Remotely Controlled Electro-Hydraulics ready for the IoT


In this years, hydrostatic pumps and motors are evolving to respond to a request of better performances and deeper collaboration with other parts and with machine user. Integration between Hydraulic and Electronic is the solution, allowing the deployment of high-level control functions. As a first step in this direction, all necessary sensors, actuators, ECU and harness are integrated with the pump. A second step is to ease the mounting of this system, and for this reason all electrical connections are grouped in just one plug. Machine manufacturers, in this way, can simplify their mounting process and increase quality level of the complete machine. The one and only connector simplify also testing process. On top of that, a Bluetooth connection is available to communicate with the Electro-Hydraulic pump. Data can be read and sent and the system is compatible with IoT principles.

Another advantage of electro-Hydraulic implementations is that is that the integration of Hydraulic and Electronic allows the implementation of smart functions aimed for example at fuel consumption reduction.

First one is the integration of electronic board and sensor on a pump with the aim of make the mounting easy having just one electric connector to link to the rest of the world. Second one is an example of fuel consumption reduction obtained driving properly the charge pump avoiding energy waste when oil flow is not necessary.

Easy Mount pump

Hydrostatic systems for mobile devices are subject to continuous evolution. On one side, the high complexity of the vehicles requires fast and reliable assembly of the hydrostatic components, on the other, the implementation of the "electro-hydraulic", i.e.: the integration of electronic control devices on hydraulic components is a technique which allows the realization of highly developed functions.
Peculiarity of this range of the “Easy-mount-pumps” consists in having enriched the hydraulic component by integrating it with a control electronics, a series of sensors, a unique electronic connector to link all the electronic components and also the actuators present on the pump. All of this is arranged under a plastic protection similar to the hood of a car which has a connector for electrical wiring for all possible communications to and from the pump.

Fig. 1: Pompa con cofano di protezione e connettore di collegamento

Fig. 2: Pompa con cofano di protezione in trasparenza per visione sensori
In essence, these are the main advantages that this range of pumps has:

**a) Easy assembly (Easy Mount).**

The pump is assembled using three interfaces. The mechanical fixing that occurs in a classic way through the coupling flange to the motor, the hydraulic connection that occurs through the normal input flanges made according to the customer's standards, an electrical connector that shows the main communication line (also with CAN protocol) and all the signals necessary to manage the pump and to read its status. A single electrical connector, therefore, which greatly simplifies the connection to the rest of the vehicle control systems. The concept of electro-hydraulic sub-system is so applied to off road vehicles and implements

**b) IoT**

Depending on the version and available space, a series of sensors are mounted on the pump with the aim of improving the control functions. On larger pumps can be fitted, for example:

- 2 high pressure sensors on the two hydraulic connection ports
- 2 low pressure sensors to read the pilot pressure of the servo block
- 1 pressure sensor to read the supply pressure of the charge pump
- 1 temperature sensor for the oil inside the pump
- 1 speed sensor for pump speed
- 1 angular sensor for reading the working angle of the swashplate
- 1 triaxial accelerometer for measuring vibrations and noise

All these sensors are connected to the integrated electronic control unit present under the protection that uses the information for three purposes:

- **Perform more precise control functions** that use the information read directly on the mechanical component.

- Realize **diagnostic algorithms** at this sub-system level aimed at identifying either components that behave incorrectly (broken or defective) and tendencies to malfunction (predictive diagnosis). This reduces machine downtime by signaling the opportunity to perform preventive maintenance actions.
The information of the sensors, either directly and in elaborated form, e.g.: calculating quantities that cannot be read directly such as, for example, the flow rate, can be transmitted externally via the single connector and dedicated protocols (for example CAN line). The transmission of data to the outside allows the pumps of this range to be connected to systems, both produced by B&P (using B&P Link connector) and by other manufacturers according to the principles of the Internet of Things (IoT). Each pump can send information on its status, operating statistics can be processed on a single pump or on a large set of pumps installed, for example, on a fleet of vehicles. The external system, therefore, takes care of processing the data received and providing the information needed by those requesting this type of service.

This type of product introduces the concept of sub-assembly made of smart components. Electro-hydraulic allows implementing also smart function. Mounting is simplified and a plug-in capability is implemented.

**Power-on-demand boost pump**

Until today the boost pump in the closed loop has the assignments of maintaining the lubrication of the sliding shoes of the axial piston pump and motor (or also radial piston motor), flush the oil in the closed loop for cleaning the oil and cool down the temperature, and provide auxiliary energy for the displacement control, as well as additional features. Typically these assignments are controlled by a fix displacement boost pump and a fix boost pressure relief valve set at 20-25 bar.

The new patented circuit design with variable boost pressure allows to reduce the average boost pressure considerably.
The hydrostatic transmission pump consists of the well known parts, but the fix boost pressure relief valve is replaced by a proportional one (12, 13) with a negative characteristic curve with a fail safe feature. Two pressure sensors (16, 17) are added into the high pressure lines and an electronic card (11) with software, so that the minimum pressure, necessary to maintain the lubrication in the closed loop besides the displacement setting, is controlled with the ECU.

The proportional displacement control of the pump (5) gets its energy no longer directly from the charge pump (4) but from the accumulator (9), which is fed from the boost pump (4) and the check valve (18). The pilot oil supply pressure in the accumulator (9) is supervised by a pressure switch or sensor (10). When the pressure in the accumulator (9) is below the minimum value, then the current of the proportional pressure relief valve will be decreased and thus increase the boost pressure for a short time in order to charge it up to the switching value programmed in the pressure switch and then return back to the necessary minimum pressure.

It is possible to achieve a saving of Diesel due to boost pressure reduction while traveling and working based on the new circuit design, which can amortise the investment in additional control components within 0.7-1.5 years (at annual use of the machine of 1500 h).

**Summary**

By installing electroproportional controls on a hydrostatic transmission pump and adding sensors, ECU's and software it is possible to create new driving performance and data communication, as well as remote control of the machine or condition monitoring via IoT.