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Innovative Technologies for Transmission Control Units

Key to Product success

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Introduction

The market for automatic transmissions continues to grow. In addition to what originally attracted interest in the product – enhanced driver convenience – the prospect of greater fuel efficiency is now a further factor in their favor. Continental has been offering transmission control units (TCU) since 1982 (Figure 1), starting with those for simple three-gear conventional automatic transmissions (for Renault), followed by all-wheel applications (for Ford) in 1985, CVT applications (Audi Multitronic) in 1999, truck applications (Eaton) in 2000, and arriving at the double clutch transmissions in widespread use today. At present Continental Business Unit Transmission is technology leader worldwide in the market for transmission controls for the full spectrum of automatic drives.

Continental offers the full product portfolio

The products offered by Continental BU Transmission are exclusively customer-specific solutions. Depending on the installation situation, a basic distinction is made between stand-alone solutions, attached-to and integrated control units. As a rule, stand-alone control units (external solutions) do not contain any sensors. They are not installed on or in the transmission. An external solution of this kind, suitably installed in the vehicle as a separate electronic box under relatively moderate ambient conditions (temperature, vibration), usually takes the form of a printed circuit board (PCB) assembly. The components are soldered, in their own packaging, to a circuit board for application temperatures not exceeding +125 °C. The attached-to control units are built into the transmission and are thus designed to withstand vibration loads comparable to those the transmission itself must stand up to. They can also tolerate higher temperatures than a stand-alone control unit. In the case of attached-to control units, sensors and actuators are generally connected to the control unit via a cable harness. The highest level of integration is achieved by mechatronic transmission control solutions. In this case, the mechanical components, hydraulics and electronics, with sensors and actuators, are integrated into one unit. This has the advantage of reducing system and installation costs and of making it possible to already test the complete transmission unit (transmission and control unit) at the transmission works prior to installation. There is also a higher degree of system reliability as there are

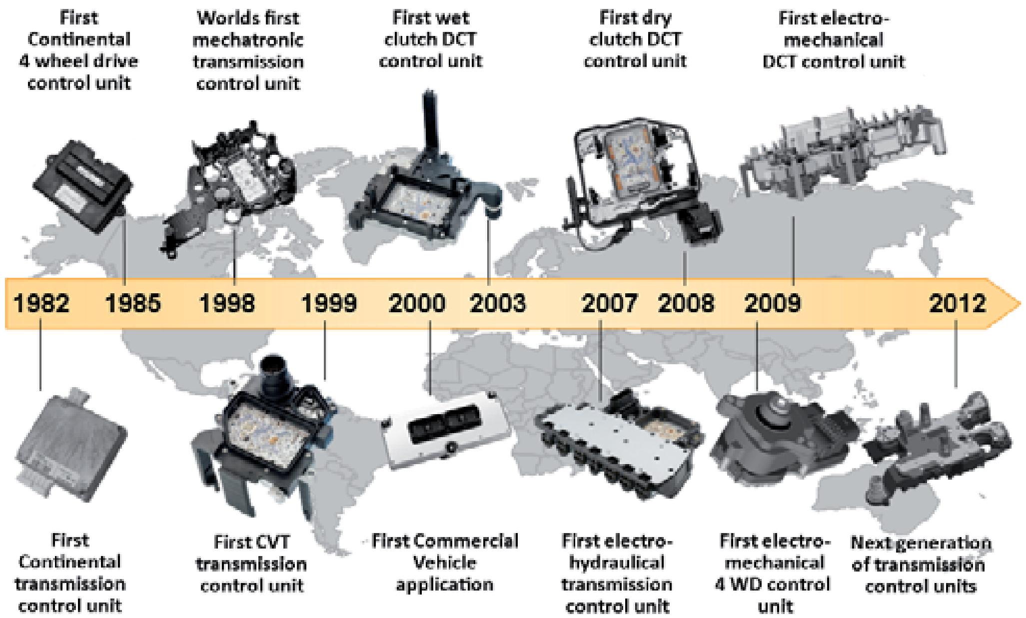
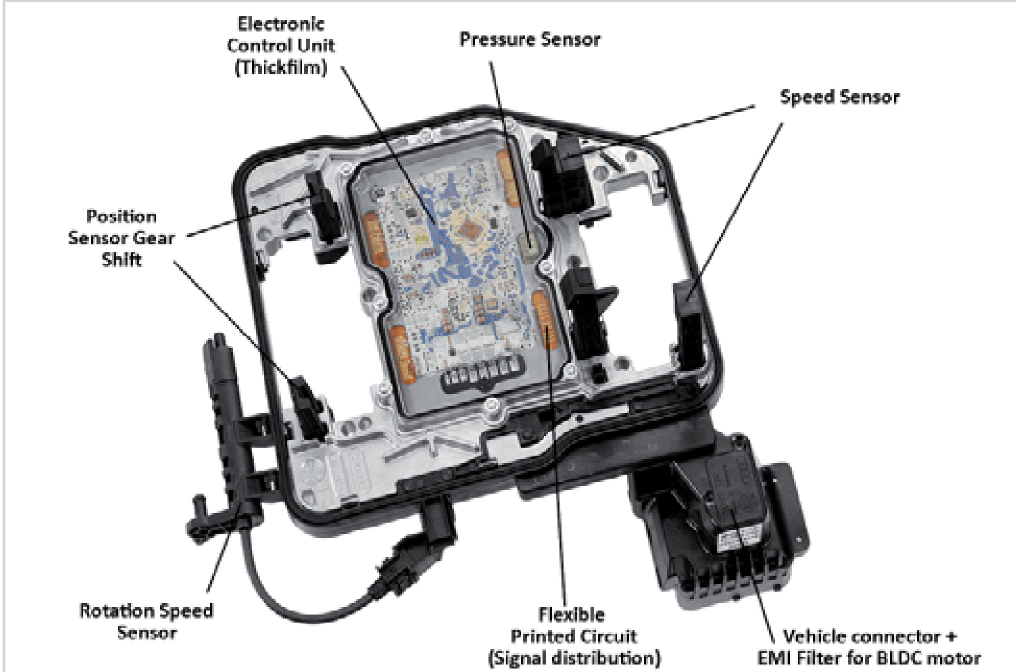


Figure 1 History of Continental transmission control units



Figrue 2 DQ200 transmission control unit for Volkswagen

fewer cables and contacts and plug junctions. Integrated control units have even higher demands in terms of vibration resistance and, above all, usability at high temperatures. The temperature on the substrate may get as high as +180 °C, therefore special substrates – made, as a rule, of a ceramic-based material – are used. The semiconductor components themselves are bonded directly onto such substrates as chip, without any own package, by electrical conductive adhesives. As a rule packaged components cannot be used under such environmental conditions due to problems in heat dissipation and vibration resistance. Installation directly into the transmission additionally forces to higher requirements in terms of the sealing and resistance to media. All told the solution approaches listed cover applications like:

- Conventional stepped automatic transmissions
- CVT (continuous variable transmission)
- DCT (double clutch transmission)
- AMT (automatic manual transmission)
- Shift-by-wire functions

Continental can credit itself with the singular advantage of realizing the control units not only as hardware but also of offering its customers the complete low-level and functional software for all the application fields cited. This is a further unique selling proposition compared to the competition and one that is crucial. The acquisition of former competitors Motorola Automotive and Siemens VDO has given the BU Transmission a preeminent market position and made Continental far and away the unchallenged market leader. Continental covers a large share of the worldwide market for double clutch transmissions! The product DQ200 serves as an example of an integrated transmission control unit, i.e. a control unit built right into the transmission. It was designed for the seven-gear dry double clutch transmission used by the customer VW (Figure 2). It is managed by means of a 32-bit microcontroller. All transmission sensors (e.g. for temperature, rotational speed and path detection) are integrated into the control unit. It operates within an application temperature range between -40 °C and +140 °C. The actuators managed by it include eight valves as well as a brushless excited electric motor for an oil pump. All connections outwards are grouped together in an 11-pole plug.

Platforms and Key Technologies

Mechanical platforms

Continental makes use of basically three mechanical platforms for its transmission control units (Figure 3): one platform based on leadframes and two with flexible printed circuits (FPC) for connecting the substrate to the sensors and actuators. All basic structures use ceramic substrates. For optimum heat dissipation, the substrate is glued directly onto a metal base plate. The platforms differ essentially in how the sensors and valves are connected to the main substrate. In the case of the leadframe solution, the signals and currents are conducted via metal leadframes. This offers technical advantages – e.g. in terms of ampacity – but also disadvantages in terms of flexibility and amenability to modification. As intermediate polyimide-based connections, flexible printed circuits have the advantage of more easily allowing for modification. If the positioning of a sensor module will be changed, for example, only the appurtenant flexible printed circuit board needs to be changed. The main housing can remain unchanged. The two platforms differ in the number of FPCs: in the first case several flex circuits are used, while in the 2nd case only one common flex circuit is used. Concrete customer projects are realized by means of one of these solutions or a combination of them best suited to satisfying the specific requirements.

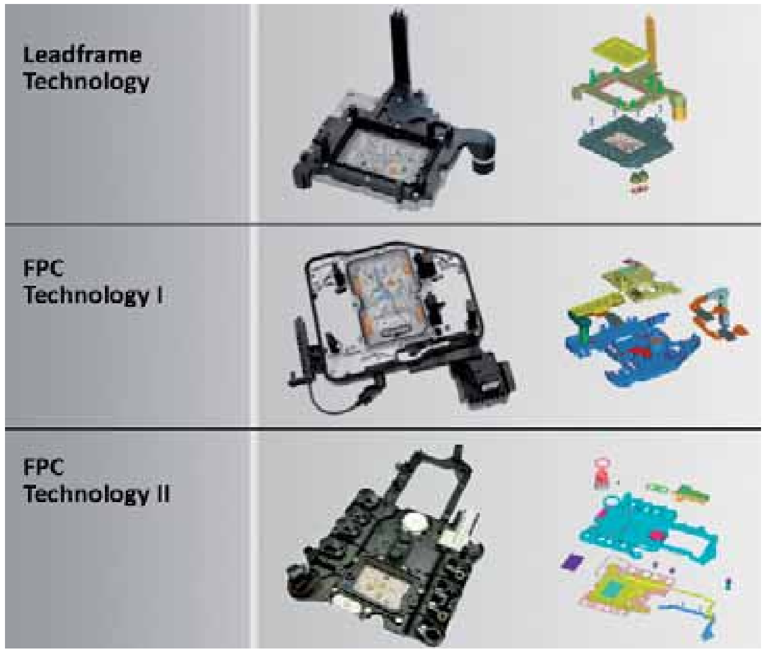


Figure 3 Mechanical platforms for realization of integrated transmission control units

Substrate platforms

The choice of the right substrate has a major impact on the success of the product. The functionality of the transmission control unit is realized in the configuration of components, their wiring and their interconnection technology on one or several substrates. The substrate has a crucial influence on the size of the control units as well as on their electric properties and their costs. A distinction is made between organic substrates (printed circuit boards, PCBs) and ceramic substrates.

Printed circuit board technology (PCB)

PCB solutions are used both for stand-alone control units and, in part, for attached-to control units. Here Continental is able to draw on the full range of PCB technology possibilities available on the market: rigid, flexible and flex-rigid. Operation temperatures are typically in the range from -40 °C to +125 °C. Standard PCBs (having between four and eight layers), of a kind used for other automotive electronic products as well, are mainly used. Furthermore specific solutions for operation temperatures as high as about +140 °C or for particularly high-density wiring are also employed. A clear characteristic of such solutions are packaged components assembled by means of suitable soldering techniques.

Ceramic substrates

In the case of integrated transmission control units, temperatures well over +150 °C can occur locally on the component or the substrate, combined with vibration loads of up to 50 g. These loads are much too high for most packaged semiconductor components. For this reason assembly solutions involving ceramic substrates and nonpackaged semiconductor components are used. In contrast to its competitors, Continental has the complete know-how, series production experience and access to all three ceramic technologies of interest and economic advantage as concerns the realization of transmission control units (Figure 4).

1. Thickfilm substrates
2. LTCC (low-temperature cofired ceramic) substrates
3. DCB (direct copper bonding) substrates

Every ceramic substrate technology has specific advantages and disadvantages as regards the implementation of digital and analog circuit parts and also circuit parts with high power dissipation. As customer requirements differ from product to product, the selection of the optimum substrate solution for the specific product is always very important. Having at its fingertips all relevant technologies, as well as series production experience with them, Continental is able to realize every specific customer requirement with optimized substrate technology. In this way, the customers obtain the best technical solution in each case.

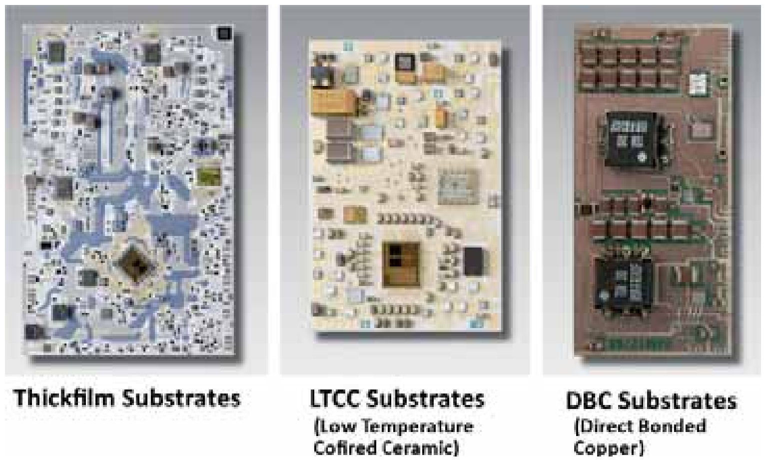


Figure 4 Platform of available ceramic substrate technologies

Integrated transmission controls with Continental thickfilm substrate technology

Substrates in LTCC and DCB technology are purchased from external suppliers. Continental has been developing and producing thickfilm substrates in-house since 1972 and is thus a leader in the field of complex thickfilm circuits. Thanks to the consequent advanced development of in-house technology and the development of innovative solutions it has remained possible up to the present day to satisfy the demands in the area of transmission controls. Insofar as the principal users of thickfilm technology (e.g. manufacturers of sensor modules) employ mainly analog circuit technology in their products, Continental had to realize both analog circuits and digital circuits as well as power stages within their thickfilm substrates for transmission applications. For the sake of a better understanding of this in-house thickfilm substrate solutions, Figure 5 shows an example of an integrated transmission control unit: the thickfilm circuit of the product DQ200. The product at outset is an aluminum oxide ceramic material (with a thickness of approx. 0.6 mm), onto which conductor lines, resistors and dielectrics are applied by screen printing and then fired. Resistors can be very exactly trimmed to tolerance by means of laser cutting. Removing resistor material (incisions in the film) by means of a focused laser beam, the cross-section of the resistor is reduced or its effective length extended. This has the effect of boosting the electric resistance. Once the substrate has been completed, glue with a high silver content is applied by means of stencil printing and the substrate is populated with semiconductor chips – so-called bare dies, or components without their own packaging – and with passive components like capacitors and coils.

Finally the signal connections on the chips

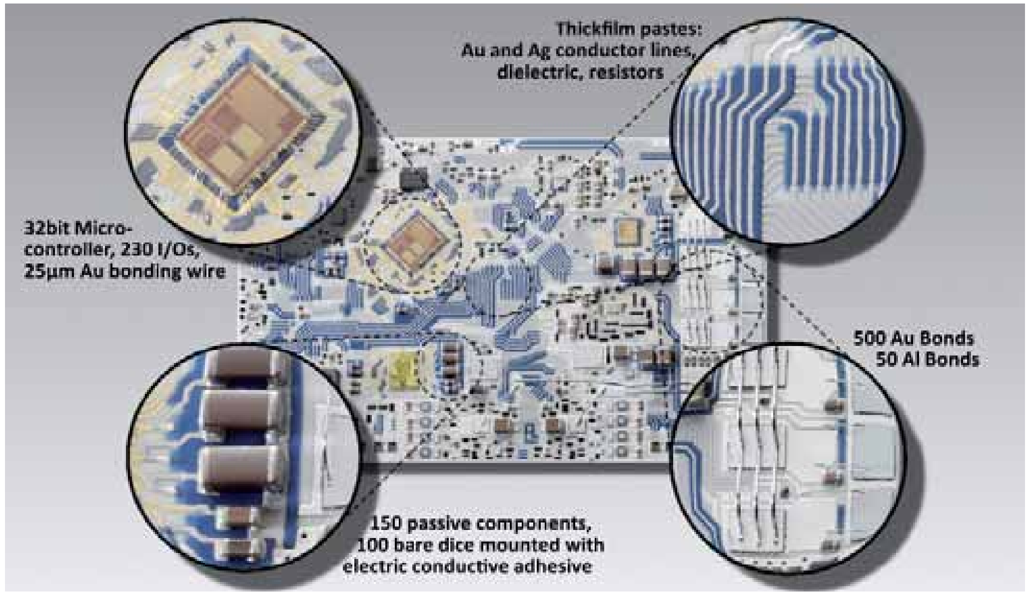


Figure 5 Substrates on the basis of thickfilm technology populated with components and interconnections by means of wirebonding (product DQ200)

are bonded onto the pads of the substrate using gold wirebond interconnections (with a diameter 25 - 50 µm) and the power components are bonded on with Al wirebond interconnections (with a diameter 125 - 400 µm, depending on amperage).

Driving forces for transmission control technologies

Customer-dominated requirements

Motivated by continually rising requirements of the performance of transmission controls, Continental is pushing ahead with new technologies. The goal is the integration of more functions with a concomitant reduction in volume and weight, and a further increase in quality and reliability. Pump and motor control and similar functions push the current values to be transmitted up to 60 A, as well as increasing the corresponding power dissipation. This has consequences for the substrate technology but also for the heat dissipation. Complex electromagnetic compatibility (EMC) solutions are needed to cope with the rise in operating frequencies up to 200 MHz and more. To give an idea of customer specifications in the case of transmission controls, temperature profile requirements will be discussed below.

An increasing critical issue is the demand for longer service life combined with simultaneously rising service temperatures. Nowadays a service life of 6000 to 8000 hours is targeted for passenger car products in series production and of up to and of up to 42 000 hours for commercial vehicle products. These requirements are defined in performance specifications in the form of load profiles/temperature profiles (also called mission profiles), with data on the ambient temperature and the respective time fraction in percentage (see table). Due to component power dissipation, especially in the power output stages, the temperatures at some points on the TCU substrate are actually much higher and may even get up to 180 °C. Within product development Continental has to select suitable materials and implement new concepts that are capable of withstanding these peak temperatures. The same applies to the much higher reliability requirements deduced from these other factors.

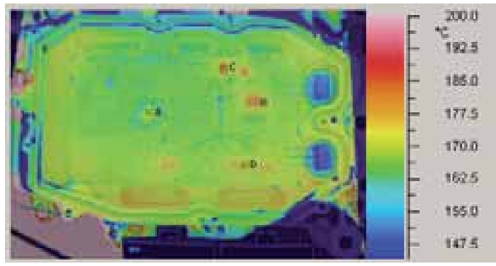


Figure 6 Thermal image of the circuit with peak temperatures of up to +180 °C

Temperature profile of a passenger car transmission application (typical data)		
Ambient temperature in °C	Time in %	Duration in h
135 ... 150	1 %	70
120 ... 135	15 %	1050
20 ... 120	64 %	4480
-20 ... 20	10 %	700
-40 ... -20	10 %	700

Table 1 shows typical values for a transmission control developed by Continental for passenger car applications with ambient temperatures of up to +150 °C. Because of the additional heat loss of the components, the peak component temperature is much higher, as the corresponding thermal image shows (Figure 6).

The high temperatures are a major challenge for the BU Transmission. Solutions previously applied in electronic packaging of transmission controls are now up against the physical and/or chemical limits of the materials used. Material properties at higher application temperatures are often not exactly known and have to be tested and qualified for suitability in expanded temperature ranges. Without doubt there is not sufficient data on the impact of material exposure to transmission oils – e.g. for materials used for sealing or housings. Transmission oils differ from customer to customer and from product to product. Furthermore, the transmission oil also undergoes changes over the service life of the respective transmission control, meaning that the material properties have to be retested for all changes. The reliability limits have to be redetermined and ensured. Insofar as very specific combined electronic loads generally apply during service (temperature + vibration + influence of oils + ...), it is essential that all relevant fault mechanisms have to be known.

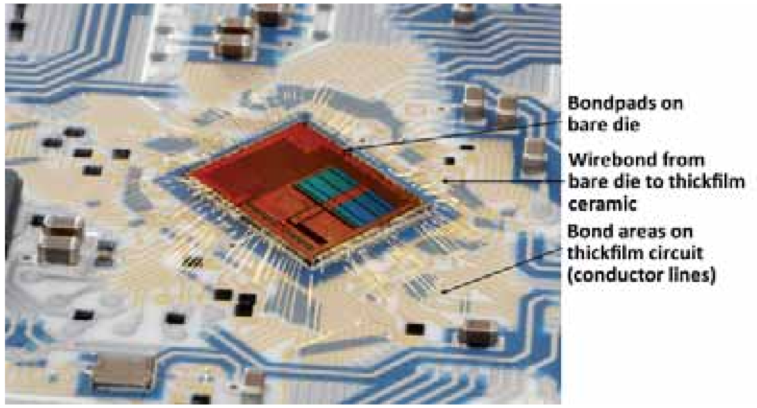


Figure 7 Detail of a photo of a transmission control unit with a 32-bit microcontroller chip

Alternative solutions have to be developed in the case that the right material and packaging solutions are not available for a new product. Examples of innovations of this kind in the area of materials and processes will be presented in the next section.

New components pose challenges and provide driving force

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A key driving force for new solutions in electronic packaging results from the diversity of new component configurations. The functional demands that transmission controls must fulfill are often realized in the form of more highly integrated silicon chips. Contingent on advances in semiconductor technology, this involves miniaturized structures on the semiconductors. The semiconductor manufacturers themselves push ahead with chip shrinking steps of this kind to increase the number of chips per wafer and, in this way, to lower per-chip costs. A consequence of this development is that the introduction of a new semiconductor generation generally means that Continental receives silicon chips with far more I/Os and more tightly dimensioned pads. This has dramatic effects for the assembly of such chips on the substrates. Figure 7 illustrates the impact of new components using the example of the 32-bit microcontroller, a central element in transmission controls.

The 32-bit microcontroller chips used in the transmission controls produced nowadays have approx. 200 to 250 pads on the chip with a pitch of 80 µm and with pad dimensions of 65 x 65 µm^2. The corresponding microcontrollers for products in development already have 300 to 400 pins with a now reduced pitch of 60 µm and current pad sizes of just 52 x 52 µm^2. Comparable miniaturizations in component dimensions are also to be found, of course, in the passive parts.

To be capable of offering product solutions, Continental must constantly respond to the effects of new component solutions and push ahead with appropriate advanced developments in the area of electronic packaging. In the case of the aforementioned microcontroller chip, the following adaptations were required for the introduction of the new microcontroller into new TCU products:

1. At the beginning of control development, it was no longer possible to wirebond the smaller pads on the chips with the 25 µm thick wire employed at the time. A reduced wire thickness was required; new materials and process qualifications had to be carried out.
2. All the requisite interconnections had to be bonded down from the chip to the substrate. To ensure stability, the permissible wire length for the thinner wire had to be considerably shortened. As a consequence of this, the bond pad pitch for the bonding wires on the substrate and the conductor widths also had to be reduced (in the case at hand 150 µm). Advanced development of the substrate technology was also necessary as this new requirement went beyond what was possible with screen printing process used up till then for fine conductor lines.
3. In integrated transmission controls from Continental, thermal conductive adhesive is generally used to mount the ceramic substrates on the housing plate. As a rule, higher integration at the silicon chip level also results in greater power dissipation density. To ensure that the chip is adequately cooled nonetheless, concrete improvements in the thermal adhesive were necessary (material with a higher degree of thermal conductivity or application of a thinner film of thermal conductive adhesive).

This list of fields where advanced developments in electronic packaging were needed in the case of the microcontroller chip on a thickfilm substrate underscores how necessary it is to pursue new approaches to solutions in the domain of substrate and interconnection technologies.

Continental innovations ensure technical solutions and competitiveness

The technical innovations cited and optimum testing and technical qualifications are crucial to Continental's success. To further bolster this edge, work on new solutions is constantly under way. There is a demand for technical solutions that can find their way into concrete products in a foreseeable time range, that can be realized in high-volume manufacturing and that are also certain to be accepted by the customers. Continental's preeminent market position in certain product segments (e.g. DCT) must also be maintained in the face of rising product demands – advanced technologies are a solution here.

The following Continental solutions can be cited as examples of current innovations in the area of new materials:

- New high-temperature-resistant housing materials
- Special types of metallization on silicon chips for highly reliable wirebonding (capable of withstanding high temperature loads of up to +175 °C for at least 10 000 h)
- Improved thermal heat-transfer materials to enable an effective heat flow from the component to the housing base plate
- Improved materials for the electrical connections of components to the substrate, e.g. electrical conductive adhesive materials and high-temperature-resistant wirebonding materials

Figure 8 Test substrate for conductive adhesive interconnections of new component shapes for use in transmission controls (detail)

- Qualification of new materials generally for service temperatures of up to +175 °C

In Continental's BU Transmission new material solutions of this kind are routinely tested and qualified on test assemblies suitable for this purpose. By way of example, Figure 8 illustrates test setups used in qualifying new conductive adhesive materials together with new component packaging shapes. The goal is to ensure that the new components themselves as well as their conductive adhesive interconnections are up to withstanding product-relevant temperature requirements (up to +200 °C) and very high vibration requirements.

All material developments must be accompanied by a characterization of these new materials determined by means of appropriate analytic methods and facilities. The Continental BU Transmission has purposefully expanded its own analytic and test competence, focusing on thermal and chemical analysis and adapting specific test methods to the requirements for transmission controls.

As an example for innovations in the area of substrate and interconnection technology, new development results on the miniaturization of thickfilm ceramic circuits will be presented below.

As already discussed, new semiconductor components with high pin counts require adapted conductor line widths and spaces on the substrate. Due to the fluxion of the thickfilm pastes during the firing process, there are process limitations for conductor lines and spacings that can be obtained. Under high-volume conditions, minimum line widths of 150 µm and spacings of 100 µm can be realized with gold paste. These structures are too coarse for the higher pin count chips of the future. In the case of more extensive requirements, additional dielectric layers and a second metallization layer will have to be included.

Continental's new laser structuring solution avoids these process-related limits. Instead of direct screen printing of the tracks, these areas are first

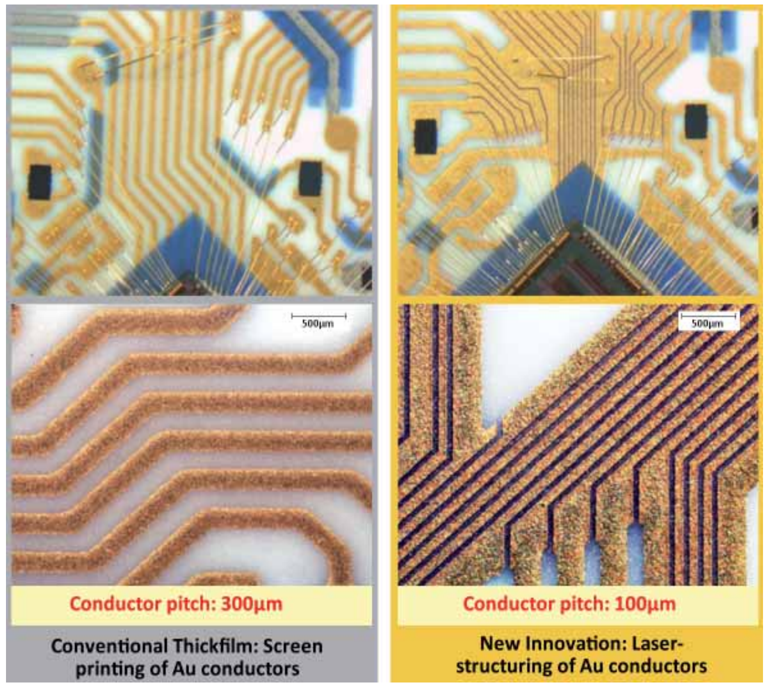

Figure 9 Comparison of conventional thickfilm technology with gold conductors realized with screen printing technology (left) and with the new process of laser structuring of gold conductors (right)

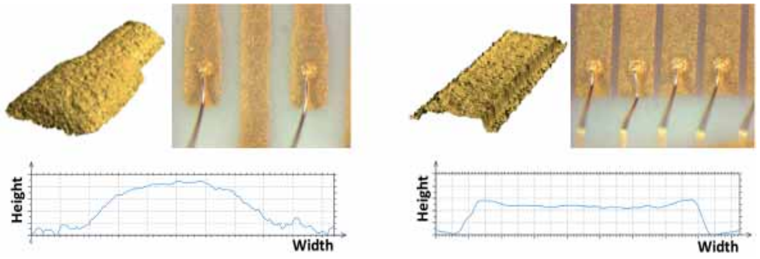

Figure 10 Quality improvement in the gold wirebond process by laser structuring
Left: Flatness of conventionally printed bond pads on a ceramic substrate
Right: Flatness of bond pads after laser structuring

printed as contiguous areas. After this the line spacings are laser cut and then the paste fired in. The result has really "incisive" advantages:

- The process allows for very small line spacings of 35 – 40 µm – in other words, spacings that screen printing technology alone cannot obtain on a ceramic substrate. In high-volume production laser structuring is today capable of realizing line pitches (= conductor line plus space) of 100 µm (in comparison to 250 – 300 µm with the conventional screen printing of gold conductor lines).
- Overall the decrease in conductor lines and spacings reduce the total area on the thickfilm substrate required for wiring. On the whole, the ceramic substrates may end up smaller.
- Decreased spacings allow for denser wiring, whereby, in most cases, additional metallization levels and corresponding dielectrics are eliminated. This saves material, production steps and, all in all, costs as well.
- The decrease in conductor spacing is accompanied by an equivalent reduction in the distances of the bond pads for gold wirebonding. Smaller bond pad distances than previously possible can be realized, allowing for the use of semiconductor chips with a higher number of I/Os.

The bonding areas can now be arranged not only much more uniformly and shorter than it was possible previously with thickfilm technology. As laser structuring cuts the bond pads out of a larger conductor plane, the bond pads on the substrate are very much more even than those realized with screen printing technology. This further increases the reliability of such wirebond interconnections.

By way of summary the introduction of innovative laser structuring of conductor lines now guarantees that in-house thickfilm substrates are suitable for the increasing circuit complexity and density expected in the next few years.

Competitive edge thanks to effective technology networking

Innovations in the electronic packaging of control units result not solely from in-house ideas during product development. The Continental BU Transmission profits also from active technology networking with research institutes, universities, suppliers and other external and internal units. Joint research and development projects – often with the active participation of customers and even competitors – make possible insights into other industrial applications and provide innovation stimulus from outside the company. Current topics that exemplify this are improved packaging concepts for microprocessors or also new soldering materials aimed at ensuring longer service life.

Innovative technologies are a top priority at Continental. In-house basic/advanced development of technologies is necessary in establishing a technical edge in the next generation of transmission controls, thereby guaranteeing the competitiveness of tomorrow's products. Intra-corporate technology networking – e.g. on design guidelines, new materials or manufacturing processes – furthers this goal.

New products by system integration

Continental and Schaeffler's automotive customers are striving for more far-reaching integration of transmission electronics, sensor modules and hydraulic units. This cuts space requirements and eliminates the need for additional interconnec-

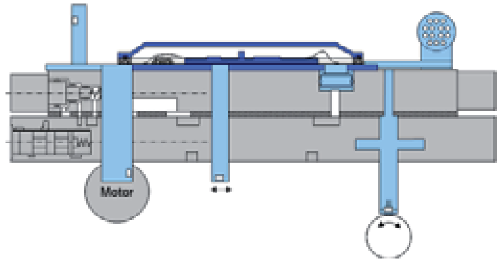

Figure 11 Higher integrated systems and products

tions, and thus reduces costs and increases reliability at the same time. Figure 11 shows which product levels Continental has covered so far and which new products will result from further integration:

The dark blue area shows the scope of transmission electronics per se, i.e. without sensors, as found in stand-alone control units as well as in attach-to product solutions offered to Continental´s customers. The inclusion of sensor modules (areas in light blue) broadens the functional scope in the direction of integrated transmission control – a product form now standard equipment in modern automatic transmissions (conventional (stepped) automatic transmission, double clutch transmission and CVT).

Current product developments as well as new product inquiries go a step further and incorporate pump and engine control, too. The nominal capacity typical for these lies in the 150 - 500 W range. Incorporating these additional functions into a control unit poses a technical challenge already today, above all because of the high currents and the extra expense for suppression shielding. If, ultimately, even the valves themselves and the hydraulic units (gray area) are included, still more highly integrated units and products will result for Continental and Schaeffler. This, in turn, opens the door to new technical issues, requiring new solutions for their products in the domain of materials and electronic packaging.

New approaches for electronic packaging solutions

Automotive electronics accounts for a 5 to 7 % share of the entire electronics market. Other application fields – telecommunications, for instance, industry and military technology – are the ones determining the key development trends: in semiconductor technology, for example, in component packaging technology, substrate technologies etc.

To ensure the success of the next transmission control generation, Continental has to survey new trends in the overall electronics world and analyze their applicability in meeting the specific needs of transmission controls. Sometimes already existing solutions (merely) have to be qualified for the higher requirements in the automotive sector. Most often, though, comprehensive adaptations are necessary (e.g. wider isolation pitches, larger conductor lines for higher current values, specific basic materials ...) or wholly new solutions (laser structuring on thickfilm circuits is, as seen, a case in point).

Important development focal points for future transmission controls are:

- More functionality (with more modest demands on space)
- Systems integration (control electronics, actuator technology, sensors, mechanical parts)
- Miniaturization at all levels (components, substrates, interconnections, overall device)
- Cost reduction
- Robustness (higher operating temperatures, longer service life, lower failure rates ...)

In the case of many customer inquiries, a crucial issue is how much space the electronics will need; this is especially pertinent with integrated transmission controls. As representative of the focal topics cited, therefore, a brief presentation is provided here on future solution possibilities as regards the miniaturization of unpackaged semiconductor chips (Figure 12):

Previous semiconductor chips were assembled by means of electrical conductive adhesives, followed by wirebonding. While the process has, in fact, established itself, it does require additional wire bonding area outside the chip, depending on the number of wire bonds and the bond rows needed for these connections. Continental is working on processes for realizing up to four rows of wires with a wire diameter of 23 µm. This method makes microcontroller chips with up to 600 interconnections to the substrate possible (Figure 12 on the left).

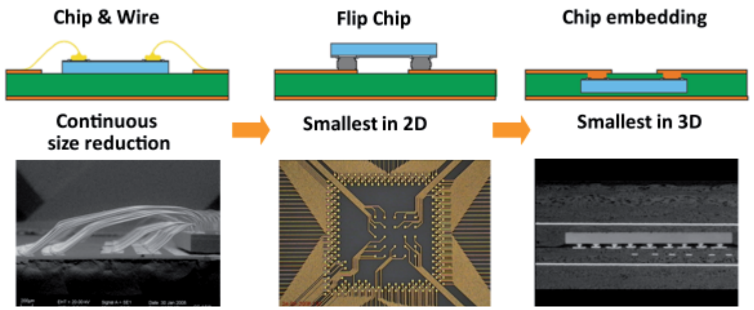

Figure 12 New concepts for solutions in the area of miniaturization of chip structures

The size of the transmission controls is determined mainly by the required substrate area, by the number and size of passive components, the number of chips, the chip areas themselves and the areas additionally required for wire bonding and for interconnections on the substrate. The lowest surface area requirement for chips at the substrate level (2D) arises if wirebonding interconnections are completely avoided and, instead, the chips are soldered on by means of tiny solder depots (solder bumps) on the substrate's connection pads. For system-related reasons, this so-called "flip chip" (FC) technology assumes that conductor line widths and spaces on the substrate are comparable to those on the chip itself. Furthermore, the production technology for populating and inspection is very complex, all of which explains why FC technologies have managed so far only to achieve a niche status. Continental is at work on this matter too. Technological studies are under way to determine whether and under which conditions microcontrollers for transmission applications can be built employing flip chip technology (center Figure: Continental test circuit for flip chip mounting of microcontrollers).

The only way to further miniaturize the structure of the tiniest 2D solution is to mount it <u>in</u> the substrate (3D) instead of <u>on</u> the substrate.

In this case, the chips are embedded in the substrates by means of various processes. These new concepts named as "chip embedding technologies" are currently what's big in PCB development for future applications in automotive electronics and elsewhere. Like its competitors, Continental is also pursuing approaches of this kind, in the form of research projects, for example. Continental BU Transmission, for instance, is presently conducting the VISA BMBF research project (Fully Integrated Power Electronics Systems in Automotive Electronics). The goal of the project is to embed active components (e.g. microcontroller chips for transmission controls) and passive components (e.g. resistors) into circuit boards and then test their serviceability in transmission applications.

Summary

For the Continental BU Transmission, innovative technologies are a key factor in the technical and commercial success of its products and in maintaining and further expanding its competitiveness, innovative capability and market position. The significance of these topics is quite evident. The right selection of materials and implementation of new electronic packaging concepts can have a decisive influence on future transmission controls. This touches on customer-relevant properties like size and weight, reliability, quality, eco-friendliness and, of course, cost.

Transmission controls are wholly customer-specific holistic solutions. Each product differs from others in important aspects like functionality, sensor systems, design, service life requirements, temperature, reliability etc. This explains why tailor-made solutions are always in demand as means of offering each customer the optimum technical solution and remaining ahead of the competition. To this end, Continental develops self-contained high-volume-grade concepts, as was discussed using the example of in-house thickfilm technology.

The whole subject area will continue to expand on into the future. It is absolutely inadequate to rely solely on the current stock of material solutions for the development of tomorrow's products. Material adaptations and qualifications are repeatedly required even for ongoing high-volume products – whenever, for example, the customer changes the transmission oil used. The customers' ever more stringent requirements as regards operating temperature and service life as well as increased reliability in the case of electronics force Continental to renew their efforts to advance the development of known materials and electronic packaging concepts and to analyze, qualify and introduce new solutions. Continental is excellently placed thanks to its basic development achievements, its active involvement in research projects and effective technology networking inside and outside the corporation. Transmission control production has been completely globalized, with factories in Europe, Asia (China) and America. The company is thus present locally in the countries in which vehicle manufacturers also have their plants. This enables Continental to close any gaps in their development and production know-how in the area of customer-specific transmission solutions for passenger cars and commercial vehicles.