

ZF-„Terra+“: Starter generator system

Environmentally conscious and fuel-saving drive system for tractors and self-propelled harvesters

- **ZF offers hybrid technology ranging from the electrical machine to the complete hybrid system**
- **Various electrification and hybrid concepts matching individual applications and customer requirements**
- **Core competence: Integration and energy management**

The ZF-Terra+ system (fig. 1) consists of an efficient electrical machine which is integrated into the transmission housing. It can be used as a generator system (micro hybrid) for supplying electric energy. Extension by a traction battery provides a powerful full hybrid system. The ZF-Terra+ system fits all transmission designs which ZF is using for tractors and self-propelled harvesting machines. All conventional transmission functions remain unchanged and are extended by generator or hybrid functions which ensure reduced fuel consumption levels and increased work output, combined with a reduction of exhaust emissions.

Reduced consumption, less exhaust emissions, improved work output

In generator mode, the **ZF-Terra+** system can operate as a power supply for electrical users. On the tractor for example, the optimum operation of electrified auxiliaries can achieve consumption benefits of about 5% on the average, while improving CO₂ emissions and work output at the same time. The **ZF-Terra+** system has an electrified transmission oil pump which ensures enhanced efficiency by optimum control, combined with improved consumption levels. Due to the system's performance, there is still sufficient electric energy left for electrifying many functions on mounted agricultural implements. Furthermore, the electrification with its great flexibility in the spatial arrangement of drives and its optimum operating conditions according to individual

requirements offers benefits regarding the implements' structure, as well as for energy consumption, work output and work quality. Extension of the **ZF-Terra+** system by a traction battery provides a powerful parallel mild hybrid which allows additional utilization of typical hybrid functions such as start/stop with operation of electrified auxiliaries, shift of engine operation point, short-term engine load relief (short-term boost) and recuperation of braking energy in agricultural vehicles. These additional functions ensure further consumption savings during transportation for example, and allow the combustion engine to be operated more silently, since the combination of electrical machine and battery makes it possible to smoothen torque peaks. Quiet engine operation and the possibility of avoiding unfavorable areas in the engine map have positive effects on the emissions of the combustion engine and the operation of the exhaust after-treatment systems.

Optional utilization as pure generator system or hybrid system

The **ZF-Terra+** system can be permanently used in generatoric operation for supplying electric power up to 50 or 70 kW, depending on the selected e-machine size. When extending the parallel hybrid by a Li-Ion traction battery, the **ZF-Terra+** system can even supply 85 kW or 120 kW boost power on a short-term basis. Furthermore, the flexibility in such a hybrid system increases considerably, since excessive energy developed during operation or resulting from braking energy recuperation can be buffered and called when required. This additionally available energy, in combination with the very high torque of the electrical machine, increases the dynamics of the driveline at low speeds, thus supporting the combustion engine, especially during vehicle starts.

Easy integration

The **ZF-Terra+** system is integrated into the transmission and can even be arranged without requiring additional space (Figure 1), depending on the application. Integration into the transmission allows for example to use the infrastructure for extended functionalities (full hybrid system) via a separating clutch, or for increased system performance by a planetary set.



Complete systems from one source

ZF is supplying complete, single-source hybrid systems for agricultural machinery manufacturers. Besides the individual components, the scope of delivery includes energy management and hybrid drive management (fig. 2). The starter generator functions match the interaction of electrical machine and combustion engine to avoid driving situations with poor efficiency and high emission levels. The optimum matching of shift strategy or CVT control strategy and energy management as offered by ZF is a key competency on the hybrid technology market. It directly influences the actual cost-saving potential and the cost effectiveness of a hybrid drive. ZF has a long-term experience in vehicle management for tractors and can rely on the comprehensive expertise gained from commercial vehicle and passenger car hybrid projects – an ideal combination to develop and produce optimum hybrid systems for agricultural applications.

Fig:

- 1.) ZF-TERRA+ starter generator 50 and 70 kW power in combination with the continuously variable S-Matic transaxle.
- 2.) ZF-Terra+ starter generator: architecture complete hybrid system with hybrid battery.

Pictures: ZF



Presseinformation
Press Information

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The ZF Division Off-Road Driveline Technology and Axle Systems specializes in the development and production of transmissions and axles for agricultural and construction machines as well as axle systems for buses and trucks. With about 7,500 employees, the division generated a turnover of 1.9 billion euros in 2008.

ZF is a leading worldwide automotive supplier for driveline and chassis technology with approx. 60,000 employees at 119 locations in 25 countries. In 2008 the Group generated a turnover of 12.5 billion euros. ZF is among the top fifteen companies on the ranking list of the largest automotive suppliers worldwide.