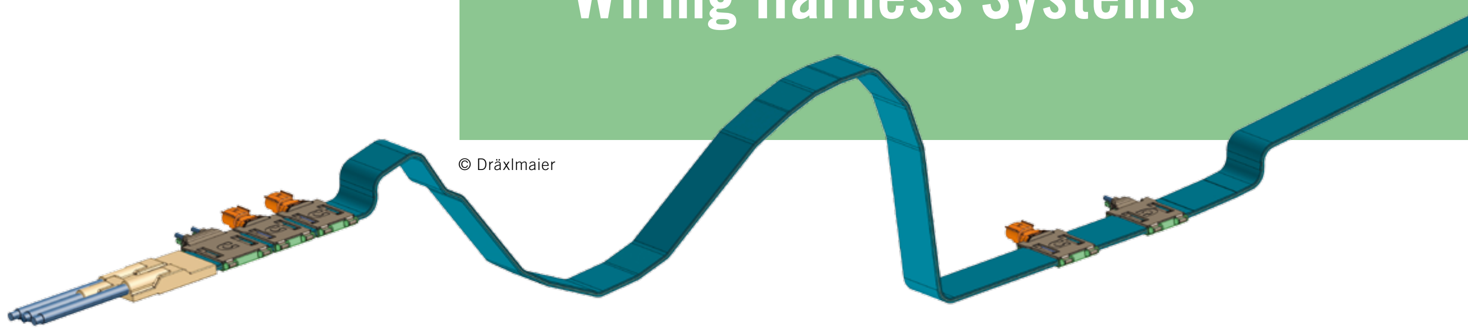
Solutions for Distributed Supply of Electrical Wiring Harness Systems



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Wiring harnesses are getting heavier, their energy supply is getting more complex and installation space more valuable. New solutions will have to be found for the design of future electrical system architectures. The Dräxlmaier Group has now taken a first step with a groundbreaking project.

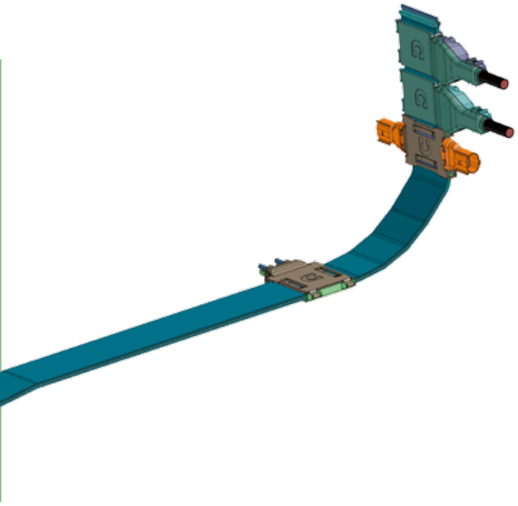
GROWING NUMBER OF FUNCTIONS IN A CAR

Mobile communication experts, entertainers, intelligent navigators: Today's vehicle is much more than just a car in the classical sense. The public is eagerly waiting to see what features tomorrow's car will have. Because the possibilities – particularly in the area of communication and intelligent driver assistance systems, are far from exhausted – the number of functions in a car will continue to grow in the future. Automated driving, which has already been partially realised in many new premium-class cars, is basically only a predecessor of the actual goal: autonomous vehicles. But even with all these technical achievements, how will automakers be able to satisfy the demands of all consumers in the future, such as economising on installation space and reducing weight?

Innovative, technological approaches are needed to deal with the challenges in current and future supply networks. In the past few years, the Dräxlmaier Group has concentrated its research and development on working out various basic approaches and has merged the results in the Dräxlmaier smart KSK experimental vehicle, a prototype with which Dräxlmaier presents viable solutions to future demands on electrical wiring systems, **FIGURE 1**.

Thus, the entire 12-V supply network that is normally implemented as a tree structure in vehicles was replaced in the Dräxlmaier smart KSK by a backbone structure – starting with the battery distributor, and ending with the front and rear power distribution. The entire grounding concept was also adapted in the course of this. As the focus in future body construction will increasingly be placed on non-conducting materials, such as CFRP or other compound materials, the backbone concept is integrated into central mass distribution.

A triple-layer multi-bus will help provide centralised 12-V power supply on the one hand and grounding return on the other – all in a single component. The use of the multi-bus has also proved to be beneficial in other respects, namely in terms of the stability of the electrical system. For example, the sandwich con-



struction of the multi-bus caused almost complete EMC field obliteration. In addition, considerably less installation space is required when using the multi-bus: Thanks to its special form and its limited height, it can easily be included in body designs. Based on the concept of lightweight construction, the Dräxlmaier smart KSK uses aluminum instead of copper; this has a beneficial impact on the overall weight of the vehicle.

INTEGRATED AND DECENTRALISED SUPPLY ARCHITECTURE

More reliable, safer, lighter, more space-saving: Not only can the new concept optimise the current electrical system, it also provides solutions on how to deal with future demands, **FIGURE 2**.

Three different contacting methods were selected for the connection: welded contacts, screwed contacts and plug contacts. While the generator and the battery are connected by a welded or screwed contact for the 12-V power supply and the ground connection, the power distribution is connected by plug contacts. That provides multi-drop capability, which makes decentralised connection of each of the power distributors possible. In addition, this means that the design of the wiring harness can be optimised because it allows decentralised functional power supply, enabling the feed lines to be shortened by an average of 1 m.

The second important improvement, which is excellently demonstrated in the Dräxlmaier smart KSK, is the new fully electronic power distributor. All seven power distributors installed in the experimental vehicle are identical in construction. The only difference is in the configuration of the various load paths.

SOLUTIONS TO OPTIMISE THE WIRING HARNESS

If each of the individually considered parts named above can now be described as being innovative, the combination of these parts in the experimental vehicle has resulted in innovatively integrated, decentralised supply architecture with intelligent electronic power distributors, **FIGURE 3**.

This required extensive vehicle measurements during research and development, which ascertained the individual load profiles of the connected functions. Based on these, an optimised cable gauge was identified for each function, **FIGURE 4**.

So, for example, the power supply of the seat heating was reduced from 2.5 to 0.75 mm². In the rear window defroster, there was a reduction from 2.5 to 1.5 mm². Supply of the electrically operated tailgate lock now requires only a gauge of 0.35 mm² instead of 1.5 mm². On average, the cable gauge has dropped by 50 %.

Ascertaining the load profiles had further benefits, as integral energy management could then be set up on that basis. The bus system to integrate power distribution is a private CAN. The master takes over the terminal signals of the vehicle and controls the individual power distributor across them. The system

FIGURE 1 The triple-layer multi-bus in the Dräxlmaier smart KSK experimental vehicle includes front and rear connection technology (© Franz Haslinger | Dräxlmaier)

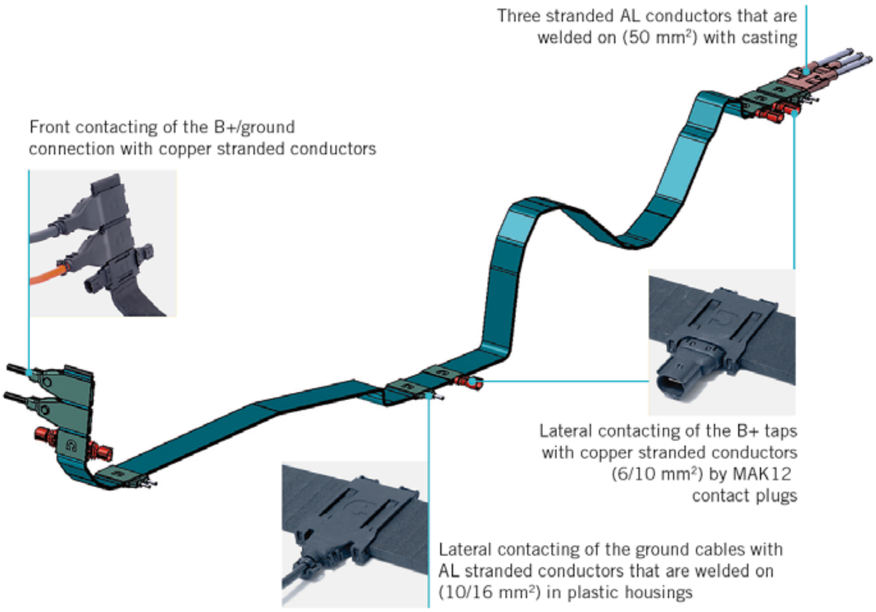


FIGURE 2 Detailed illustration of the triple-layer multi-bus including the various connection methods, such as welded contacts, screwed contacts and plug contacts (© Dräxlmaier)

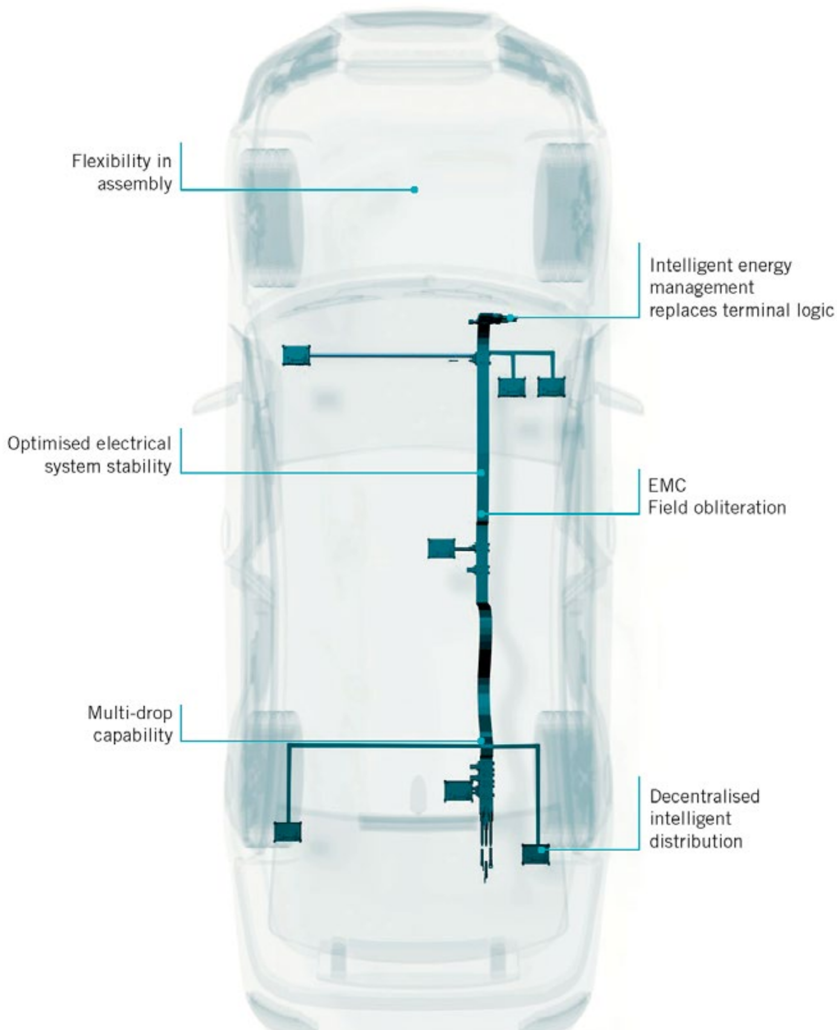


FIGURE 3 Backbone vehicle electrical system architecture in the Dräxlmaier smart KSK (© Dräxlmaier)

functions also support energy management by way of temporary overload cut-off and enable fast, autonomous access control to stabilise the electrical system. A particular challenge was designing the concept for the intelligent power distributor that was suitable for low voltage and quiescent current, **FIGURE 5**.

An electronic switch now takes over the function of the former three control elements: It is a clamping circuit, a fuse protection and functional circuit all in one. This type of redistribution will produce a whole new generation of electrical system architecture concepts, although in the case of the Dräxlmaier smart KSK, only the clamping circuit and the fuse protection can be put into effect for the time being, as a functional circuit would require accessing the communication architecture of the vehicle. This is one of the next targets for future experimental vehicles.

The results of the developments speak for themselves: Reducing the load paths in the lengths and decreasing the cross-section of the wires has reduced power dissipation. The power balance of the vehicle is therefore positive. The weight of the wiring harness in the experimental vehicle has been reduced by 10 %. When projected to the various equipment variants, the electrical potential varies between 6 and 14 %. Thus, an optimised design of the load path could result in up to 2 % cost savings in the wiring harness.

The task now is to promote development by gaining experience with the experimental vehicle. Based on the overall electronic approach and the described decentralised supply topology to optimise the energy flow in the vehicle, future cross-linked energy management should form the basis of a concept for fail-operational functions in the supply layer. Moreover, it could show considerable potential for wiring harness development.

It is too early to predict the extent of an electronic design. The goal should be to find a worthwhile combination of proven and new methods. Being able to monitor and control the supply of functions may be particularly crucial in the fail-operational range and thus of special interest for the realisation of autonomous driving.

One approach here lies in modularising according to need and function in each power distributor. Cross-linking the power distributors, as has already been

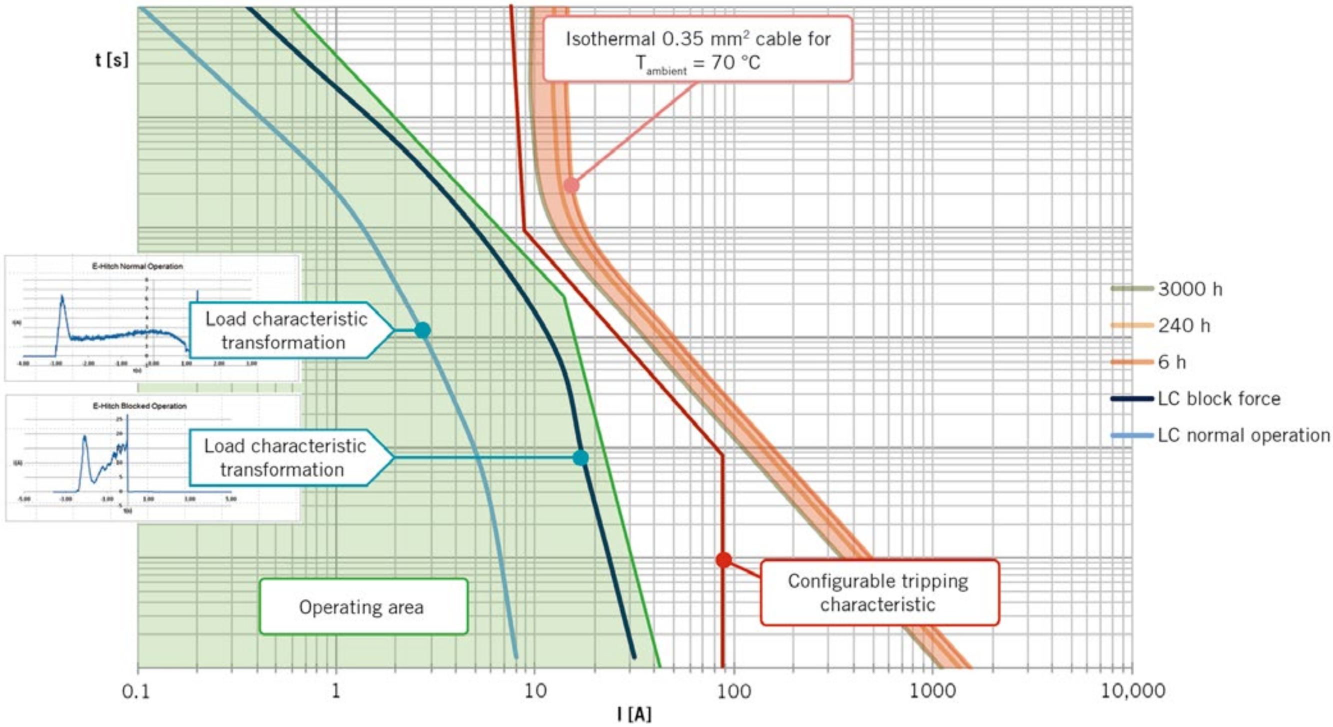


FIGURE 4 Example of using load characteristics for the design of a cable – in the example, the cable was reduced from 4 to 0.35 mm² (© Dräxlmaier)

done in the experimental vehicle, will also be indispensable here. However, modularity like that will also interfere with the setup of the power distribution. Ultimately, some communication functions will have to be retrofitted. From a production point of view, this will doubtlessly be a challenge because up until now, installing electronic parts in wiring harnesses is not usual in the industry.

The integration of the power distribution will also involve functions in the electrical system in the future because the electronic switch, as already indicated above, can take over the actual operation of the functions. This will result in package advantages, as fewer energising leads will be needed. In order to guarantee high-scale integration of the power distributors, the communication interfaces will be flexibly designed. To do this, it will not be absolutely necessary to use CAN; LIN or Ethernet integration would also be conceivable.

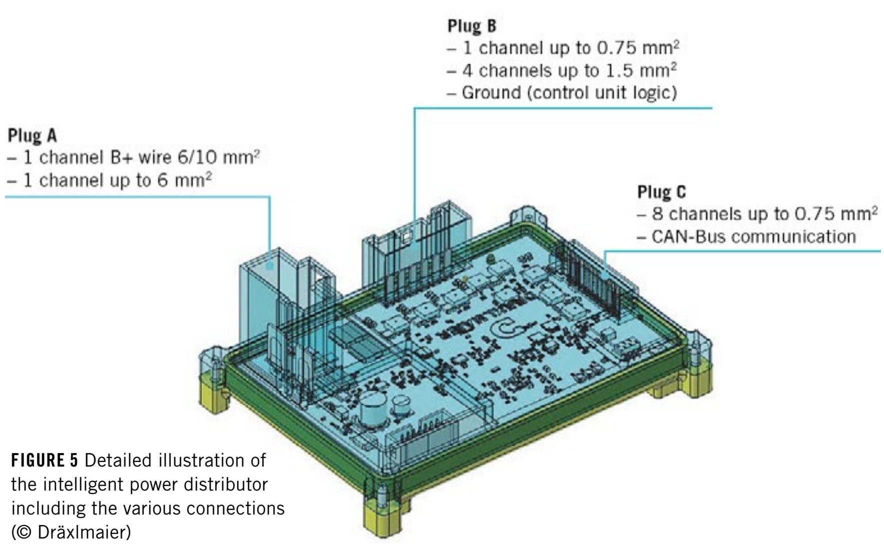


FIGURE 5 Detailed illustration of the intelligent power distributor including the various connections (© Dräxlmaier)

OUTLOOK

The experimental vehicle is the first to apply the new decentralised vehicle power supply with distribution, sensing, switching and fusing functions. In the next stage of expansion, integration methods will be researched for circuit switching, fuse protection, functional operation and energy management, and also for the power distributors. Special importance will also be attached to the integration of the fail-operational functions.

As a partner to the OEMs in the development of vehicle power, the Dräxlmaier Group aims at meeting new demands in the automotive area and providing solutions. The Dräxlmaier smart KSK experimental vehicle was able to set a new milestone for this.

The next step will be to examine system designs on the basis of a new vehicle power system structure with a modular approach. Focus will be on showing functional and design engineering in integration levels – from the application of an integrated circuit, right up to fuses. Development is in full swing because the goal is to derive practical system solutions for the challenges of the OEMs with regards to package, bundle cross-sections, weight and power system stability.