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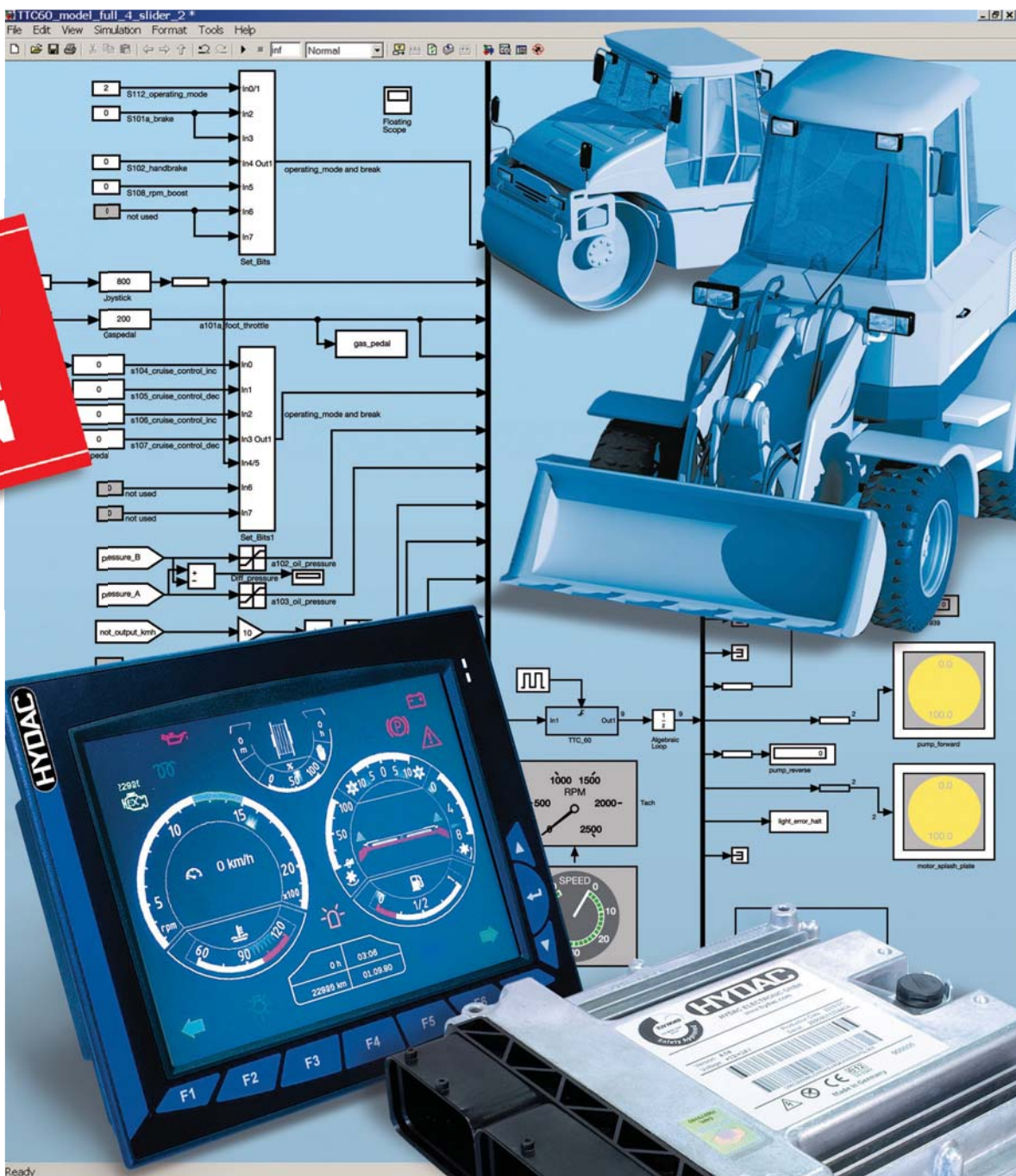
Simulation:

Reglerauslegung für hydraulische Tiefziehpressen

Messtechnik:

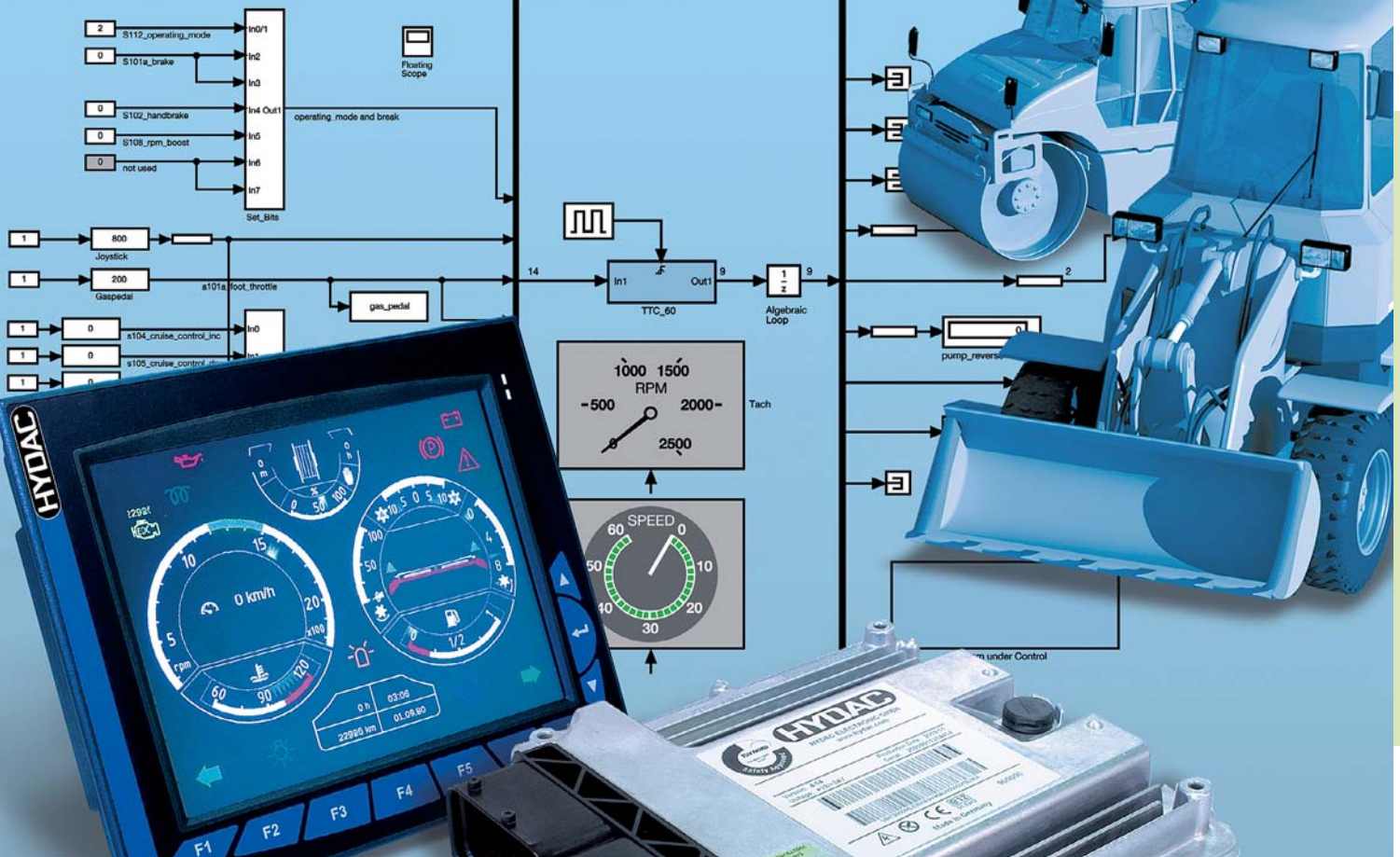
Messung der Reibkraft unter Mischreibung – Ein Ansatz zur Berechnung der Reibkraft unter Mischreibung

HYDAC SPECIAL EDITION



TITLE

Hydraulic Solutions based on electronics



Hydraulic Solutions based on electronics

Significant simplification of mobile machines with regard to design and operation

Ralf Leinenbach

Global competition demands constant optimization of design from all manufacturers of machines, systems and utility vehicles. In this regard, system partners like Hydac proved to be a valuable support. Not only, they assume development tasks for complete function modules, but also they contribute in high degree to innovation due to their systems thinking. The results of such an “under one roof” practice are efficient, energy-saving and economical power solutions.

Although Germany had to surrender the title of the “world export champion” to China after six consecutive years, German engineering is still in the premier league in the world. A major reason for that is the many years of experience as well as the perfection in developing and manufacturing components.

Another important aspect is that machines, systems and utility vehicles manufactured in Germany are cutting-edge, robust and durable. Major focus is put on high availability and a long life cycle in addition to the price.

A prominent example from a product developer growing up to a system partner is Hydac, a company located in Saarland. The group of companies ranks among the leaders in the fields when it comes to fluid technology.

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1: HY-TTC 200 and HY-TTC 60: high-capacity electronic controller for establishment of safety-relevant systems for utility vehicles



3: Control HTTC 90 mounted inside the machine, TÜV certificate according to SIL 2



2: For this municipal machine an innovative hydrostatic drive was designed by means of modern authoring tools

Hydraulic "electronification" gives a good push to the industry

The increasing electronification of machines, i.e. the change from a strictly mechanical to an electromechanical control is pushed intensely by the legislator, the manufacturers and the customers.

The legislator asks for more safety (e.g. EN 13849), power efficiency and emission control (e.g. Emission Directives) and fixes a timetable for implementation. Because of the world-wide competitive pressure, manufacturers call for innovations and unique selling points.

The purchase decision of the customer is based on the price, increased productivity, a higher ease of use, along with an ergonomic design. According to market development the supply industry has to face new requirements. For almost 50 years, Hydac has met the constantly changing challenges and thanks to its sector expertise and machine know-how, has evolved from a mere provider of components to a supplier of entire systems. Moreover, there is the possibility to provide development partnership together with system responsibility.

High-Tech control devices: the "brains" of modern hydraulic systems

Main focus is put on electronic controls including the according peripherals. The

controller family HY-TTC 200 and HY-TTC 100, especially adapted for mobile applications, features a 32-bit processor and a multitude of inputs and outputs (fig. 1).

This hardware configuration is mainly used in central control architectures. The family HY-TTC 50, 60 and 90 is suitable for stand-alone solutions for smaller mobile machines or in a network with decentralized control architecture. I/O modules, such as the HY-TTC 36 allow a directed extension of inputs and outputs and thus, to customize the respective application.

Specially customized controls have to be used with systems requiring a higher functional safety by IEC 61508 or EN 13849 for a defined SIL or performance level. Hydac offers TÜV certified SIL 2 or PL d versions for both controller families.

Saving money on tools is making false economies

A major aspect in choosing electronic control devices is the availability of authoring tools. A limited choice leads to unnecessary high investments in development time and make it difficult to find an optimal solution. The programming language used for the application software is of utmost importance. Hydac controllers are programmed using C, CoDeSys or MATLAB/Simulink. This development platform, for instance, is suitable for the workout of complex control functions by simulation.

The results can then be converted into a fully functional version of the control.

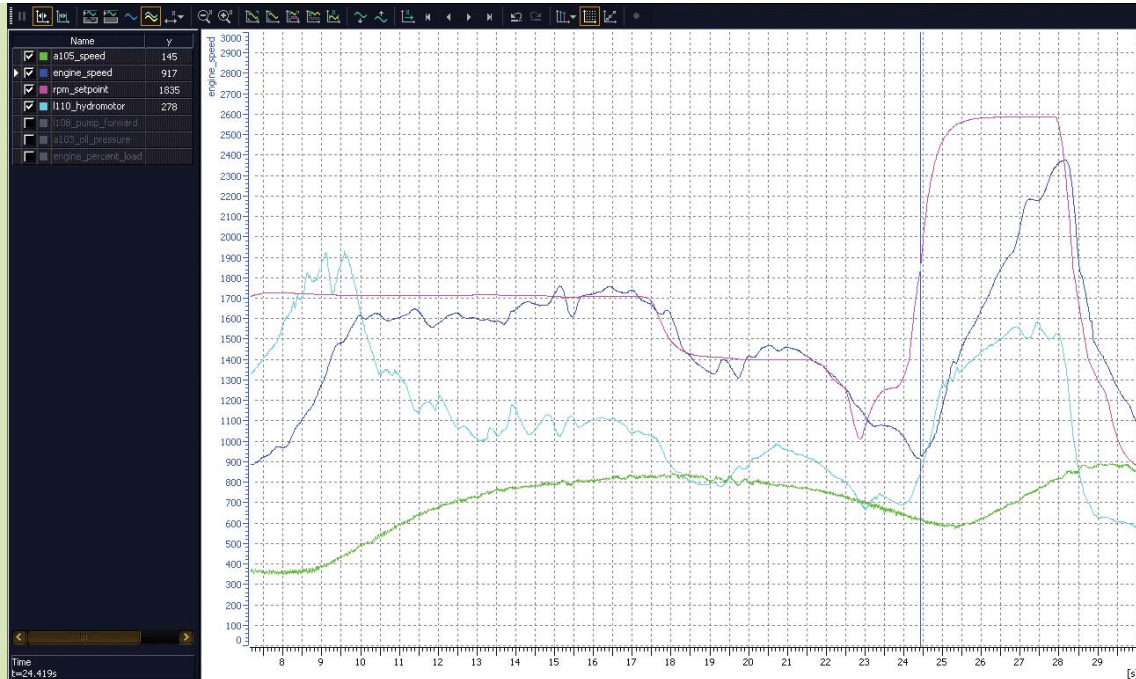
Another important aspect is the availability of library elements that can be integrated into the application software. The internet offers a large variety of complete and free of charge software modules, e.g. controllers for different working functions. However, the results are mostly disappointing. Either the detailed control function is unknown or it lacks a good calibration with the component used, e.g. a proportional valve. Therefore, Hydac is constantly improving and expanding its library modules with an optimized adaptation to the own hydraulic components, such as valves, for instance.

Visualization: the key to communication between operator and machine

Visualization controllers of the "Vision" family build the bridge to the machine operator. Different display solutions, partly trans reflective, with fixed function keys or touch screens meet individual customer requests. Graphic display elements are programmed in C or in CoDeSys. Furthermore, there is the possibility to display the live-recording of multiple cameras, e.g. for monitoring during reversing.

The communication of the used control and display devices as well as of the additional peripherals by default is effected via CAN-Bus-Network, CANopen or J1939 as communication protocol.

4: Measured curve recorded for determination of system deviation and for controller optimization



Additional digital interfaces such as RS 232, RS485 or LIN and a multitude of analogue and timer interfaces increase the possibilities to add more system components. In connection with two SIL 2 control devices, even a highly safe SIL 3 system can be realized via CAN or TTP (Time Triggered Protocol).

Economic customizing by software adaptation

As a system partner, Hydac can offer more than its broad range of products, like consultancy, development support and the complete system responsibility. If desired, the customer will be supported during the whole development project, from design and simulation process to application software and commissioning.

This can be demonstrated using the example of a recently realized hydrostatic traction drive for a new municipal machine (fig. 2).

One of the requests mentioned in the technical specification was the jolt-free and energy efficient drive at all load conditions and drive operations (work, drive and mixed operation). The first step was to establish a risk analysis together with the customer. The results showed a drive function relevant to security. The choice of the components and the design then was based on these facts. After determination of the requested inputs and outputs and estimation of the necessary processor performance, controller HY-TTC 90 featuring a SIL 2 and

a PL d-certificate was chosen (fig. 3).

In addition to the hardware, the software also had to comply with the safety directives and was designed on basis of the “Hydac Safety Manuals”, some kind of road map for software engineers.

While the manufacturer of the machine was completing the construction of the prototype, the control structures were designed with MATLAB/Simulink and optimized by simulation. The result was a traction drive controller consisting of seven superposed single controllers, including power limit control, cruise control and energy optimization. The next step was the transformation of the control software generated by simulation into a functional program code. The resulting function module was integrated into the simultaneously developed and safety-compliant application software of the control device.

Hydac: from product development to system partnership

Commissioning is part 3 of the stages of development, bringing together theory and practice. First road trials showed that the controller firstly designed and pre-configured on screen met the real functional requirements. The road performances in different drive operations and at different load conditions were recorded and optimized by adjustment of the control parameters (fig. 4).

After commissioning the customer concluded:

- the traction controller generated by simulation met all requirements stated at the beginning surprisingly well
- this development model saves costs and energy, and
- the performances obtained placed the mobile machine on a leading position compared to its competitors.

This example is an indication of the possibilities development can offer by choosing the right product and software platform and also shows the tendencies of the market. The part of electromechanical control systems developed before commissioning of the first prototype will make up a growing proportion.

Hydac's range of products and services make this kind of modern development approaches possible, including processes like “hardware in the loop” and “software in the loop”. Based on its large product range and the development possibilities described, Hydac has designed several projects both independently and in partnership, e.g. axle suspension systems, cab suspension systems, traction drives or additional steering systems. Particularly in the field of active suspension systems Hydac has occupied a leading market position for 22 years and has developed high-capacity standard modules for this. Target industries for system developments range from construction machines, mobile cranes, municipal machines, agricultural and forestry machines to drilling units and snow groomers.



5: Magnetostrictive position sensor HLT 1000 for full integration inside a cylinder of a utility vehicle

6: Extract from the product range of utility vehicles: hydraulic components and sub-systems, sensors, electronic controllers, visualization controllers and accessories.



All-round sensor technology as a basis of complex systems

The functionality of electronic control devices is only possible with sensors, in some measure the ears and eyes of hydraulics. Therefore, Hydac disposes of a large product range including pressure transducers, electronic pressure switches, position sensors, temperature sensors, flow rate transmitters and oil condition monitoring sensors. Special measuring devices with a higher functional safety are required for safety relevant applications. Particularly pressure sensors have to face a higher demand for SIL 2 or PL d. Herefor, Hydac offers one or two channel solution, i.e. with one or two sensor cells. The electrical interface is designed as 4...20 mA or CAN Safety, depending on the type.

In addition to pressure sensors, a great number of position sensors with different measuring methods are used in mobile machines. Devices fixed on the outside of the machine are particularly subject to mechanical damages. To prevent this, one can find adventurous constructions on the market, leaving the device to be an expensive choice when taking a close look at it. For measuring tasks on cylinders, a better solution is to integrate the sensor inside the cylinder. For that purpose, Hydac has developed a magnetostrictive position sensor which meets the requirements of accuracy for mobile applications, with a good cost/performance ratio and which can be fully integrated in the cylinder.

HLT 1000 is available with 50 and 2500 mm measuring length and with analogue or CAN output (fig. 5).

Cost efficiency by "under one roof" solutions

When developing an electro-hydraulic system, the aim is that all components work perfectly together. Everybody, having ever worked-out development projects can tell a word or two about the mismatch caused by mechanical connections, electrical plug-in connectors, analogue input and output signals, supply voltage, communication protocols, the switching behaviour of actuators and much more. Finding solutions to these problems often goes together with a huge loss of time and a lot of rotten compromises. In general it is of great benefit to purchase the most from one source. Not only the compatibility of the components is at its best, but also the number of contact persons is considerably reduced. That generates cost reductions in development, machine and service.

System partners like Hydac offer a large range of mechanical and electronic products for the fluid technology, extended sector knowledge and system-know-how (fig. 6).

This, in combination with the manufacturer's know-how concerning machines and applications, provides an ideal basis for professional and innovative solutions, which ensures a lasting competitiveness on the international market.

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With over 5,000 highly qualified staff, HYDAC is a leading supplier of fluid technology, hydraulic and electronic equipment, both worldwide and at a location near to you, creating solutions for mobile system technology.



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