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COMPUTER ASSISTED ELECTRO-HYDRAULIC STAND FOR TESTING SERVOVALVES

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Abstract:
Widespread of electro-hydraulic drive systems and equipments along with their integration into industrial manufacturing processes requires the usage of computer systems or dedicated digital or analog control modules. The integration of new measurement and processing technologies into hydraulic equipment allow us to measure and connect them to informatics manufacturing systems thus improving command and control performances. Overall development of microcontroller based smart systems along with the development of new types of sensors enabled the development and integration of mechatronic measuring technologies in modern driving systems, even at equipment level.

Keywords: electro-hydraulic, test stand, software

1. INTRODUCTION

One of the significant directions of development in servo hydraulics field is represented by the integration of electronic modules into the structure of hydraulic equipments. The technical advances in the analog and digital electronics fields had a positive impact on the design of new electro-hydraulic equipment especially on servo and proportional types thus improving response times, dynamic characteristics and overall reliability. A significant trend in the development of new servo hydraulic equipment is reducing manufacturing and maintenance costs by modularization and usage of new materials. Mechatronics is not just a technical field which, basically, includes mechanics, electronics and informatics in its structure, but a way of integrating modern ideas and concepts into the structure of hydraulic equipment. Informatics technologies are used much more nowadays because of the practical facilities it offers regarding easy reconfiguration and recalibration when dealing with some changes in the structure of a certain stand. The usage of data-acquisition cards or digital microcontroller boards has improved overall reliability of electro-hydraulic systems.

2. Stand description

The authors have configured an experimental research stand equipped with high precision electronic, hydraulic, measurement and data acquisition equipment. It was used a 16-bit data acquisition board type USB-6218 manufactured by National Instruments.

Testing stand hydraulic diagram is given in Figure 1, having the following structural blocks:

a. testing servovalve supply block, made by a variable flow pump (1); its maximum pressure it is done by using driving the pressure electro-valve (6);
b. circuit selection block for the servovalve input, made by four release electro-valves that can generate the following states:

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- connecting pressure circuit 4 with P circuit through (8.1) valve or with T through (8.2) as well as blocking it;
- connecting circuit (T) with circuit 6 (no pressure) through valve (8.3) or with circuit 7 (with pressure) through valve (8.4) and hydraulic resistance (13). In absence of electric driving signals, both ways are blocked. In both cases hydraulic flow passes through flow-meter D_2;

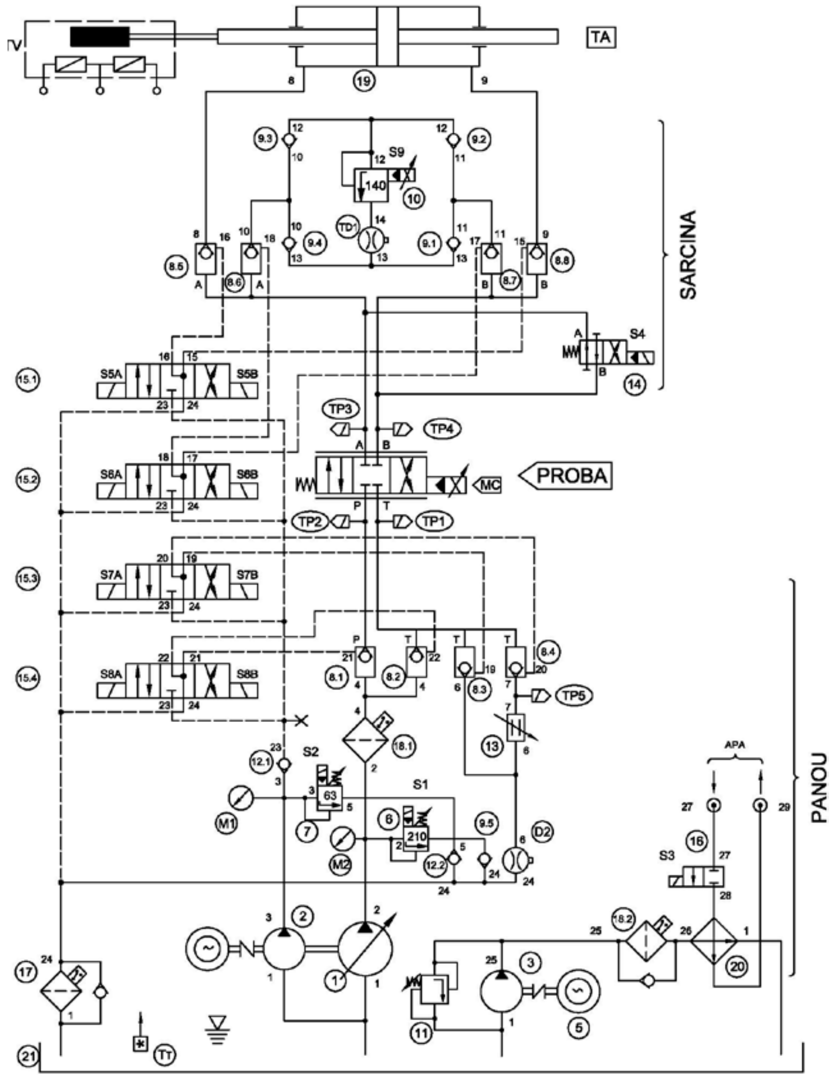

Figure 1 - Testing stand hydraulic diagram

c. output circuit selection block, which can have the following states:
    - flow from A to B without any load by switching the directional valve (14);
    - static load on A circuit by controlled valve opening (8.6), A-10 circuit; flow through check valve (9.3), 11-12 hydraulic circuit, flow through proportional pressure valve (10), circuit 12-13, flow-meter (D1) circuit 13-14, flow through check valve (9.2) circuit 13-11, spontaneous pass through unlockable valve (8.7) circuit 11-13;
    - static load on circuit B;
    - dynamic load on circuit A by controlled opening of unlockable valve (8.5), circuit A-8, hydraulic cylinder (19) supply, hydraulic cylinder (19) discharge by spontaneous flow through unlockable valve (8.8), circuit 9-13;

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- dynamic load on circuit B which is made on symmetrical circuit sequence.

Also, in these functional states it is done measuring acceleration with (TA) transducer, speed with transducer (TV) and flow with transducer (TD).

d. auxiliary functions:
   - select commands of allowed flow paths during a test are realized with electric driven directional valves 3/4, marked with (15.1), (15.2), (15.3) and (15.4) in Figure 1, supplied by circuits 3 and 23 by the constant flow pump (2) – its working pressure adjusted by electro-valve (7);
   - working fluid conditioning realized with an electro-pump made of asynchronous motor (5), low pressure and constant flow pump (3), filter (18.2), heat exchanger (20) and electro-valve (16).

   On circuit (17) there is mounted a return filter.
e. control and measurement system:
   - pressure transducers TP1, TP2, TP3, TP4 and TP5 are mounted on the servovalve's circuits
   - manometers M2 and M2 installed on circuits of pumps 2 and 3;
   - flow measurement for load circuit is made with (D1);
   - flow measurement for servovalve's tank is made with (D2);
   - temperature measurement – (TT) thermometric gauge;
   - acceleration transducer (TA);
   - speed transducer (TV);
   - filter clogging indicators.

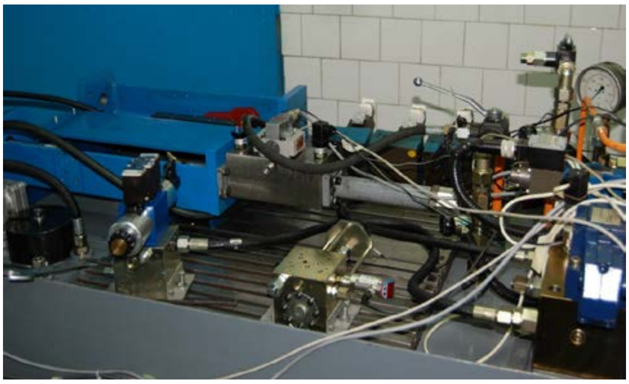

Figure 2 - Computerized electro-hydraulic stand

Figure 3 – Electronic control and data acquisition block

Figure 4 – Example of a servovalve mounted on the computerized stand

The computerized stand has a data acquisition structure that comprises the following:

- electronic transducers for specific interest process parameters, such as flow, force, pressure or temperature;
- measurement amplifiers for conditioning the output signal of the transducers;
- the data acquisition board itself;
- software application – virtual instrument – for data conditioning, processing, storage and graphical display;
- power source and electrical noise filters.

The data acquisition structure must be capable of meeting the following criteria:

- data acquisition of all interest parameters that run during tests on the computer assisted electro-hydraulic stand;
- processing of acquired data;
- storage of acquired and processed data during tests;
- graphical screen display of parameter variation, characteristic curves and diagrams.

Being based on a classical structure of simultaneous data acquisition, the schematic diagram of the computer assisted stand includes also electronic driving modules for hydraulic control equipments. The data acquisition board type is USB-6218, with the following main features:

- 32 single-ended or 16 differential analog inputs;
- 16-bit resolution;
- sampling rate of 260kS/s;
- input voltage range: -10…10V;
- on-board sample memory: 4095 samples;
- 2 16-bit analog outputs;
- 8 TTL input channels;
- 8 TTL output channels;
- digital trigger.

The computer assisted electro-hydraulic test stand allows performing various specific static and dynamic tests on servovalves, from which the most significant ones are step response and dynamic response at sinusoidal driving signal input.

Looking at the software component of the testing stand, there has been elaborated a virtual instrument using TestPoint environment, because of its easy integration with industrial measurement and driving processes. In Figure 5 it is shown the main panel of the virtual instrument.

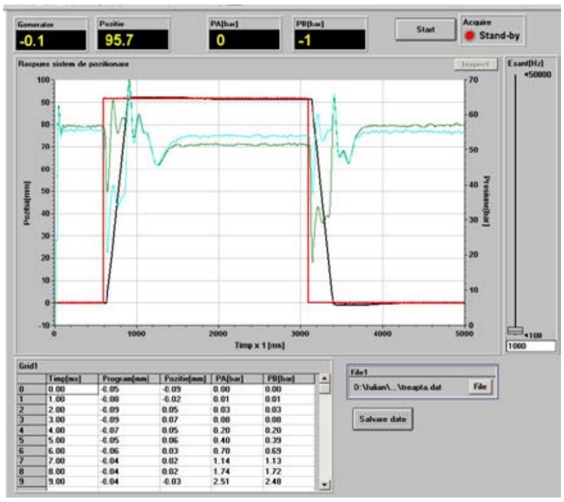

Figure 5 - Main panel of the virtual instrument

The virtual instrument is able to perform both static and dynamic tests, having a minimum need of user-intervention. In the starting part of the virtual instrument there are initialized the environmental variables, the data acquisition channels and other auxiliary tasks. The experimental data are acquired continuously after the user selects one type of test and presses the Start button. Data is displayed on a graphic control, the values being stored in comma separated .DAT files. This type of data storage gives later access for processing and easy integration with familiar spreadsheet processing software.

3. CONCLUSIONS

Electro-hydraulics field has developed a lot past years because of the technological advances in materials science, electronics and informatics. Nowadays, a reliable and precise hydraulic system includes digital or analog electronic control realized with computer assisted systems or dedicates solutions using PLCs or microcontroller based modules. Transducers technology developed new solutions providing in the same casing the measurement part itself along with self-calibration, auto-diagnosis or bus communication modules. Data acquisition and virtual instrumentation widespread has enabled the development of new software measurement, data processing, data storage or plotting various graphical diagrams.

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