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VEREINIGTE FACHVERLAGE

Moderne Hydraulik

Mehr Effizienz und Präzision in der Landwirtschaft

At the turn of the year 2014/15 the world's population amounted to roughly 7.28 billion people [1]. The United Nations expects this number to rise to 9.5 billion by 2050 [2]. This trend caused the amount of agricultural land per person to drop from 0.3 ha in 1961 to 0.2 ha in 2012 [3]. While mechanisation, breeding and area expansion have so far been able to produce higher harvest yields and thus maintain growth, a different solution will be needed in the future. The amount of land available for agricultural use is after all not unlimited, and the current increases come at the cost of valuable untouched woodland. Agricultural land is also being used to grow energy crops to meet the increasing demand for energy. Agriculture, just like industry, sees Industry 4.0 as the next development step that will increase efficiency in production, with more intelligent machine control providing greater yields and reduced loss in harvest, transport and storage. Another objective is to reduce the amount of fertiliser and plant protection products used by collecting and evaluating large quantities of data ("big data"). In summary, then, precision farming means greater knowledge, more intelligent control and more efficient performance. And this is where intelligent electronic systems come in – the kind that HYDAC will be exhibiting at Agritechnica 2015 (hall 16, stand A08) as components or whole systems.

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Aware of the machines doings: now and how

High-precision hydraulic controls make it possible to increase working width and speed. Intelligent systems (GPS steering, headland management) reduce the drivers' workload, allowing them to work more effectively and with less stress and giving them time to plan subsequent tasks. For example, HYDAC components from the HYSTEER modules (figure 01) for electrohydraulic superimposed steering systems use GPS data or sensors (row/lane recognition) to support autonomous steering of the machine, with safety playing a crucial role. The orbitrol is still given priority so the driver can intervene at any time. Depending on the particular safety requirements, partially or fully redundant systems can be used with duplicate sensor, control and valve technology, with the valve equipment, sensor systems and the software and controller all provided by HYDAC.

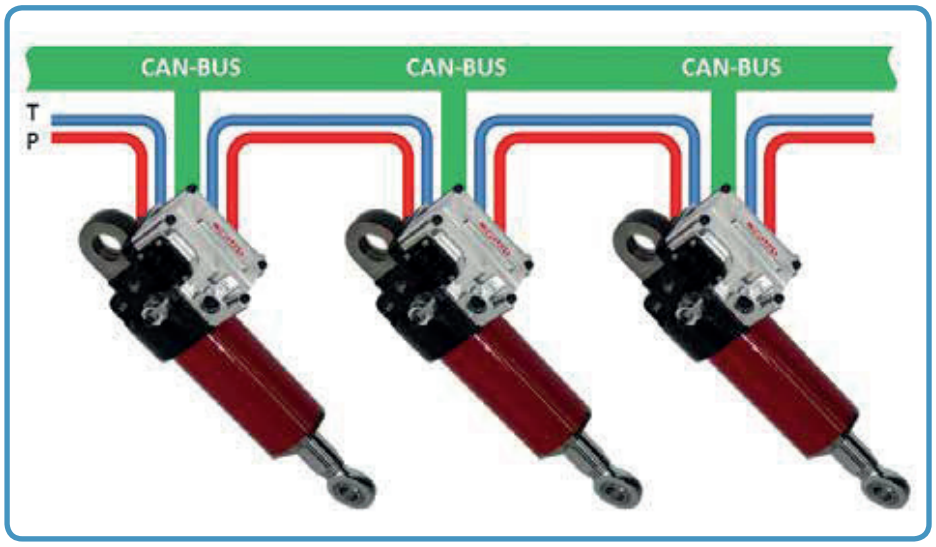
Precision Farming means: more insight, smarter controls, efficient job fulfillment

The latest developments in agricultural machinery focus on increasing output per area to reduce working time and costs. This can be achieved by increasing the working width or improving the speed. However, these two factors combined with vibrations and bumps in the ground surface make it difficult for the rod system to be kept at a consistent height above the crop. Deviations in height impair the efficiency of the plant protection product. To reduce the driver's workload without compromising height consistency, HYDAC offers components that can be used to establish active rod system control. Ultrasonic sensors monitor the distance between the rod system and the crop, and the controller actuates proportional valves to correct any deviations (figure 02). The intelligence of this system is located mainly in the HYDAC TTC controller, as the system needs to regulate the height with limited vibrations despite the intense motion forces involved. The proportional poppet valve series PWSM06020W, which was developed specifically for this application, has an adjusted characteristic curve that enables sensitive turning and rapid compensation movements.

Drivers assistance

To increase output per area, the working widths of soil working machines and sowers have constantly increased throughout the past decades. The tasks performed, on the other hand, are the same as ever. When seeds are sown, the distribution, separation and precise placement of the seeds must be

01 **Ultrasonic distance sensors and highly dynamic valve and control technology provide slope and distance control for a spraying rod system**



02 HYDAC smart cylinders connected in parallel with integrated valve technology, pressure and position sensors and a controller for cylinder control and communication with the CAN bus

monitored and regulated. In both soil-working and sowing, the working depth must be set and continuously readjusted. At working widths of 24m, the ground conditions can vary so much that the working depth needs to be set in individual segments distributed across the working width. This means that hydraulic oil has to be supplied to up to 40 cylinders that are working with a variety of pressures and cylinder strokes. Using central control blocks usually results in thick hydraulic hose bundles supplying the individual cylinders.

Flexible depth, minimized hosing

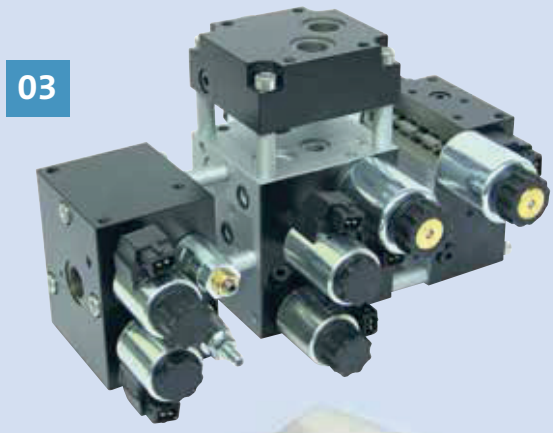
The HYDAC smart cylinder (figure 03) allows the hosing to be minimised as the cylinders are connected with a continuous pressure and tank line, much like an electronic bus system. The valves, the controller and the pressure and position sensors used to control the cylinders are integrated into each cylinder and connected to a CAN bus. The optimum sowing depth can now be calculated on the basis of offline geo-reference data or online sensors. The individual sowing units are controlled via CAN bus signals, so various sowing depths can be set to match the local ground properties (figure 04). This results in better plant growth and greater yield. Thanks to the functionality of the HYDAC smart cylinders, they are also suitable for other agricultural applications.

Precision farming entails stricter demands with regard to function, precision and processing time. This results in a significant increase in the complexity of the machines and of the corresponding mechatronic systems. The electronic part of these systems needs to be able to process more and more information in increasingly complex calculation algorithms. Accordingly, more and more data and data flows are

03 HY-STEER steering system modules

04 HYDAC sensors for applications in agricultural machinery

05 HY-TTC-500/30 controller and HY-eVision2 display with integrated controller



transmitted – for example between various controllers within the machine, between human and machine or externally to other machines or communication networks.

Sensors are responsible for detecting what the machine is currently doing and how. Whenever more information is required to enable particular functions, more sensors are needed. It is not only the number of sensors that must be increased, but also the number of measured variables. HYDAC has prepared an extensive range of sensors to meet these needs (figure 05). For applications in agricultural machines, these are mainly sensors for pressure, distance, position, angle, inclination, fluid level, temperature and speed.

To accommodate this large number of different sensors, some with different output signals, electronic controllers need to have numerous input channels with highly flexible signal adjustment. The calculation algorithms, which are sometimes complex and often need to be run in real time, require a highly powerful computer core. The controller requires access to a large number of sufficiently powerful switching and proportional outputs to control the hydraulic actuators. On the machine side, the functional units still largely communicate via the classic CAN bus. Agricultural machines in particular mainly rely on ISOBUS communication, which has become standard. These requirements can be met by HYDAC controllers from the HY-TTC 500 family. A high-power 32 bit processor core forms the hub of these controls that greatly fulfil the needs of the sensor system and the hydraulics with almost 100 inputs and outputs. CAN and ISOBUS interfaces enable internal and external machine communication. Modules from the HY-TTC 30 family can be added for decentralised architectures or simple I/O extensions.

The path to system integration

To put together a complex system made up of hydraulics, sensors, controller and control algorithms, considering the subsystems individually is not enough. This particularly applies to highly dynamic systems such as the suspension in agricultural vehicles or position control for attachments under the influence of oscillations caused by bumps in the ground and steering movements. To allow the interactions of sensors, controllers and hydraulics to be researched and optimised early on, HYDAC uses simulation tools such as AMESim, MATLAB and RecurDyn as needed and even combines them for co-simulations (figure 07). This makes it possible to discuss the interactions of the components with the vehicle manufacturer early on and to optimise them with regard to the mechanical conditions. Exchanging mathematical simulation models with the manufacturer simplifies the entire development process.

In the further development stages, the vehicle developer faces the task of combining the domains of hydraulics, sensors, controllers and displays as well as possible and then testing them. For this task, HYDAC provides the development-support software program MATCH. MATCH is a modular development environment that supports the designer in system development, software development, testing, initial operation and simulation, in addition to documenting results.

Hydac shall exhibit components and systems about Precision Farming on the Agritechnica 2015 Fair, pavilion 16, stand A08.

References:
[1] World population at end of year, Stiftung Weltbevölkerung (German Foundation for World Population) Status date: 23.12.2014, http://www.weltbevoelkerung.de/aktuelles/details/show/details/news/zum-jahreswechsel-leben-7284283000-menschen-auf-der-erde.html (accessed on 30.07.2015)
[2] World Urbanization Prospects – The 2014 Revision, United Nations Department of Economic and Social Affairs (New York, 2015)
[3] World Development Indicators (WDI) – Arable Land, World Bank (Washington, D.C., 2015)

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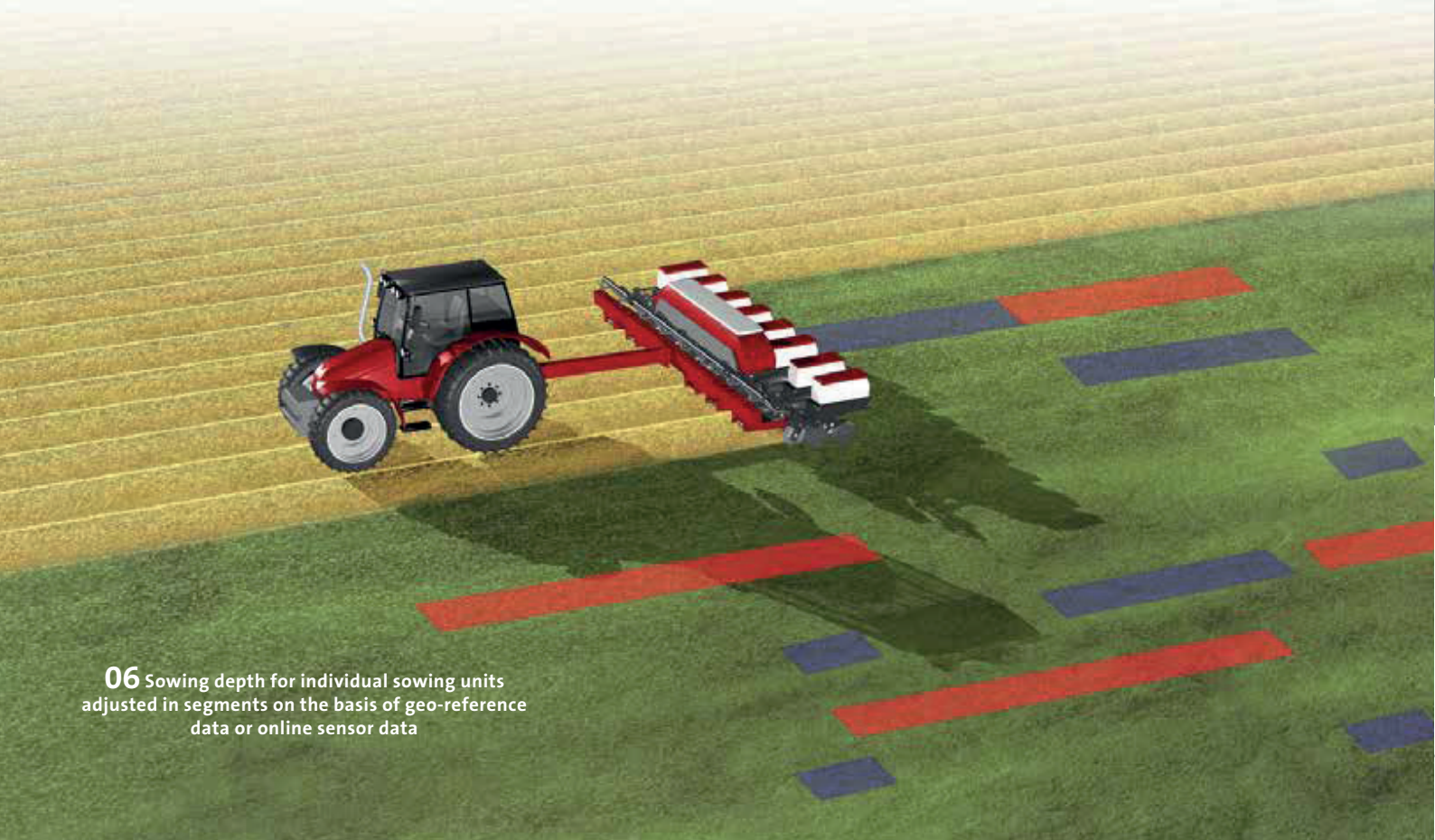
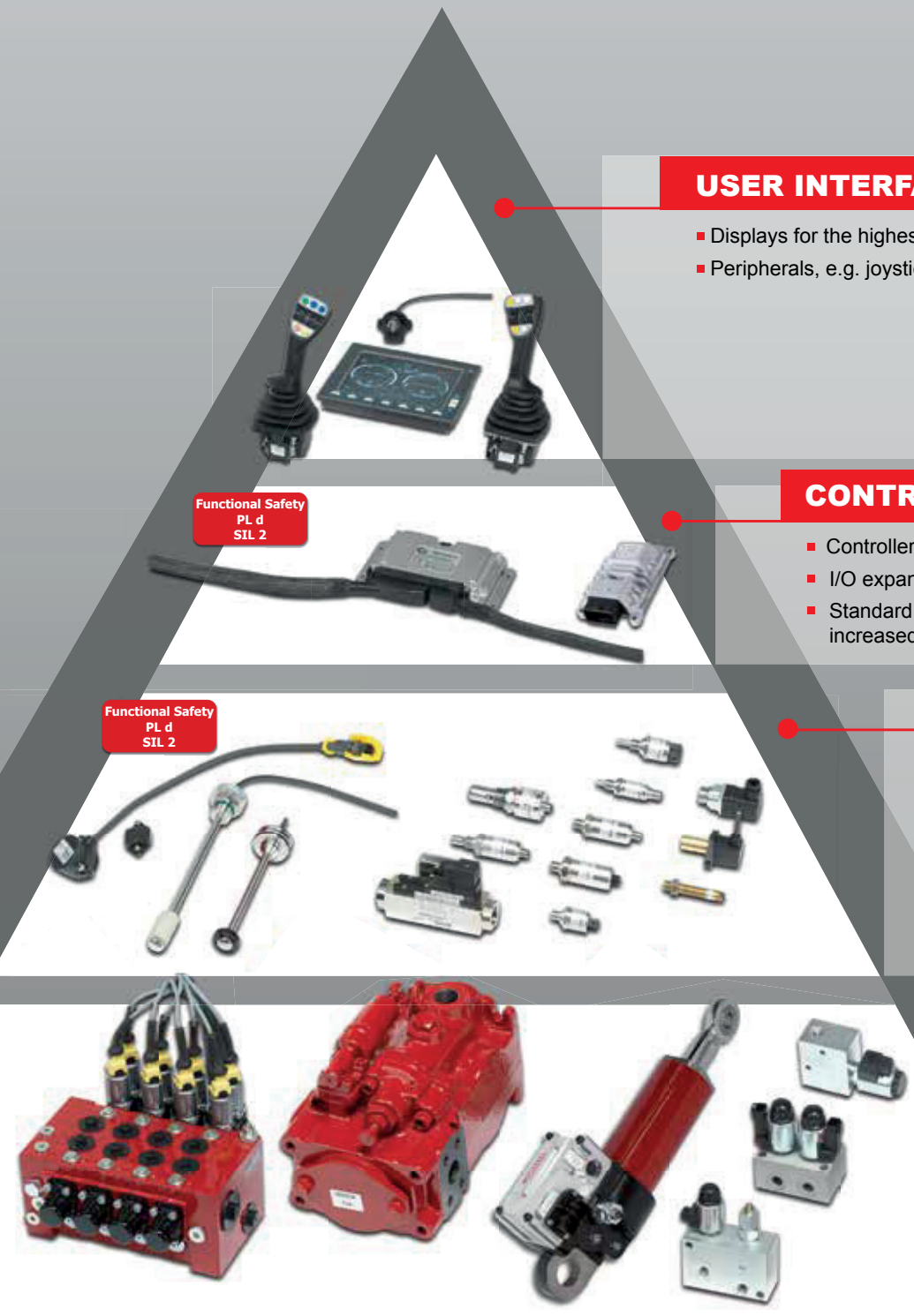


06 Sowing depth for individual sowing units adjusted in segments on the basis of geo-reference data or online sensor data

From the components to the intelligent drive solution.



USER INTERFACE

- Displays for the highest visual requirements
- Peripherals, e.g. joysticks

CONTROL INTERFACE

- Controllers in various performance classes
- I/O expansion modules
- Standard version and versions with increased functional safety

SENSOR INTERFACE

- Pressure, temperature, and level
- Distance, position, angle, inclination and speed
- Flow and oil level
- Standard version and versions with diagnostics and increased functional safety available

ACTUATOR INTERFACE

- Pilot-operated and direct-acting valves
- Control blocks (monoblock/sandwich)
- Pilot and primary control systems
- Intelligent axes
- Cylinders and motors

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Precision farming – how modern hydraulics can help to provide greater efficiency and precision in agriculture

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Populations are growing and with it an increased demand for food. As the areas for agriculture are not unlimited, improving efficiency in the farming business is urgent to cope. Precision Farming is the way out for this challenge.