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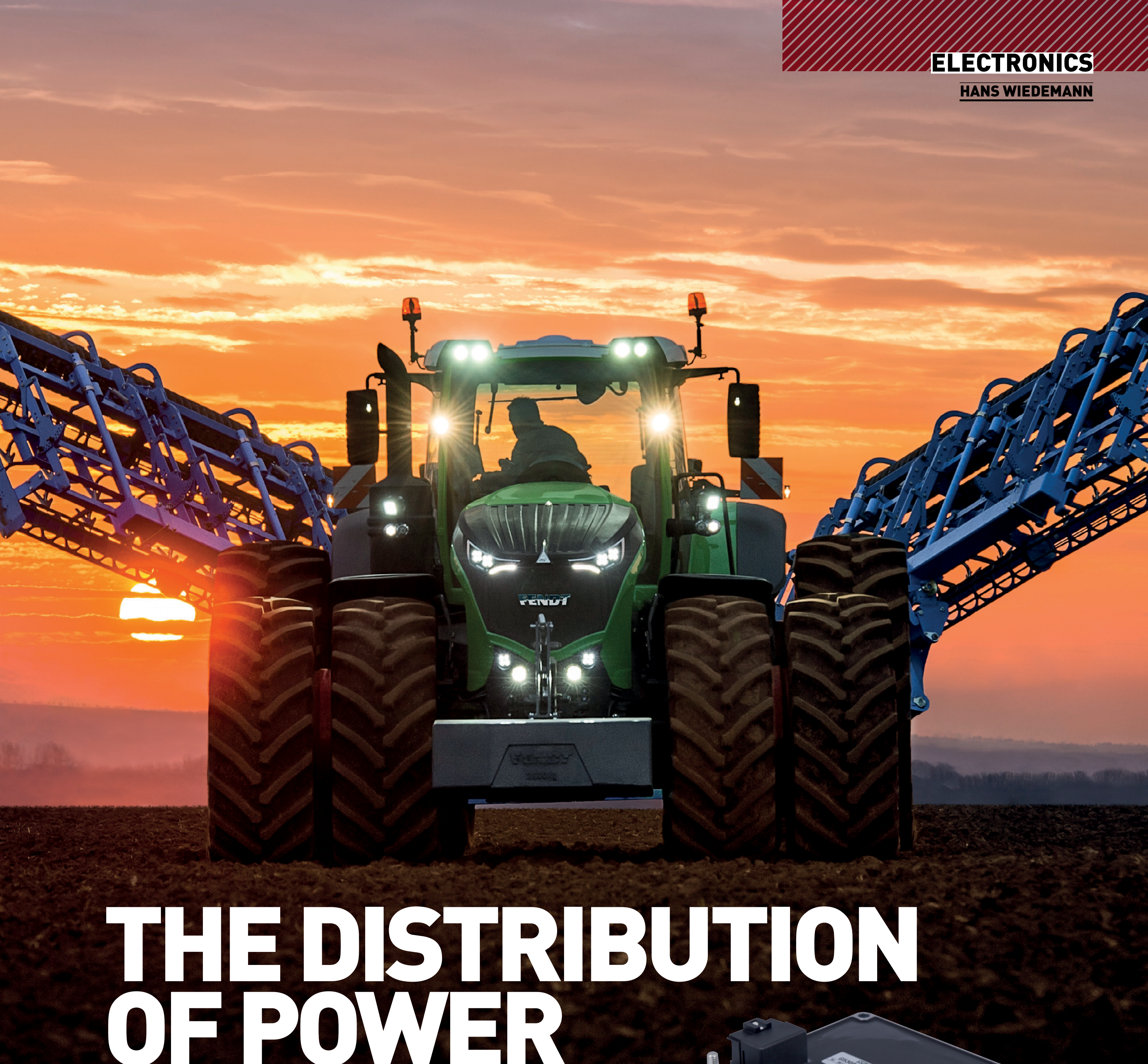

THE DISTRIBUTION OF POWER

WHEN FENDT DEVELOPED ITS FLAGSHIP 1000 VARIO, A KEY IDEOLOGY WAS TO ENSURE THAT ALL OF THE ENERGY MANAGEMENT COULD BE HANDLED IN THE MOST INTELLIGENT WAY

MAIN: **Fendt 1000 Vario**
FIGURE 1: **'ZE' power board**

The 1000 Vario tractor from Fendt is impressive, both in terms of its size and performance. Additionally, for the energy distribution within the vehicle, new concepts have been implemented in association with STW (Sensor-Technik Wiedemann). Two power boards within the 1000 Vario tractor supply intelligent energy management to provide convenient diagnostics and simple maintenance.

In 2003, the first power boards were developed in a collaboration between the two companies, and put into serial production. Since then, the demands placed on these systems have continued to increase. Whereas the predecessor models were simply concerned with the switching of larger currents, today increasing intelligence is required. This might be a CAN connection, via which the switching is conducted and read-back of the switching status is possible, but calculation and storage capacities are also increasingly important, as the power boards take over the functions of a decentralized control unit. This is linked with the growing complexity of the units supplied by the power board. Initially only single

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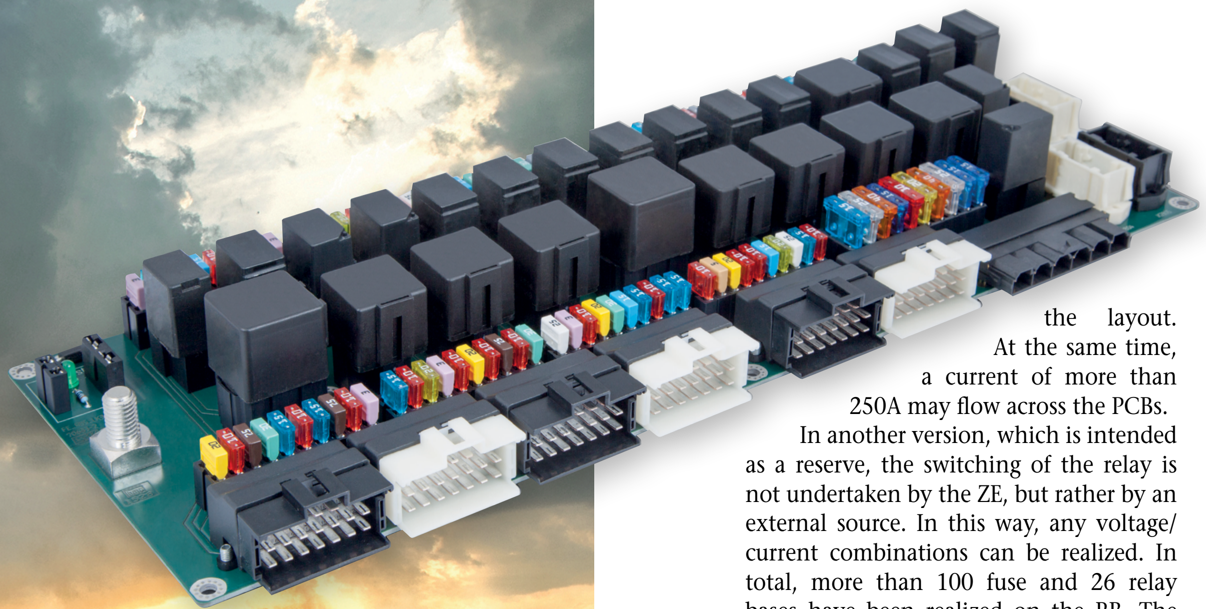

FIGURE 2: **'RB' relay board**

consumers such as driving lights or working lights were connected to the power board, but today, however, multistage fans or controllable windscreen heaters are supplied. With a consistently increasing number of consumers, the total electric current to be managed by a power board is also increasing.

The task for the new power board on the Fendt 1000 Vario is supplying, safeguarding and controlling the entire electrical system within the tractor. It must ensure the distribution to all electrical circuits and include all the required plug-in sockets for relays and fuses. For the new Vario 1000, the 'divide and command' principle was employed to address the two primary factors: intelligence and the number of inputs/outputs. Instead of one single power board, a dual approach is used. While one unit mainly deals with the communications with the main control unit and the tasks concerning programmable switching processes, the second unit is mainly responsible for the safeguarding and switching of the electrical currents. One important argument for this division was the need for simpler wiring. Of course, the design had to account for the accessibility of the connections, the ergonomic necessities and the spatial specifications. The construction space was, as is usually the case, limited.

Precise specifications

With regard to the intelligent unit, known in-house as the 'ZE' (Figure 1), Fendt had a very clear idea of what it wanted. The core of the board was to be an LPC1778 by NXP; an ARM Cortex-M3 processor with 512KB Flash, 96KB SRAM and 4032-byte EEPROM memory. One of its two CAN channels is connected to the central control bus of the Vario 1000 and can communicate at up to 250Kbps. The second is intended for use as a reserve.

Three of the five UART interfaces are utilized via appropriate transceivers for the connection to LIN (Local Interconnect Network), a one-wire bus. Via the LINbus, different consumers such as the windshield and side window wipers can be set or configured. In addition, the processor provides 165 multipurpose I/O pins, which ensure the flexibility of the layout. Because the switching of large electric currents is to be avoided on these PCBs, output pins are used to activate appropriate relays on the second unit.

The commands for switching to the ZE are either received via the central control bus or, in some cases, directly via an input connected to a switch. One major advantage of the unit also lies in its diagnostic capabilities. It permits the read-back of the status of important consumers. These include the driving and position lights or the indicators. If these do not function correctly, operation in road traffic is prohibited. Thanks to the diagnostic capability and the communications via the CANbus, a fault can be displayed directly in the cockpit.

In addition to the design, STW was responsible for the implementation of the test software and a flash loader. The application software was subsequently written by Fendt.

The relay board (which gives rise to the internal designation 'RB', Figure 2), does not just house the electricity and power distribution via fuses. Here three options are always provided. The most simple current course, in which the RB acts only as a fuse box, runs via the plug onto the board, through the fuse and then back through the plug to the consumer. This generally concerns sensors.

On the second version, the power supply comes from a 'power bolt', an M8 bolt that is directly connected with the positive terminal of the battery. From here, the current runs via a relay, which is switched via a ZE output. Once the relay is set to 'on', the current continues via a fuse and a plug to the consumer. This typically concerns heating systems or work lamps.

The distribution of the currents from the power bolt to the plugs on the PCBs was one of the main challenges regarding the layout. At the same time, a current of more than 250A may flow across the PCBs.

In another version, which is intended as a reserve, the switching of the relay is not undertaken by the ZE, but rather by an external source. In this way, any voltage/current combinations can be realized. In total, more than 100 fuse and 26 relay bases have been realized on the RB. The fuses and relays used are generally products from the automotive sector. The connectors, which are also suitable for automotive purposes, provide space for more than 40 inputs and 125 outputs.

Exhaustive testing

Due to the long periods in which tractors are in use, particular focus was placed on the quality of the products. For this purpose, tried and tested concepts were relied on even in the development phase, which were then confirmed in environmental qualifications. In addition, a 100% inspection of the power boards is conducted in the in-house production at STW. Test adaptors were developed especially for the ZE and RB. These are used during the production test and the burn-in procedure in the climate exposure test cabinet. All inputs and outputs are addressed via the test software developed in-house, and the functions are tested on the boards.

The two units are mounted over the rear wheel, on an assembly plate under a cover. Although this is a relatively dry space, the boards are also cast in polyurethane casting resin, to protect them from moisture. In this way, the plugs and fuses are easily accessible, which is an advantage when mounting the wiring harness. To permit easy replacement of the relays, the originally planned distance between the relays must still be adapted to 'thumb size'.

Because this is a low-voltage supply (only 12V or 8.5V connections are available), both units fall into the protection Class III for electrical devices. They are connected so that no risk to people is generated even when coming into contact with conductive components. In this way, the second important aspect, the maintenance-friendliness, is guaranteed, in addition to the diagnostic capability. **iVT**

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