch to the market, and in 1985 the first dual-mass flywheel. This was later followed by CVT (Continuous Variable Transmission) components for torques greater than 300 Nm and the world's first electro-mechanical automatic transmission. Meanwhile, every fourth car in the world is driven with a LuK clutch. Today, the focus of the company's development is on alternative drive concepts too, such as components for dual-clutch transmissions and hybrid drives.

Until now, dual-clutch transmissions were only available in wet technology, i.e. with components running in oil. Although they offer the advantage of greater power loss absorption by oil cooling, this is contrasted by the disadvantages of a lower friction factor and a larger drag torque when idling. Since LuK uses electric motors to actuate the dry dual clutch, this offers even greater potential for reducing fuel consumption and CO<sub>2</sub> emissions.



**Figure 1:** The core of the modern dual-clutch transmission: Dry (left) or wet (right) dual clutches ensure gear shifts without interruption of tractive force. Software development for these drive concepts by LuK required frequent flashing.

### Intelligent Software protects the Clutch System

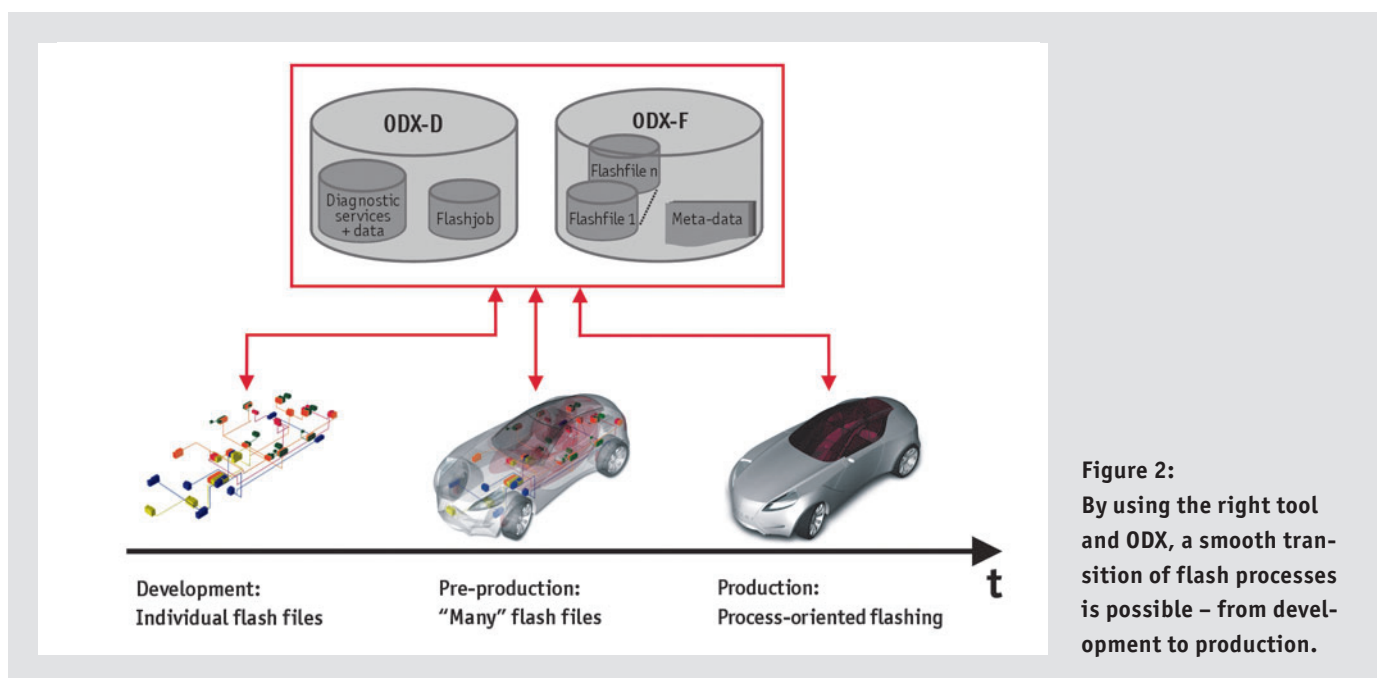
A problem specific to the dry clutch becomes apparent when stopping on a hill, when the driver applies the braking torque via the gas pedal and clutch instead of the brakes. Due to poorer cooling, the clutch gets hot much quicker than in a wet system. To protect against premature wear and failure, intelligent driver warning strategies are required, which support the driver in optimally utilizing the clutch. The software might achieve this, for example, by allowing the vehicle to slowly roll free after a short period of time, which induces the driver to automatically step on the brake pedal. During the drive, the electronics must adjust the clutch engagement to be quicker or slower depending on vehicle speed, gas pedal position, etc.

Overall, numerous constraints and parameters need to be considered in automatic clutch operation, and they change dynamically during operation. The clutch heats up, cools down again and is therefore continually changing its characteristics. The electronics must continually adapt the behavior of the automatic dual clutch to these changing parameters. LuK utilizes an advanced computational model that yields a clutch mechanical design that is less complex and is therefore more economical for the automotive OEM.

### From in-house Flash Tool Development to universal Flash Solution

At first, LuK handled the flashing that is frequently needed in software development (updating of program code or data in the ECUs) with an in-house development that was even used to flash production ECUs. Independently, the clutch specialist conducted a search for a diagnostic tool for CAN. After finding, during a test phase, that other products were lacking in various areas – ranging from the graphic user interface to product support – LuK decided on CANdito from the Stuttgart-based company Vector Informatik. Vector impressed them with a solution that can implement all of the various flash methods and can also serve as a full diagnostic tester (Figure 2).

In the diagnostic tester CANdito, the LuK employees found precisely what they had been looking for, and more. The tool enables symbolic access to all data and functions that are accessible via the diagnostic protocol. It reads in ODX-2.0 description files and supports scripts for automating diagnostic and operating sequences. ECU variants are automatically detected. The authoring tool CANDelaStudio is used to describe the diagnostic data in CDD and ODX formats. Each ECU is described in a separate document that is based on a document template. A variants concept makes it possible to define the commonalities and differences of an ECU's variants, largely without redundancies. Full parameterization simply



**Figure 2:** By using the right tool and ODX, a smooth transition of flash processes is possible – from development to production.

involves reading in the ECU description file. All communication parameters and all existing services and data are immediately available. In a separate work step, the embedded software can also be generated from the description file. This ensures that the diagnostic description, the software in the ECU and parameterization of the diagnostic tester are always coordinated.

### Diagnosics and flashing with one Tool

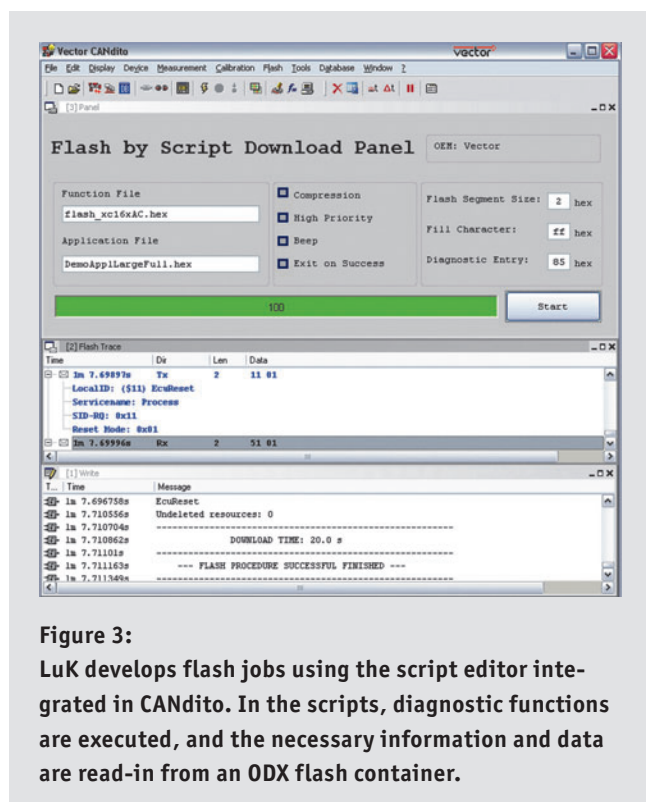
A key basic requirement for LuK is that it must be possible to read out the software currently in the ECU before flashing. This is necessary to ensure that the correct software version is being flashed in the relevant ECU. Furthermore, this capability is important for reading out system parameters and the error memory or for making before/after comparisons. In the old solution, the diagnostic tester was needed to access these data. After the user had read out the necessary data, the user would stop the tester, start the flash tool and select the appropriate files – an intricate procedure.

A remedy to this situation was found in use of the script language integrated in CANdito (Figure 3). After communication has been established, the tool reads out the identification of the software currently in the ECU. Based on a table, the tool autonomously decides

whether an update is even necessary. Scripts ensure that the tool always uses the right software for the particular hardware variant, even when the same ECU hardware is used on numerous different vehicle models. Use of CANdito as a diagnostic tester and flash tool – including script functions to simplify the job – goes a long way toward improving process reliability.

### Outlook

Current trends in reprogramming memory chips include: ODX-F, parallel flashing and flashing with increased bandwidth via FlexRay. In light of these wide-ranging trends, questions related to protection of investment and assurance of future coverage are thoroughly justified. Users of Vector products benefit here, not only because they represent a scalable tool chain with multiple flash solutions, but also because they offer timely program versions that meet current standards. While ODX-F support and parallel flashing are already available, FlexRay support is already coming with the next release. Existing authoring tools for the development of diagnostic parameterization or the ODX-F flash containers round out this area.



**Figure 3:** LuK develops flash jobs using the script editor integrated in CANdito. In the scripts, diagnostic functions are executed, and the necessary information and data are read-in from an ODX flash container.



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