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CONSTRUCŢII DE MAŞINI

TEST STAND FOR HYDRAULIC CLAMPING DEVICES

BY

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Abstract. The paper relates to a stand for static and dynamic, multi-parameter, hydraulic and mechanic multi-component tests to be performed on hydraulic cylinders as components of modular technological clamping devices, intended for machining or mounting processes.

Keywords: stand; testing; hydraulic device.

1. Introduction

The performance evaluation of hydraulic power cylinders as components of modular technological clamping devices has been challenging. It has been implemented through an innovative solution (Hanganu, 2012, p. 1).

2. Types of Hydraulic Power Cylinders as Components of Modular Technological Clamping Devices

The synthesis of representative hydraulic devices (Hydraulic, 2016, p. 37-120; Hydraulic, 2012, p. 2-65; Workholding, 2014, p. 8-93), author's research, is on the Table 1:

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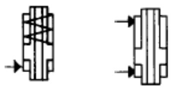
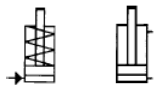
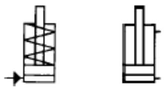
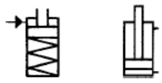
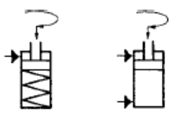
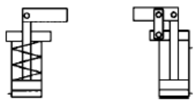
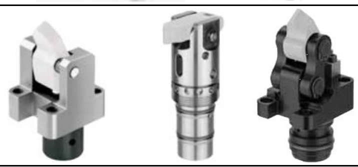
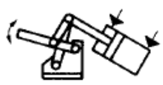
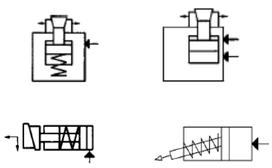
Table 1
The Types of Hydraulic Devices

Type	Symbol	Picture
Hollow-rod cylinders		
Threaded cylinders		
Block cylinders		
Push-pull cylinders		
Swing clamps		
Vertical clamps		
Toggle clamp		
Pull down clamping elements		

3. Innovative Test Stand for Pull Down Clamping Elements

The stand is equipped according to the parameters to be tested (Figs. 1÷4).

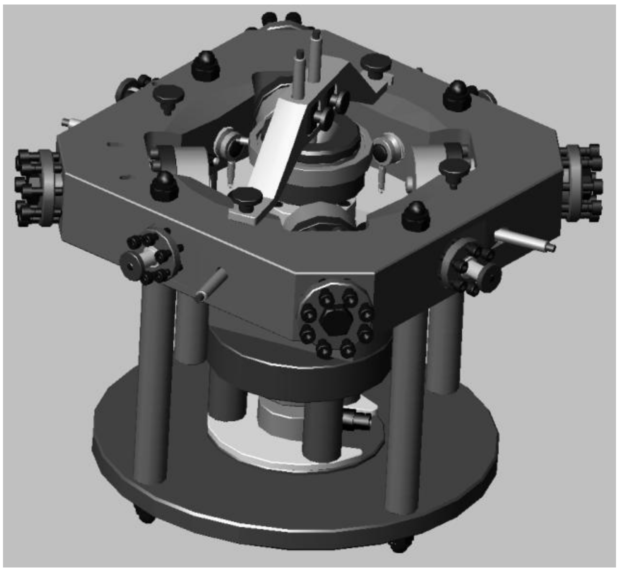


Fig. 1 – 3D stand equipped to evaluate the stroke and the force operation.

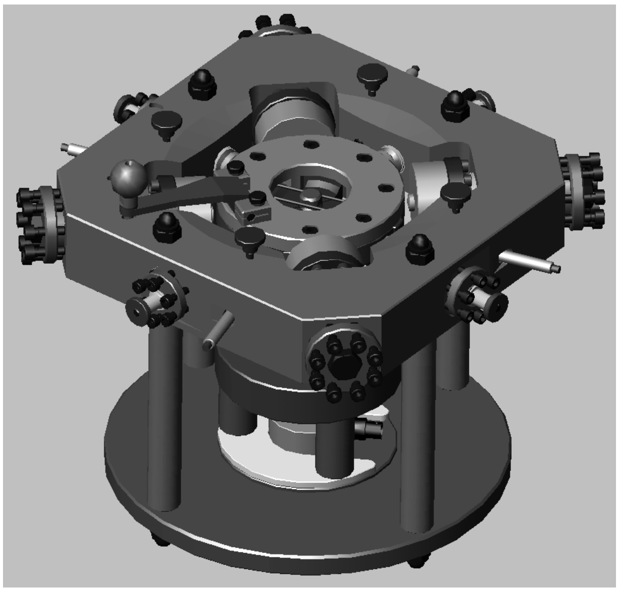
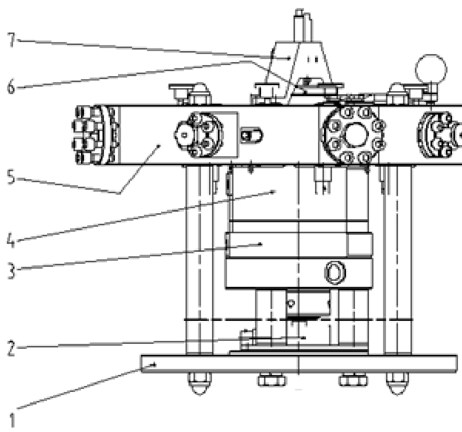
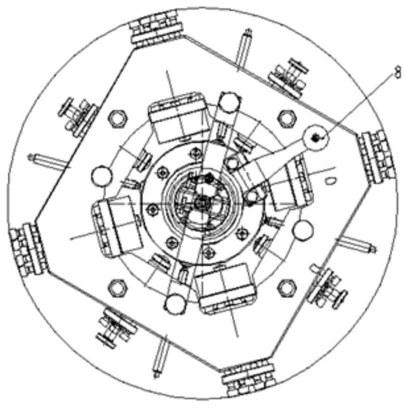


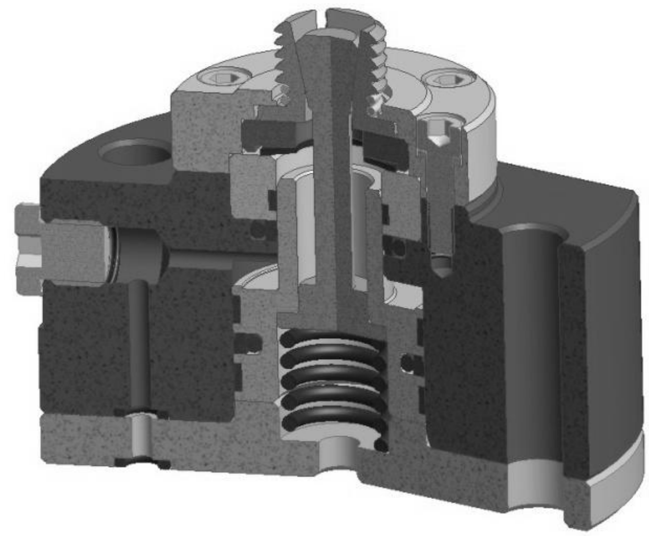
Fig. 2 – 3D stand equipped to evaluate of the strokes and the forces gripping.



a



b



c

Fig. 3 – 2D Test Stand for Pull down clamping elements (Hanganu, 2012, p. 4-5); *a* – lateral view; *b* – upper view; *c* – the pull down clamping elements:

1 – Main body; 2 – Force transducer (for axial force evaluation, action or/and clamping force); 3 – Support alimentation – pressure circuit; 4 – Testing device; 5 – Motion transducers assembly (4 pieces, for radial/clamping stroke evaluation) – force transducers (4 pieces, for radial/clamping force evaluation); 6 – Force transducer (preliminary force evaluation); 7 – Displacement transducers assembly (1 piece for action stroke evaluation, 1 piece for preliminary and clamping stroke evaluation); 8 – Adapters with radial plungers.

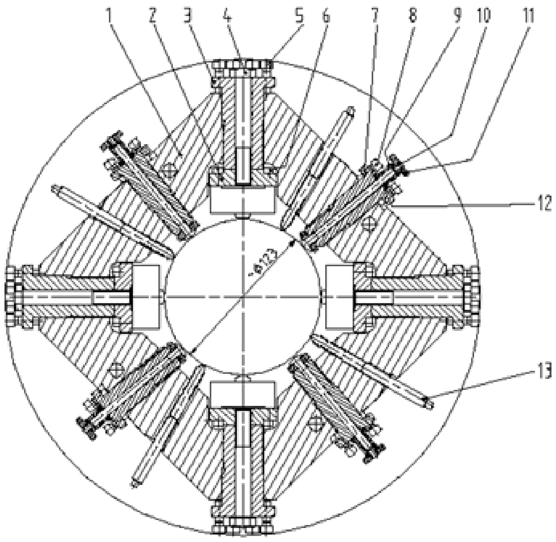


Fig. 4 – Test Stand for Pull down clamping elements (section) (Hanganu, 2012, p. 6):

1 – Transducer support for displacement and force; 2 – Force transducer (for radial/clamping force evaluation); 3 – Force transducer support; 4 – Clamping screw for force transducer assembly; 5 – Screw for force transducer pre-charging; 6 – Clamping screw for force transducer; 7 – Position system for displacement transducer; 8 – Special nut; 9 – collar bush; 10 – Plunger with spherical head; 11 – Bush; 12 – Elastic washer; 13 – Displacement transducer.

4. First Experimental Evaluations

One use an 700 bar electrohydraulic power unit with 0.5 L/min. flow. For data acquisition oe use the following devices and software:

– Notebook Dell Precision M4300/2.0 GHz DualCore/HDD 500 GB/2 Gb Video, Windows XP SP3;

– Data acquisition board NI DAQCARD-6036E PCMCIA, block connector NI BNC- 2110, cable NI SHC68-68-EPM;

– Force transducer K-K12/N250 50 kN, 0.1% acc., output 12±8 mA, unified signal adaptor E-LCV 14;

– Piezoelectric force transducer PCB 201A76 Piezotronics: measuring range: (compression) 5000 lb (22.24 kN), precision (±0.15%);

– Force transducer L 305 - 20 K OMEGA (4 pcs.) measuring rate: (compression) 20000 lb (88.96 kN), precision (±0.5%);

– Pressure transducer Applisens AP-2000, 0-500 bar, antiex, LCD, 0.075% acc., output 4÷20 mA;

– Temperature transducer, code DTM-F5-80-P-B1 A40-S;

– Flow rate transducer RH-1240, flow 1-26 L/min 2.5% acc., output 4÷20 mA, p_{max}. 100 bar, G ½;

– Desktop Fujitsu Siemens 2.5 GHz DualCore/HDD 500 GB/2 Gb Video, Windows XP SP3;

– Displacement transducer DK802R SONY: measuring range: 0÷2 mm, precision ±0.5μm;

– Displacement transducer DK812R5 SONY (5 pcs.) measuring range: 0÷12 mm, precision ±0.8μm;

– Panel with 4 digital instruments for signal conversion from mV/V in 0÷10 V, with display;

– Data acquisition board NI 6624 PCI, block connector NI SCB-100, cable NI SH100-100-F;

– Software LabView Full Development v.8.5.1.

In the Figs. 5, 7, 8, 11, 13 and 14: Generate and Display Block Diagram in LabVIEW v.8.5.1 (LabVIEW, 2010).

In the Figs. 6, 9, 10, 12, 15 and 16: Generate and Display Front Panel in LabVIEW v.8.5.1.

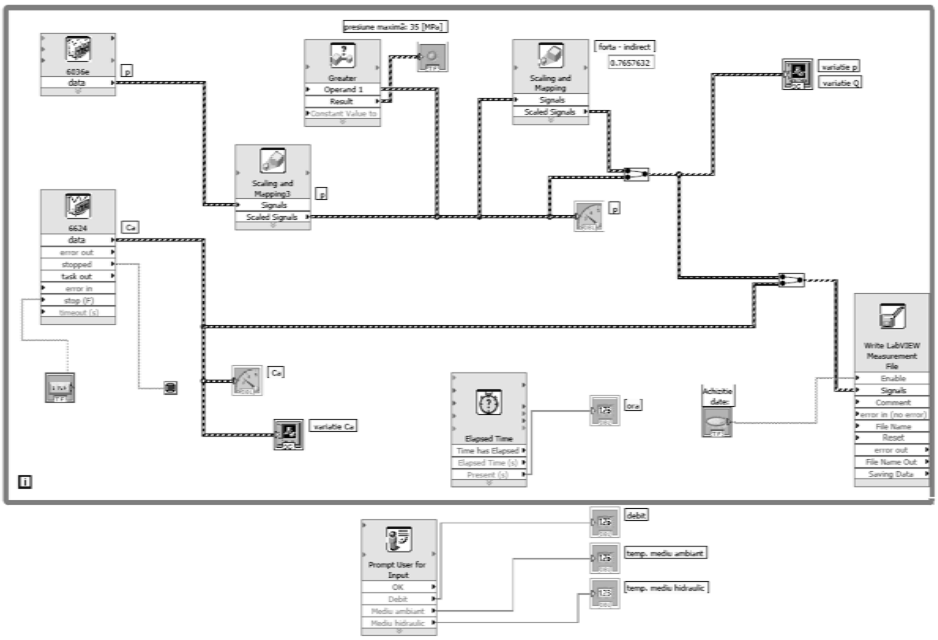


Fig. 5 – Evaluation of the stroke operation - Generate and Display Block Diagram in LabVIEW v.8.5.1.

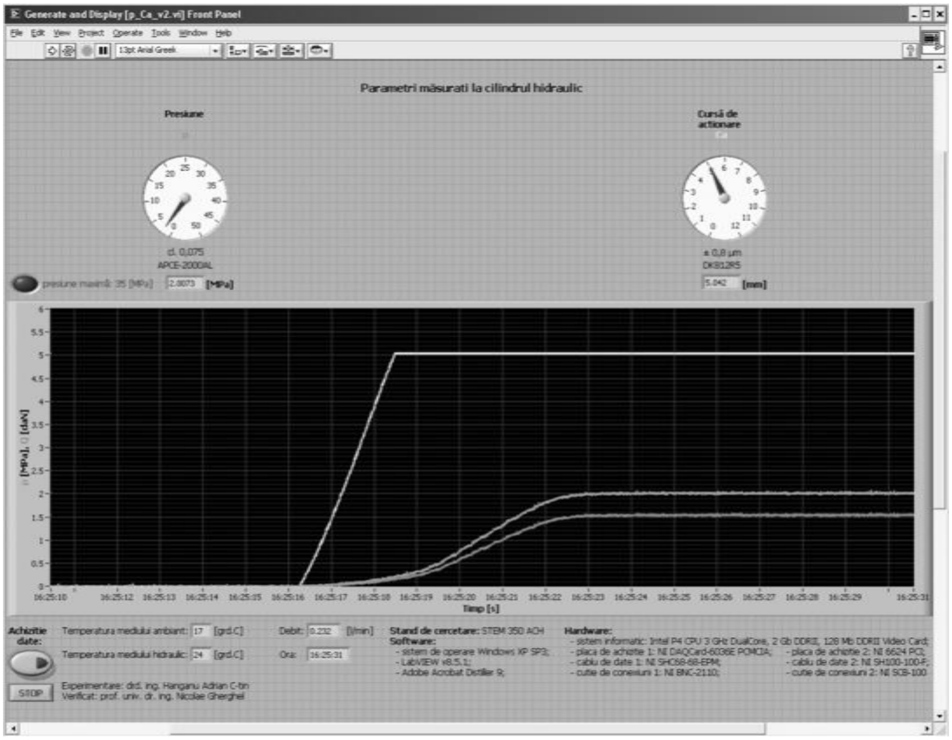


Fig. 6 – Evaluation of the stroke operation - Generate and Display Front Panel in LabVIEW v.8.5.1.

In Fig. 6 the diagrams contains the characteristics curves for the action stroke, pressure and action force, as evolution in time. The maximum action stroke value (5.042 mm) is obtained at minimum pressure values (0.27 MPa) and action force (0.15 daN). After 4 sec, the preliminary force/ pre-clamping reach the value of 1.5 daN for the pressure value of 2.007 MPa (as a function of functional parameters of hydraulic power unit). Fig. 7 present the friction force assessment.

Data acquisition board NI 6624 PCI, block connector NI SCB-100, cable NI SH100-100-F is used for acquisition of data taken by the SONY displacement transducers.

Data acquisition board NI DAQCARD-6036E PCMCIA, block connector NI BNC-2110, cable NI SHC68-68-EPM and panel with 4 digital instruments for signal conversion from mV/V in 0 ÷ 10 V with display are used for acquisition of data taken by all force transducers.

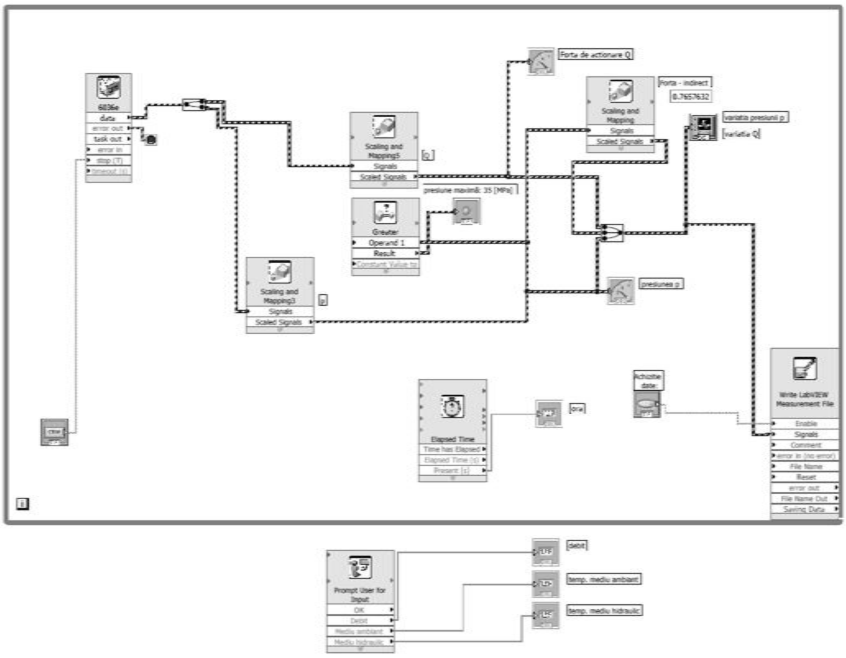


Fig. 7 – Assessment of the friction forces - Generate and Display Block Diagram in LabVIEW v.8.5.1.

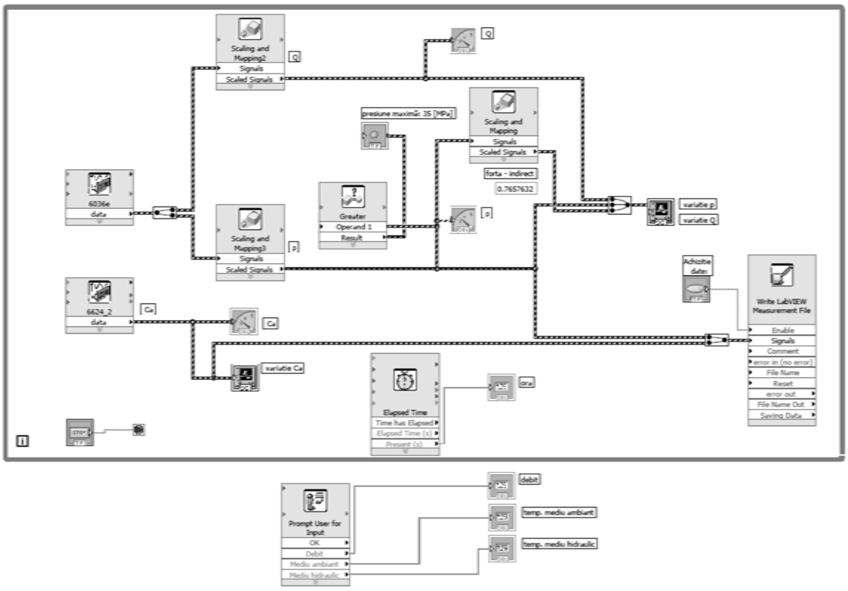


Fig. 8 – Evaluation of the strokes and the forces operation - Generate and Display Block Diagram in LabVIEW v.8.5.1.

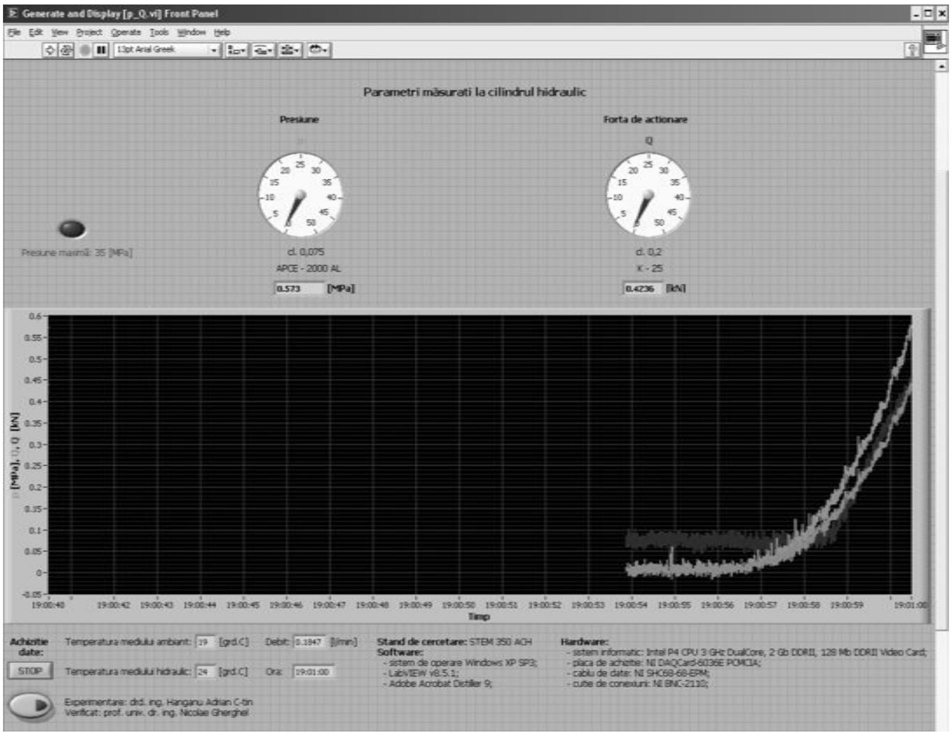
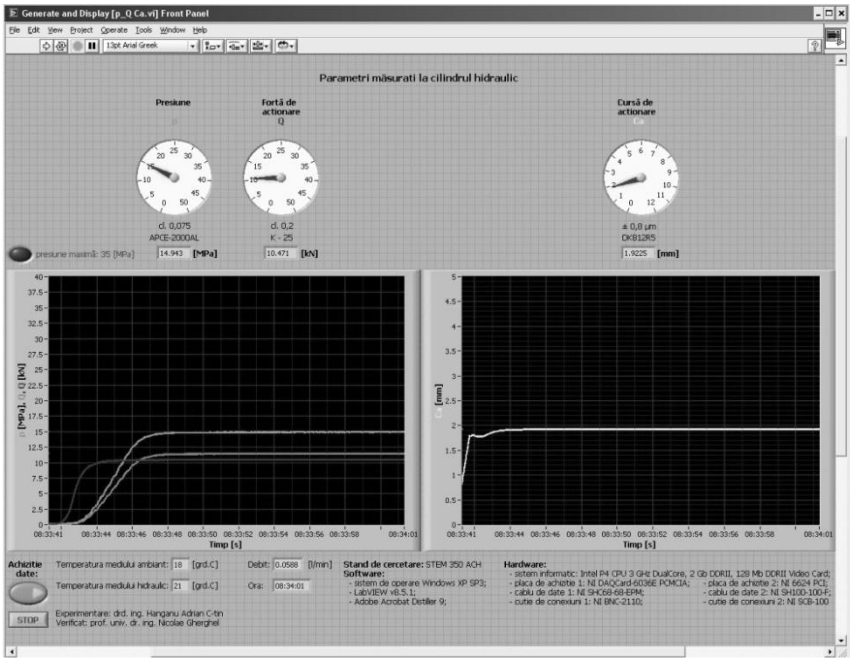


Fig. 9 – Assessment of the friction forces - Generate and Display
Front Panel in LabVIEW v.8.5.1.

In Fig. 9 are represented the characteristics curve for pressure, action force (values based on a signal obtained from the axial force transducer) and the integrated action force (values obtained from the pressure transducer) as a function of time. The values of the friction force from the hydraulic cylinder are obtained as a difference between the characteristic curves of the action force values given by the transducers (direct and indirect measuring) and it is approximate 1.5 daN. From the diagram one can observe an inflection point for both characteristics curves which is due to pre-charging of a return spring, component of the given device.

In Fig. 10 one have two cases, corresponding to the limitation of the maximum pressure from the hydraulic power unit, at a value of 15 MPa and 32.5 MPa, respectively. In the left diagram one have the characteristics action diagram with signal given by the axial force transducer and integrated action force with signal given by the pressure transducer, as a function of time. In right diagrams are given the characteristics curves for clamping stroke, as function of time. One observe that the shape of these diagrams are similar, regardless of the maximum working pressure.



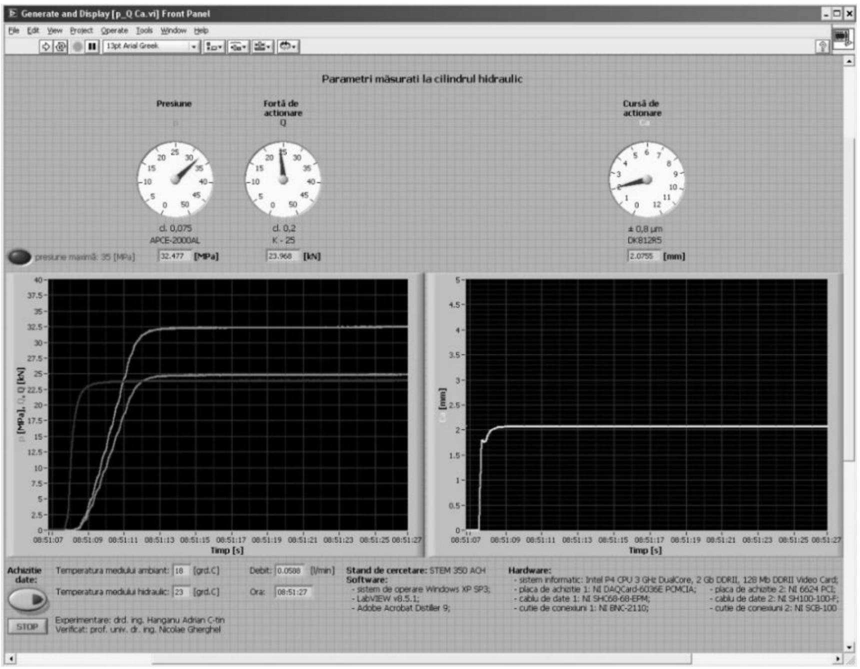


Fig. 10 – Evaluation of the strokes and the forces operation
(15 MPa and 32.5 MPa) - Generate and Display Front Panel in LabVIEW v.8.5.1.

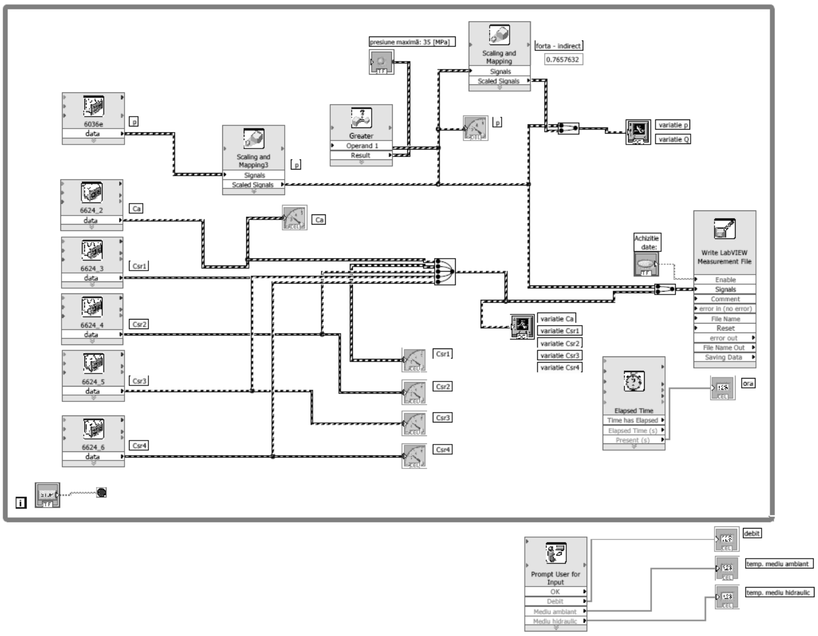


Fig. 11 – Evaluation of the strokes gripping - Generate and Display Block Diagram in LabVIEW v.8.5.1.

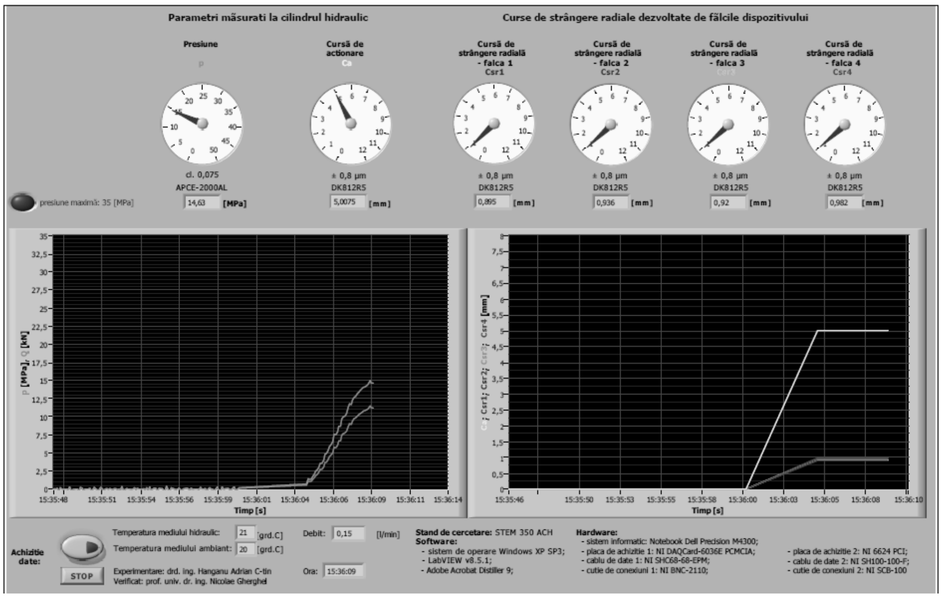


Fig. 12 – Evaluation of the strokes gripping - Generate and Display Front Panel in LabVIEW v.8.5.1.

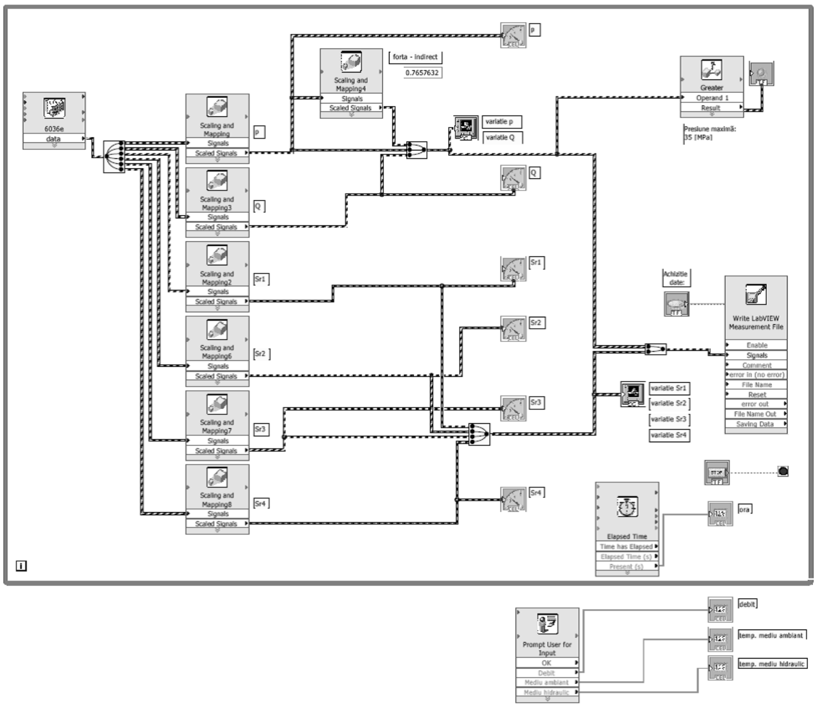


Fig. 13 – Evaluation of the forces gripping - Generate and Display Block Diagram.

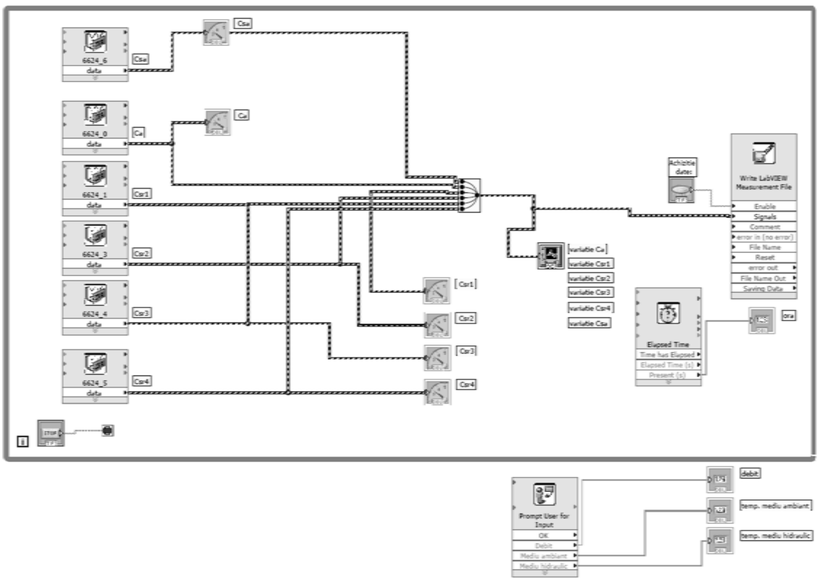


Fig. 14 – The study of device behavior - Generate and Display Block Diagram.

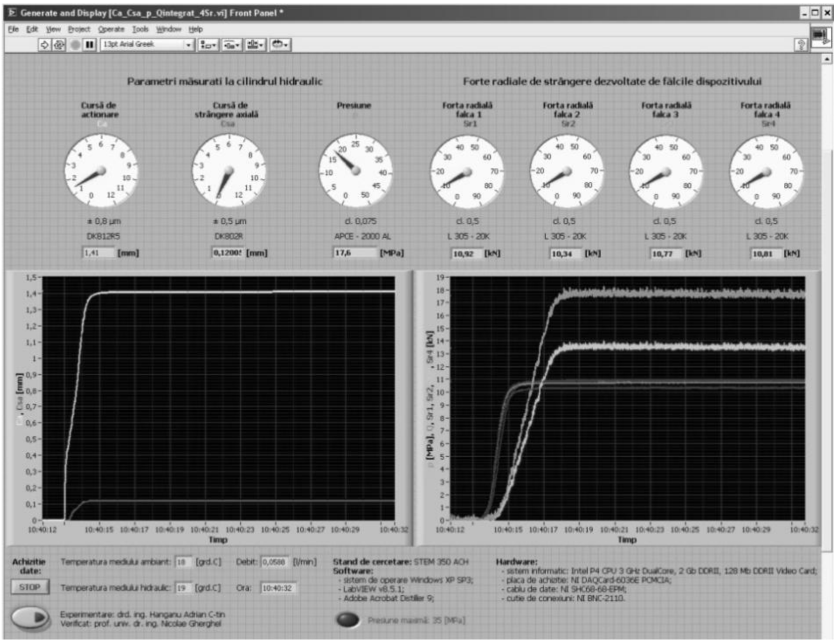


Fig. 15 – Evaluation of the forces gripping - Generate and Display Front Panel.

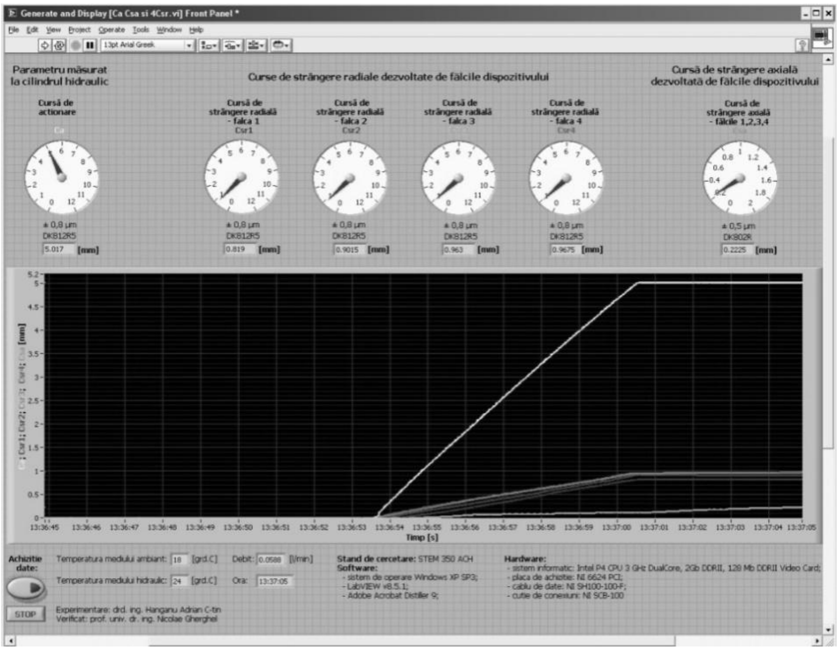


Fig. 16 – The study of device behavior - Generate and Display Front Panel.

Left diagram from Fig. 12, indicate the characteristics curves for pressure and clamping force with signal obtained from the axial force transducer, as a function of time. Right diagram, also from Fig. 12, indicate the characteristics curves for the axial action stroke and radial clamping stroke with signal given by the displacement transducers, as a function of time.

In left diagrams from Fig. 15, one show the characteristics curves for action stroke and axial clamping stroke, as a function of time. In right diagram from Fig. 15, one obtain the characteristics curves for pressure and radial clamping forces, as a function of time.

In diagram from Fig. 16 one have the characteristics curves for the action stroke, radial clamping stroke and axial clamping stroke, as a function of time, with signal obtained from the displacement transducer. One can observe that the clamping of the workpiece is obtained in two distinct stages: first stage one make a simultaneous radial and preliminary axial clamping; second stage an increase of the axial clamping force until a stable value.

5. Conclusions

The precision of the transducers allows the evaluation of the parameters to be researched. The first experimental evaluations are conclusive.

Future research directions are the assessment of influence parameters: the material quality of the piece, hardness of parts, pressure, viscosity, temperature etc.

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*** *Hydraulic Clamping Systems*, Quiri Hydomecanique, Molsheim, France, 2-65 (2012).

*** *LabVIEW v.8.5.1*, 2010, http://www.ni.com

*** *Workholding*, E215e, Actuant Enerpac, Owatonna, Wisconsin, USA, 8-93 (2014).

STAND DE TESTARE PENTRU DISPOZITIVE CU ACȚIONARE HIDRAULICĂ

(Rezumat)

Articolul se referă la un stand pentru încercarea statică și dinamică, multiparametrică, hidraulică și mecanică, multicomponentă, a cilindrilor hidraulici din componența dispozitivelor tehnologice modulare de strângere, destinați proceselor de prelucrare sau montare.