42V PowerNet in Door Applications

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ABSTRACT

This article describes the effects of a future 42V automotive electrical system on the vehicle electronics, focusing mainly on the consequences for power semiconductors and their associated technologies. Taking the example of a door module, it then shows how existing 14V loads can be operated on the 42V PowerNet and what advantages result for operation of adjusted 42V loads. The following different problem-solving approaches are presented for typical loads such as power windows, electrically positioned and heated outside mirrors, and central locking:

- Power windows: A test motor specially developed for the 42V supply is continuously operated directly from the electrical system using suitable power semiconductors.
- Central locking: A conventional 14V motor is operated at 42V, its operating point being set using pulse width modulation (PWM).
- Remaining door module: Smaller 14V mirror motors and the control electronics are supplied from a second 14V system. This second supply can be taken from the current 14V system or generated locally by appropriate switching regulators, or even by a central DC/DC converter from 42V.

INTRODUCTION

Plans to introduce a new 42V automotive electrical system are well advanced, and a relatively clear concept for implementing this electrical system is emerging thanks to thorough groundwork. Worldwide standardization of this new development has now come to the fore. Using demonstrators and models, the advantages and the various possible implementations can be demonstrated in suitable applications.

In this context, the need for power semiconductors with corresponding dielectric strength and suitable power ratings is obvious. However, in the field of intelligent power semiconductors (smart power switches), the choice has until now been somewhat limited for breakdown voltages in excess of 60V. Infineon Technologies is therefore endeavoring to get new technologies and products for these 42V applications off the ground. These can also be applied to related applications requiring higher operating voltages, such as direct fuel injection or complete truck or commercial vehicle electronics. Many new products are already in preparation or even available as samples.

ADVANTAGES OF A 42V ELECTRICAL SYSTEM

The main advantage of the new concept is the substantial reduction of the currents occurring. Assuming constant power in the loads, the currents are reduced to a third due to the tripling of the voltage. The losses caused by electrical resistances in leads, connectors and switches are reduced by as much as a factor of nine. This underlines the potential savings opened up in this area. The cross-sections can be considerably reduced for the wiring harness and plug-in contacts alone. This provides additional weight advantages, which in turn have a favorable effect on fuel consumption. Consequently, the efficiency of the entire vehicle is increased. However, the requirements and effects on power semiconductors are also considerably impacted by this new trend.

ADVANTAGES FOR POWER SEMICONDUCTORS IN THE 42V ELECTRICAL SYSTEM

If the power dissipation in a semiconductor switch is to remain the same at a given, constant load, the response of the necessary conductance is inversely proportional to the square of the nominal voltage ($\sim 1/V_n^2$). This means a marked reduction in the necessary conductance if higher
Voltages are used, based on consideration of the 14V value. In this consideration, the minimum breakdown voltage of the semiconductor was assumed to be $V_N + 30V$ (nominal voltage $V_N$, e.g. 14V). This gap between the breakdown voltage and the nominal voltage prevents breakdown of the device in the event of static or dynamic overvoltages (e.g. load dump or jump start).

This corresponds to today’s standard practice. Based on the same conditions, the illustrated exponentially increasing specific forward resistance of a semiconductor is produced as a function of the nominal supply voltage. This is because of the larger field strengths occurring in the semiconductor. The structures must be enlarged to ensure that the maximum permissible field strengths are not exceeded.

Multiplication of the two curves described now provides the resulting silicon area. As Fig. 1 shows, it first reduces sharply, but then increases slightly again at higher reverse voltages. It is nevertheless apparent that, for the power semiconductor at least, increasing the supply voltage has obvious advantages in terms of chip area.

This development has somewhat different implications for intelligent power semiconductors. These smart power switches have additional logic areas integrated on the chip which implement a wide range of protection and diagnostic functions. These circuits are mainly supplied with an internally generated and stabilized voltage. Consequently, their area requirement is first of all independent of the electrical system voltage used or of the maximum breakdown voltage of the semiconductor.

However, the circuit for the internal supply voltage itself, as well as over- or undervoltage sensing functions are dependent on the maximum system voltage and have an adverse effect on the chip area required if this voltage is increased. Fig. 2 shows the internal design of a smart power highside switch of this kind. The areas negatively affected by the higher electrical system voltage are highlighted in color. Approximately 3 to 5% of the entire logic section is affected in this way.

In the case of low-resistance switches, however, the logic represents only a small proportion of the total chip area. The overall cost of the chip will not therefore be greatly affected by enlarging some circuit sections.

However, not only the chip-related costs but also the costs for a suitable package affect the price of a power semiconductor product. At this point, some thought should therefore be given to the package. As discussed above, for the same load power, the overall area of a power FET device can be reduced. This also reduces the area requirement in a package. Consequently, even smaller packages can be used. Although this often reduces the transient thermal impedance of the device, the simultaneous reduction in the power dissipation means that the heat sinking in the application need not be as good as in a 14V application.

In addition, the smaller packages and often the absence of heatsinks can result in considerable space saving in the control devices. Fig. 3 illustrates this using the example of a rear-window heater. The very fact of operating from higher supply voltages improves the situation of semiconductors compared to relays and...
other electromechanical components. In very high current applications, a relay solution has often been cheaper in today's 14V systems. However, in the 42V system the equation is different. Relays and switches require larger contact clearances and complicated designs to prevent arcing. Moreover, fuses are additionally required. This results in a cost difference in favor of a semiconductor. A desirable side-effect of a semiconductor solution is the high reliability and functionality, especially in terms of protection functions and diagnostic capability. As smart power switches also have excellent turn-off characteristics under short-circuit or overload conditions, any additional protection can be dispensed with.

As already mentioned, changing over to a 42V system can reduce the power dissipation in switches or leads by a factor of nine, assuming the same forward resistance as in the corresponding 14V application. Based on this premise, the dielectric strength of a semiconductor switch has to be increased, which leads to an increase in chip area of approx. 40%. Conversely, however, this also means that the forward resistance could be increased by a factor of nine if the power dissipation in the switch remains constant. As a result, the chip area of this switch can be reduced by approx. 80%. This relationship is illustrated in Fig. 4.

However, the best solution to optimization of an application is very likely to lie somewhere between these two extremes. Increasing the ON resistance while simultaneously reducing the power dissipation appears to be the best compromise here. An attempt to reduce the power dissipation should be made in any case, since a higher-impedance switch with a smaller chip area tends to be mounted in a smaller and hence thermally less efficient package.

![Normalized Chip Area](image)

Fig. 4: Relationship between chip area, power dissipation and R<sub>DS_ON</sub>

A welcome side-effect of adopting the new 42V system is a reduction in conducted EMI emissions. As in future pulse-width modulation will be increasingly used for power control, this prospect is appealing. The costs and complexity of interference suppression measures are considerably reduced. Conducted electromagnetic interference is determined by the current amplitude occurring. Measurements have shown that with constant load power and identical turn-on or turn-off times, the emissions are 10dB lower than for a 14V supply. Fig. 5 summarizes these results:

![Field Application Failure Rates](image)

Fig. 5: Summary of EMC characteristics

No drawback in terms of the reliability of the semiconductor components is to be expected from changing over to higher blocking technologies and processes. The failure rate is determined not by the voltage across the device but by the electric field strength in the semiconductor structures. When developing a new product, these structures are therefore designed so that no excessively high field strengths can occur and the specific service life of the semiconductor can be guaranteed. If the product- or technology-specific design rules are observed, the service life of a product is independent of its reverse voltage. The failure rates for the various power semiconductor technologies employed by Infineon Technologies are less than 1ppm (parts per million). Fig. 6 compares different technologies developed by Infineon in the past in terms of their failure rates. It is clear that the bipolar CMOS DMOS technologies (SPT) are particularly reliable at the high voltages in question.

![Failure rates of different technologies](image)

Fig. 6: Failure rates of different technologies

DEVELOPING TECHNOLOGIES FOR SEMICONDUCTORS IN THE 42V SYSTEM

A large number of modern power technologies are already being used by Infineon Technologies today. Numerous products have been developed for automobile applications, based on both standard MOS technologies and on more complex structures such as SMART-SIPMOS or SPT (Siemens Power Technology). In addition, chip-on-chip processes have also been used for some considerable time now, allowing a combination of the above technologies. However, the largest volume...
is currently being fabricated using technologies specially designed for the 14V electrical system. The reverse voltages involved are mainly less than 45V. These products are therefore only suitable to a limited extent for the 42V system. Aside from this, a range of products with a breakdown voltage of >60V has been available for many years for truck and industrial applications. Having been developed with earlier objectives in mind, these products too have only a limited suitability for the 42V system. However, as Infineon Technologies is highly committed to the 42V sector, the decision has been taken to accelerate the development of higher blocking technologies. At the same time this also enables products to be manufactured for applications employing higher operating voltages (e.g. direct fuel injection or 24V commercial vehicle electronics).

The SPT4 technology currently in use has already been supplemented by a variant with 90V blocking capability. This allows highly complex power switches with high analog capability to be realized. An IC for gasoline direct injection is one example of a first product. Likewise conceivable are ICs for engine management applications in the commercial vehicle sector. The S-SMART process is particularly well suited to achieving high switching powers, i.e. low ON resistances, and medium logic complexity. Here too, first products, including a technology variant with 80V dielectric strength, have been developed and are already available as samples. A typical example is the BTS723, a double highside switch for 24V commercial vehicle ABS applications, which is also used in the door module described below. The BTS660P, with a forward resistance of 9mΩ, is an example of a general-purpose high-current switch for 42V loads. Other products which are particularly suitable for half and full semiconductor bridges are the TEMPFETs. These products are ideal for PWM operation of loads with extremely high currents, such as those present in multiphase motors or DC/DC converters. They are fabricated using the chip-on-chip process mentioned above and consist of a base chip in a modified 70V S-FET technology and a top chip used as a temperature sensor.

Based on higher blocking technologies, more complex devices with comprehensive protection and diagnostic functions can also be implemented using chip-on-chip processes. The product range can therefore be extended as required and the functionality increased accordingly.

**EFFECTS OF TRANSITION TO 42V ON ELECTRICAL LOADS**

Like semiconductors, standard loads such as lamps, coils, relays and electric motors will, of course, be massively affected by the changeover to a 42V system. The modifications or new requirements placed on these loads will not be examined in further detail here. The following listing is intended purely as a brief overview:

- **Lamps:** The service life of lamps operating at 42V is considerably reduced and continues to pose problems. Consequently, vehicle lighting will presumably continue to be supplied with 14V. Alternative concepts such as LED lamps and gas discharge lamps are becoming increasingly interesting in this context.

- **Coils:** Inductors and magnetically switched loads must also of course be adapted to the new conditions. In view of the lower currents involved, thinner winding wires can be used, though this can lead to processing problems with very thin wires. The number of windings, on the other hand, will be tripled. Modifications to the cable connectors and mechanical components will also be necessary in some circumstances.

- **Relays:** The contact clearances must be increased. Special measures, such as bridge contacts, are necessary for preventing arcing. Some control coils will have to be adapted. The external mechanical dimensions and the connectors may be changed.

- **DC electric motors:** The number of windings and wire thickness will be changed. The armature resistance and the motor inductance will be increased by a factor of nine. Losses, motor weight and efficiency will only change insignificantly. Interference suppression and electromechanical thermal protection will become more complex.
POSSIBLE CAR DOOR IMPLEMENTATION OF A 42V MODULE

The concept presented here is only a proposed implementation. Countless other solutions are also conceivable but cannot all be considered here.

To enable a universally valid proposal to be made, only the typical loads and generally encountered functions are described here. Fig. 8 shows a standard configuration for a decentralized door module.

![Diagram of a decentralized door module](image)

Fig. 8: Typical configuration for a decentralized door module

The most frequently used components will be briefly described below:

- The electric window lift: The core element is a comparatively high-powered electrical motor (100-300W) which is used to drive a mechanical window regulator. The window is opened or closed as long as a switch is actuated. However, many manufacturers nowadays also provide additional convenience functions, such as automatic opening and closing. In this case the window is automatically moved to the upper or lower stop as soon as the corresponding switch is momentarily pressed. However, it is a legal requirement that sufficient injury protection be provided for this function. If forces exceed 100N, the closing process must be stopped immediately. This requirement is met in various ways. A very effective but expensive method is the anti-trapping strip. This consists of a flexible, electrically conductive material whose resistance changes in response to mechanical pressure. When mounted on the upper window frame of the vehicle door, it can detect whether a body part or an object has been trapped between window and frame. Another monitoring option is to detect motor current and motor speed. If the current rises and the speed falls, it can be assumed that something has been trapped in the window. Another possibility is optical monitoring of the window gap. This solution deactivates the mechanism before anything can become trapped. However, the anti-trap solutions vary between different manufacturers and vehicle types. Algorithms which can differentiate between different operating states of a car door such as “trapping”, “window frozen” or “door distorted” are already available or under development.

- The electrically adjustable heated external mirror is nowadays to be found on virtually all automobiles. It has become a standard fitting. In most cases two small electric motors (~10W) are used for positioning on the two axes. To heat the mirror during adverse weather conditions, a voltage is applied to resistive foil typically bonded to the rear of the mirror, causing the foil to heat up. However, heated wire e.g. of the type used for windshield heaters is also used.

- For central locking systems there are a large number of solutions. Pneumatic, electromagnetic or electric motor actuation are frequently used principles. In the module shown here, an electric motor (~10W) is used to disable the door lock.

Other functional features of a door module are evaluation of the control switches and interoperation of the module with the vehicle body bus for exchanging diagnostic and status data. Here, too, a variety of logic distribution strategies exist.

**Door modules in 14V electrical systems**

An example of a 14V door module is shown in Fig. 9.

An integrated full-bridge semiconductor circuit is used to drive the window lift motor. (BTS7900). We shall now briefly examine the basic operating mode of a bridge circuit of this kind. The bridge consists of two smart power highside switches and two likewise intelligent lowside switches.

These switches are all individually protected against a wide variety of fault conditions such as short-circuit, overtemperature, over- and undervoltage, as well as overload. The ON resistances are optimized to very small values so that a bridge path resistance of max. 17mΩ is produced at 20°C.

This allows the currents of 10 to 15A present and blocking currents up to 35A to be controlled. In order to reduce the space requirement of such circuits, a special power package has been developed in which all four switches can be integrated and which additionally ensures good heat dissipation.
Fig. 9: Proposed circuit for a 14V door module

This allows the application to remain operational even at elevated ambient temperatures. In addition, the lowside switches are designed for rapid switching (<30kHz). This permits pulse width modulation (PWM) outside the audible range. This PWM capability allows the mechanical stresses affecting the window lifting mechanism during starting and stopping to be selectively reduced by means of soft starting and soft braking. In addition, speed fluctuations caused by dynamic changes in the electrical system voltage can be compensated. This measure improves the anti-trap protection conditions. If the glass always moves at the same speed, the maximum trapping force occurring is also always of the same magnitude. In this proposal, evaluation of the anti-trapping strip combined with current monitoring is used as anti-trap protection.

A similar full-bridge semiconductor circuit to the one just described is also used for central locking. However, for this application the current flowing is much lower (<2A). In addition, PWM is not absolutely necessary, as here the mechanical stresses are lower and also no speed regulation is required. A BTS7750 therefore fully meets these requirements. The P-DSO28 package is ideally suited to transient thermal loads of the kind predominantly present here. Depending on the type of lock, the motor must be switched on for a defined time in one or other direction (in this case ~700ms).

Device TLE6208-3 is suitable for positioning the outside mirror. It consists of three half bridges and is likewise equipped with all conceivable protection functions. Here, the individual bridge switches are no longer actuated directly via parallel input pins, but via a serial interface also known as SPI or SSC. The diagnostic information from the bridge arms is also fed out via this interface.

The three half-bridge arms are connected to the two motors as shown in Fig. 9. Thus, two full bridges can be implemented using only six power switches. Both motors must not be operated simultaneously, as this would overload the shared half-bridge arm.

An 8-bit microcontroller is used for driving, regulating and evaluating the power switches and for communication with the vehicle bus. The requirements for this device are relatively simple:

- 2-4 PWM ports
- Approx. 10 I/O ports
- Serial interface SSC
- CAN module
- 1-2 A/D channels

These requirements are met in full by the C505 microcontroller used in this case. If more complex control algorithms for anti-trap protection and additional measures for driving the power semiconductors (e.g. active freewheeling of the window lift bridge) are required, a 16-bit microcontroller is certainly also advisable.

Door module proposal for the 42V electrical system

In the proposals being considered here it is assumed that the technical requirements placed on the functionality of the door module will be unchanged when the industry changes over to a 42V system. The applications will have to meet the same requirements in terms of function, speed and environmental conditions. However, the type of operation, the motors and the drive devices are in some cases completely different from the familiar 14V module. As described at the beginning of this article, the current is reduced by a factor of 3 by the higher supply voltage. Other semiconductors will therefore also be used to switch the loads. In the example described here, three different possibilities for handling the 42V environment are described.

The window lift motor has been specially designed for a 42V supply. The number of windings has been tripled, the winding wire diameter has been reduced to a third, the commutator and the brushes adapted accordingly. As a result, the motor torque and speed correspond to the ratings of the 14V motor. In principle, this motor can now be operated from a 42V supply in precisely the same way as in the 14V system. The requirements for the power semiconductor full bridge are clear:

- The breakdown voltage of the switches must be higher than the maximum electrical system voltage present. In the example, this is >65V for the highside switches and >55V for the lowside switches.
• The forward resistance must be rated such that the motor current can be handled without the devices overheating. Power dissipation calculations must be carried out according to the cooling options, the packages used and the ambient conditions.

• The normal switch protection functions (short circuit, overvoltage, overtemperature, etc.) are of course also required here.

• In order to provide the monitoring facility often required, the devices must be provided with a suitable diagnostics interface.

In the example application, the semiconductor bridge for the window lift motor is designed using discrete components. A fully protected dual-channel smart power highside switch (BTS723) forms the upper part of this H bridge. The two lowside switches are standard MOSFETs (SPD28N05) possessing no protection functions of any kind. By suitable dimensioning of the power dissipation in all the devices, the protection mechanisms of the two highside switches can also be used to protect the grounded MOSFETs. A full bridge configured in this way is shown in Fig. 10. Using this configuration it is again possible, as in the 14V solution, to use PWM for soft starting or for compensating the voltage variations, as the lowside switches can be switched very rapidly.

If a shunt resistor is employed for current monitoring, its value must of course be matched to the new lower current. Connector diameters and cable cross-sections can also be reduced accordingly. However, the entire control algorithm remains identical to the 14V module. This part of the software can be taken over unchanged.

The advantages of the 42V solution can be seen very clearly here. Instead of the arm resistance of the 14V bridge with 17mΩ, the 42V bridge shows an arm resistance of 95+26mΩ = 121mΩ, accommodated in one P-DS014 and two DPAK packages. Because of the possible higher forward resistance, the 42V bridge can be implemented in a much smaller footprint and at a much more reasonable cost. There is nothing to prevent further development of the bridge constructed here out of discrete devices and its implementation in a single package.

Converting the central locking is somewhat more complicated. These small motors cannot be so easily adapted to 42V requirements, as the physical dimensions would also have to be changed here because of the thinner wires and greater numbers of windings. It is possible, however, to operate a conventional 14V motor from the 42V system using pulse width modulation. This is possible in principle based on the semiconductor bridge already in use today. The system design can, as it were, be taken over unchanged from the 14V solution, with only the switching speed and dielectric strength of the semiconductor bridge needing to be adapted to 42V. This results in a slight increase in the costs for the devices used in the semiconductor bridge.

The motor moves the door locking mechanism within a defined time (here approx. 700ms) between its two end stops. In order to ensure that the lock is actually disabled, the motor is also operated for a short time in the locked-rotor state. As shown in Fig. 11, with 14V operation the maximum locked-rotor current flowing is approximately 2A. This is also the order of magnitude for which the motor is rated. If 42V were now to be applied directly, the maximum locked-rotor current would be three times this figure, as the windings have not been adapted to the 42V environment. In this case only the armature resistance of the motor limits the current.

This results relatively quickly in thermal overload of the armature windings and destruction of the motor. Even under dynamic conditions, problems would occur. Because of the higher voltage, the motor speed is higher, resulting in increased mechanical wear.

This is also why it is necessary to go over to pulse width modulated operation. In a first approximation, a maximum ON-time of 30% is selected. This causes the
mean current to settle to values very closely approaching 14V conditions. However, the frequency cannot be randomly selected in this case. The inductance governs the current rise and therefore indirectly the minimum frequency and maximum ON-time also. Fig. 11 shows the current rise of the motor inductance at 14V supply voltage rotor-locking operation. It can be seen that saturation is reached after approx. 3ms, at which point the current is only limited by the armature resistance.

Fig. 12: Current waveform during a closing process with 14V supply voltage. The starting current, the locking process and the rotor-locking at the end of locking can be seen.

This is the maximum current specified for the motor. If 42V were now to be applied precisely in this way, the current would rise more quickly and reach a higher final value. This would cause the overload situation already mentioned. However, the curve shown in Fig. 11 can be replicated by selecting suitable pulse width modulation. For the motor in the example application, a frequency of at least 3.3kHz and a maximum ON-time of 130µs are now obtained. The resulting current characteristic is shown in Fig. 13.

In order to smooth the characteristic somewhat, the frequency could be increased a little more. This would make the negative-going curve sections somewhat shorter and the distances between the peaks somewhat smaller.

Fig. 14, finally, shows the overall current profile of a locking process. The current characteristic is virtually identical to that in the 14V case (Fig. 12). The motor is therefore undamaged and a similar service life can be expected. The same discretely designed full bridge is used for driving the system as that used for driving the window lift motor. In this way the variety of devices used can be considerably reduced. The same potential for integration of the bridge in a single package applies here as for the window lifter mentioned above.

For a motor specially adapted to 42V requirements, an H bridge with a much higher impedance could of course be used, as will be made clear in the following. A third way of operating with a 42V supply will now be examined. For certain applications there are often special ICs, e.g. for mirror positioning. An IC of this kind has already been described in a previous section in connection with the 14V module. But if one wishes to continue using such devices, it is generally impossible to supply them at 42V. However, with the introduction of the 42V system a second 14V system will certainly also be provided. In this case, part of the door module can then be operated using this voltage. However, if no 14V connection is available, a local DC/DC converter can also be installed relatively inexpensively for small and medium currents (<2A). A variety of commercially available ICs are available for these applications. Both fully integrated devices and switch-mode power supply control ICs with external power output stage are available as products. The TLE 6387 is an example of such a device. As the familiar controllers and bus systems (e.g. CAN bus) are commonly supplied today from the 14V system, a possible solution is to set up a 12V or 14V supply locally. Applications such as mirror positioner or mirror heater carry only relatively low currents and therefore could then be supplied via this switch-mode power supply as well, to provide a rapid implementation. A proposal for
the design of a complete 42V door module is shown in Fig. 15.

![Diagram of 42V door module](image)

Fig. 15: 42V door module with internally generated 14V supply

With this approach it is already feasible today to implement a door module which is supplied exclusively with 42V. Only the window lifter motor has been modified for 42V, all the other components are more or less unchanged. As 42V solutions are more widely adopted, the remaining 14V loads can be gradually replaced by 42V loads. This will lead to a gradual reduction in the costs of semiconductor switches and DC/DC converters until an optimum cost level is reached.

**DOOR MODULE VISION FOR THE 42V ELECTRICAL SYSTEM**

In the example above it was shown how a door module can be built without first having to immediately redevelop all the individual components for a 42V supply. A vision of a solution will now be presented in an attempt to illustrate in two steps how the electronic part could be realized if all individual loads are directly supplied at 42V. Fig. 16 shows optimized semiconductors using some 14V loads, whereas Fig. 17 presents a design based exclusively on 42V loads and semiconductor components optimized for this.

As far as the window lifter is concerned, there is no change as compared with the example shown. However, the bridge could be implemented as a discrete device, e.g. using an 80-150mΩ arm resistance, depending on cooling options, in a power IC package (see Fig. 16).

The H-bridge for the central locking could be integrated in a small SO package (Fig. 16). If 42V motors are used later (as in Fig. 17), the currents occurring will reduce to approx. 100mA continuous current and 300mA blocking current. For the same dielectric strength, the bridge can now be given a significantly higher arm resistance of approx. 800-1400mΩ and hence be implemented in a much smaller footprint and much more cheaply.

The control electronics for mirror positioning and mirror heating could likewise be implemented as a very high-impedance solution in a single package. Mirror positioning using 42V motors (Fig. 17) results in currents of <200mA, and consequently bridge path resistances of several ohms. Mirror heating is a similar case. The cost argument in favor of the semiconductor is clear. A device already developed for 42V, the BTS 752R with 200mΩ in the SO-8 package, is a likely candidate for mirror heating.

![Diagram of 42V door module](image)

Fig. 16: Door module with 42V supply only. All the switches are optimized. Some of the loads are still designed for 14V operation. The bus driver is supplied at 12V via a voltage divider.

In order to supply the microcontroller, other logic devices, possible sensors and bus driver, a step-down converter is used to reduce from 42V to 5V or even smaller voltages. The recently developed TLE 6361 device is ideally suited for this task. This device enables independent and individually protected voltages of 5V, 3.3V and 2.5V to be generated from 42V. Notable features of this solution are a low filter overhead and low power dissipation. Direct supply by means of linear voltage regulators from 42V is unrealistic due to the high power dissipation.

It is of course possible to pursue this approach even further. As a next step, functions such as voltage converter, bus driver, and possibly even the mirror controller and mirror heating, could be implemented as a peripheral device or system chip. In a further stage this could, of course, also include the microcontroller and other logic functions. However, this development route only appears worthwhile if it results in benefits in terms of reduced system costs.
The introduction of a new 42V automotive electrical system offers good prospects for power semiconductors. The silicon areas can be dramatically reduced. By minimizing power dissipation, new mechatronic actuators are also conceivable for which the drive electronics can be directly incorporated in the load. An example of this is the window lifter or door lock. With reasonable system approaches and taking all components – actuators as well as drive circuitry – into account, a cost benefit must surely be achieved. However, in the short term a complete changeover to 42V is unlikely. Even for the vehicle lighting system using filament lamps alone, an additional 14V supply seems to be necessary at the present time, assuming no new solutions are found in the near future. This voltage can be generated centrally or on a decentralized basis using suitable DC/DC converters. However, for door modules or other car body control devices, an immediate and complete conversion to 42V is also conceivable. Costs can be minimized, at least for higher-current applications. Infineon Technologies has all the necessary technologies under development, has first products already available as samples, and is well geared up to this new trend. If necessary, development of new, possibly even application-specific devices can be commenced at any time.

**CONCLUSION**

The information given here specifies technical characteristics; no commitment to deliver these characteristics is implied.

**GENERAL DISCLAIMER**

The introduction of a new 42V automotive electrical system offers good prospects for power semiconductors. The silicon areas can be dramatically reduced. By minimizing power dissipation, new mechatronic actuators are also conceivable for which the drive electronics can be directly incorporated in the load. An example of this is the window lifter or door lock. With reasonable system approaches and taking all components – actuators as well as drive circuitry – into account, a cost benefit must surely be achieved. However, in the short term a complete changeover to 42V is unlikely. Even for the vehicle lighting system using filament lamps alone, an additional 14V supply seems to be necessary at the present time, assuming no new solutions are found in the near future. This voltage can be generated centrally or on a decentralized basis using suitable DC/DC converters. However, for door modules or other car body control devices, an immediate and complete conversion to 42V is also conceivable. Costs can be minimized, at least for higher-current applications. Infineon Technologies has all the necessary technologies under development, has first products already available as samples, and is well geared up to this new trend. If necessary, development of new, possibly even application-specific devices can be commenced at any time.

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Dr. Alfons Graf studied general electronics engineering and electrophysics at the Technische Universität, Munich. He also gained his doctorate there after researching in the field of MOS breakdown and laser scanning in the years 1985-1990. In 1990 he began working at Siemens AG on the design, layout and testing of CMOS ASICs. After switching to power semiconductors in 1993, he was initially responsible for the design and application of power semiconductors, before subsequently becoming head of technical marketing for power semiconductors. Today, Dr. Graf is head of innovation activities at Infineon Technologies AG, and is also responsible for EMC requirements for power semiconductors in motor vehicles.

Since 1995 Dr. Graf has been a permanent member of various international bodies dealing with the introduction of 42V automotive electrical systems, and he also works on the 42V standardization committee at FAKRA/VDE in Frankfurt. In 1999 he chaired the ‘1st International Congress 42V PowerNet: The First Solutions’ in Villach.

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